



# **Accessibility Reaching Everywhere**

## **Conference Proceedings**

### **2nd International AEGIS Conference and Final Workshop**

**28 - 29 - 30 November 2011  
Diamant Conference Centre,  
Brussels, Belgium**

**[www.aegis-conference.eu](http://www.aegis-conference.eu)**

**AEGIS  
Open Accessibility Everywhere:  
Groundwork, Infrastructure,  
Standards  
FP7 - 224348**

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## The AEGIS Project

The big AEGIS innovation lies in the fact that, while there have been limited and rather isolated attempts at addressing a few specific pieces of this ICT development process, never has such a comprehensive and holistic approach been taken, and never on so large a scale (encompassing rich Internet applications and mobile devices, in addition to the desktop).

The fundamental scientific objectives of the AEGIS Open Accessibility Framework are:

- to demonstrate and prove that use of 3rd generation access techniques results in equal or better end-user access experiences as compared to the existing, 2nd generation approaches;
- to identify and develop the right combination of developer's tools aiding in creating accessible applications with leverage sets of pre-built and accessibility enabled user interface components for desktop, mobile, and rich Internet applications; which together allow developers to comfortably and easily create accessible applications;
- to develop a set of embeddable assistive technologies for mobile devices that fit into this framework and deliver a satisfying experience to people with disabilities;
- to develop a set of user agents for desktop and mobile devices which leverage and translate a cross-platform accessibility API from the 3rd generation access techniques of the web, to the desktop and mobile accessibility APIs – in such a fashion as to give users with disabilities the same accessibility with rich Internet applications as they have with accessible desktop applications.

In addition to this overarching framework approach to providing generalised access to mainstream ICT, AEGIS also addresses two of the key purposes for which people use ICT – for creating accessible documents and information, and for communicating with other people in an accessible manner.

The final, core objective of AEGIS is to address the major economic barriers to e-Inclusion. The project takes the traditional approach of involving key industrial partners in the consortium, and then goes a step further by developing all of infrastructure, developer's tools, our prototypes assistive technologies – the vast majority of code in this project – under an open source software license.



## Executive summary

The AEGIS project organised its final Workshop and 2nd International Conference entitled "Accessibility Reaching Everywhere" on 28-30 November 2011 in Brussels, bringing together both end-users (people with disabilities) as well as platform and application accessibility developers, representative organisations, the Assistive Technology industry, and policy makers. This 3-days event came ahead of the European Day of People with Disabilities that was marked by the European Commission via a policy conference (1-2 December 2011), in close cooperation with the European Disability Forum (EDF).

The workshop on 28 November focused on the realisations of the AEGIS (Open Accessibility Everywhere: Groundwork, Infrastructure, Standards) project and provided attendees the opportunity to try out all outcomes of the project. The demonstrated products offer barrier-free access to desktop, mobile and web applications, are open source based and freely available.

The conference on 29-30 November gathered a wide array of experts, end-users and their representative organisations, designers and developers, as well as gatekeepers (service providers) and local, national and European policy makers from 28 countries to discuss scientific and policy developments in accessible technology; showcase relevant projects and initiatives in the area of assistive technology.

The event was free of charge and took place at the Diamant Conference and Business Centre, Boulevard A. Reyerslaan 80, 1030 Brussels.

The event has been an outstanding platform for the AEGIS project to present not only the AEGIS work, but also many relevant initiatives from across the world that relate to ICT AT (Assistive Technologies). In total 47 presentations (44 papers), spread over eight sessions, were presented to the participants. These proceedings bring together all accepted, reviewed and presented papers at the Conference in the different sessions over the two days.

The proceedings start with the opening address by Helga Stevens, Senator and Flemish Member of Parliament, who provides an "embedded" view on the impact ICT AT can have on the life of people with disabilities.

All papers presentations have been uploaded in PDF format to the conference website [www.aegis-conference.eu](http://www.aegis-conference.eu) so that the reader can combine this with the papers enclosed in these proceedings. The same page also provides the Workshop presentations.

Finally, we would also like to highlight the videos that were recorded during and shortly after the events. These can be viewed via [www.youtube.com/user/AccessForAlleu](http://www.youtube.com/user/AccessForAlleu).

The proceedings conclude with a snapshot of the many pictures that were taken at the three event days and a list of the attendees. A full "photographic" coverage is available on the public AEGIS Facebook page ([www.facebook.com/Aegis.Accessible](http://www.facebook.com/Aegis.Accessible)), which we highly recommend to "like" and join.

We would like to thank the entire AEGIS project management team for their support in making this a successful 3-days event, and in particular also to the EPR team for the successful organisation.

Also available via the conference website [www.aegis-conference.eu](http://www.aegis-conference.eu)



## 2nd International AEGIS Conference and Final Workshop - The Events

The **AEGIS Final Workshop (28 November 2011)** presented the finalised outcomes from the Open Source AEGIS mobile, desktop and internet applications to end-users and experts in the field of assistive technologies.

The **AEGIS Second International Conference (29 -30 November 2011)** gathered a wide array of experts and users in the area of Assistive Technology to discuss scientific and policy developments in accessible technology, and showcase relevant projects and initiatives in the area of assistive technology. The working language of the conference was English, and interpretation to and from Dutch and French was provided during the plenary session on Tuesday 29 November.

The Conference was organised by the AEGIS IP initiative (Open Accessibility Everywhere: Groundwork, Infrastructure, Standards) with the support of EPR, the European Platform for Rehabilitation. AEGIS is partially funded under FP7 (Theme: ICT-2007.7.1 ; ICT & Ageing). For more details, visit [www.aegis-project.eu](http://www.aegis-project.eu).

### Conference exhibition

Exhibitors, both commercial and non-profit, showcased a wide variety of products and research during the Conference with dedicated stands.

Following external exhibitors participated: BAUM Retec AG, HaptiMap, Nottingham Trent University, Plextalk Europe and Sclera NPO.

Also the AEGIS project had dedicated stands to present its results.

### Posters Exhibition

AEGIS organised a poster session where accessibility related initiatives were offered the opportunity to present aims and objectives. An Award was given to the best poster in the spirit of AEGIS.

### Conference Awards

The AEGIS conference concluded with an Awarding Ceremony to distinguish outstanding participation in the following categories:

- Best accessibility project in the spirit of AEGIS, awarded to Edwige Pissaloux for "Vision For Assistive Technologies".
- Best AEGIS Conference paper in the spirit of AEGIS, awarded to Shadi Abou-Zahra for his paper "Web Accessibility Guidance, Evaluation Methodologies, and Research Explorations".
- Best AEGIS Conference poster in the spirit of AEGIS, awarded to Guillermo Peris Fajarnes for the "EYES2021" paper.

### Social Media

During the three event days, social media was used extensively, so that those who could not attend were kept updated on the conference presentations and results. All presentations were shared in real time.

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Following social media tools were used:

- Tweetwall: [aegisconf.tweetwally.com/](http://aegisconf.tweetwally.com/). Tweets bearing the #aegisconf were aggregated on this Tweetwall throughout the events.
- Twitter: [twitter.com/aegisproj](http://twitter.com/aegisproj)
- Facebook: [tiny.cc/aegis](http://tiny.cc/aegis)
- SlideShare: [www.slideshare.net/aegisproject](http://www.slideshare.net/aegisproject)





## Speakers and workshop chairs (Alphabetical order)



**Jan Albers**, one of EPR's founding fathers, started off as director of communication at the SRH in Heidelberg, Germany before setting up the Vocational Rehabilitation Centre of the SRL (now Adelante) in Hoensbroek, the Netherlands. Now a retired CEO, he acts as a facilitator for various discussions and learning groups and provides expert input in the rehabilitation field, in EU-programmes and various other international activities.



**Jon Azpiroz** is responsible for several accessibility projects in the innovation area of Vodafone Spain Foundation since 2006. He is currently involved in the AEGIS, ACCESSIBLE and CLOUD4ALL projects, focusing on mobile accessibility and user experience. He is a member of the GT3 of the AENOR Spanish Standardization body, which is working on the standardization of mobile device accessibility guidelines.



**Maria Fernanda Cabrera Umpierrez** is a professor of Telecommunication and Biomedical Engineering at the Technical University of Madrid, and the Innovation Director of the Life Supporting Technologies (LifeSTech) research group. Maria coordinates the AEGIS project where, with LifeSTech, she contributes to the development of assistive software for mobile phones, personalising the applications and interfaces for users with cognitive, motor and speech disabilities as well as assessing user experiences.



**Jan Engelen** holds a PhD in Electronics Engineering and specialises in technological developments, both hardware and software, intended to help visually-impaired people. He is currently focusing on standardising efforts for both assistive technology developments and design for all solutions. With his Docarch group, he has contributed to the Open Source developments "odt2daisy" and "odt2braille" within the AEGIS framework.



**Maria Gemou** holds a degree in Mechanical Engineering and has been a Research Associate at the Hellenic Institute of Transport of CERTH since 2005. Her main fields of expertise include Information and Communication Technologies, Transport technologies for PSN, e-learning and eAccessibility. She is also involved in many research projects, including AEGIS as a subproject leader.





**Peter Korn** is Oracle's Accessibility Principal – their senior individual contributor on accessibility. He is also Technical Manager of the AEGIS project. He co-developed and co-implemented the Java Accessibility API, and developed the Java Access Bridge for Windows. He also helped design the open source GNOME Accessibility architecture



**Jose Angel Martinez Usero** is the Director of International Projects and Relations at Technosite (Fundación ONCE). Jose Angel Martinez has led many outstanding research projects and initiatives at national and European levels. He is currently one of the references in eAccessibility in Europe, and is either leading or participating in several high-level projects and studies in the fields of e-inclusion and e-accessibility.



**Jan Spooren** has been the Secretary General of the European Platform for Rehabilitation (EPR) for 10 years, and is an expert in the policy developments taking place within the disability and social services sector, both at European and international levels. As representative of civil society in the Disability High Level Group and several other standing committees, he is considered as a key player in the EU disability policy arena.



**Paul Timmers** is Director of the Directorate ICT addressing Societal Challenges in the European Commission, DG Information Society & Media. He holds a PhD in theoretical physics from the University of Nijmegen, the Netherlands and an MBA from Warwick Business School, UK. He is widely published in the field of technology and policy, and has been a visiting professor and lecturer at several universities and business schools across the world.



**Jutta Treviranus** is the Director of the Inclusive Design Research Centre (IDRC) and professor at OCAD University in Toronto. She has led many multi-partner research networks and pioneered personalization as an approach to accessibility. She has played a leading role in developing legislation, standards and specifications (including WAI ATAG, and IMS AccessForAll).





**Karel Van Isacker** is a consultant in the field of eInclusion and has managed numerous projects that support people with disabilities, as well as older people. His focus is on ensuring end-users' needs are included, whilst also piloting research outcomes. He is the AEGIS project manager for EPR, the European Platform for Rehabilitation.



**Gregg Vanderheiden** is a professor of Industrial and Biomedical Engineering, University of Wisconsin-Madison, Director of the Trace R&D Center, and co-founder of Raising the Floor - International. A pioneer in the field of Augmentative Communication, he has developed many accessibility features that are now built into every MacOS, OS/2, Linux and Windows systems.



**Konstantinos Votis** is a senior Research Associate at the Informatics and Telematics Institute/Centre for Research and Technology Hellas. He works on eAccessibility initiatives, and is also participating in European standardisation initiatives and working groups concerning accessibility. Since 2006, he has been involved in several R&D projects related to accessible and interoperable ICT technology.



**Jan Vystřcil** is a researcher and a lecturer at the CTU in Prague, Department of Computer Graphics and Interaction. He focuses on the development of the navigation system NaviTerier for visually impaired people and also other interaction with the impaired users. He works on developer support, creating accessible rich internet applications for AEGIS.



**Patrick Welche** is a researcher in David MacKay's Inference Group at the University of Cambridge. The group specialises in Bayesian inference, machine learning and information theory, developing computer software such as dasher, an information efficient text-entry programme.



## AEGIS Workshop - Workshop Programme (with links to presentations)

Time	Topic	Presenter(s)
9.00-9.30	Registration	EPR
9.30-9.45	Welcome	Jan Spooren – EPR
9.45-10.00	<a href="#">AEGIS concept &amp; realisations</a>	Maria Fernanda Cabrera Umpierrez – UPM
10.00-10.30	<a href="#">The AEGIS story: building an accessible application</a>	Peter Korn – ORACLE
10.30-11.00	Coffee break	
11.00-12.00	Round-table discussion	
	<ul style="list-style-type: none"> <li>• Users – David Zanoletty (FONCE) / Karel Van Isacker (EPR)</li> <li>• Experts – Martinez Usero Jose Angel (TECHNOSITE) / Brown David (NTU)</li> <li>• Key developers – Welche Patrick (UCAM) / Vystrčil Jan (CVUT) / Lundälv Mats (SU-DART) / Strobbe Christophe (KUL)</li> <li>• Industry – Azpiroz Jon (FVE)</li> </ul>	
	Chair: Peter Korn – ORACLE	
12.00-13.00	<a href="#">Rich internet applications (demos) with discussion</a>	chair: Dimitrios Tzouvaras, CERTH-ITI
	<ul style="list-style-type: none"> <li>• Haptic RIA maps (Dimitrios Tzouvaras, CERTH-ITI)</li> <li>• MooTools UI components (Jan Richards, IDRC)</li> <li>• Accessible jQueryUI Components (Jan Richards, IDRC)</li> <li>• WAIARIA implementation on UI toolkits (Jan Richards, IDRC)</li> <li>• CMS demonstrator (Dimitrios Tzouvaras, CERTH-ITI)</li> <li>• <a href="#">Accessibility Advisor</a> (Jan Vystrcil, CVUT)</li> <li>• <a href="#">NetBeans Plugin</a> (Jan Vystrcil, CVUT)</li> </ul>	
13.00-14.00	Lunch	
14.00-15.15	<a href="#">Mobile applications (demos) with discussion</a>	chair: VFE (Jon Azpiroz)
	<ul style="list-style-type: none"> <li>• Dasher for Android (Patrick Welche, UCAM)</li> <li>• Dasher for iPhone (Patrick Welche, UCAM)</li> <li>• Accessible Contact Manager and Phone Dialer, Java version (Maria Fernanda Cabrera Umpierrez, UPM, Jon Azpiroz ,VFE)</li> <li>• <a href="#">Accessible Contact Manager and Phone Dialer, Android version</a> (Adrián Rodríguez , UPM, Jon Azpiroz ,VFE)</li> <li>• Accessible RTT for mobile (Maria Fernanda Cabrera Umpierrez, UPM, VFE)</li> <li>• Tecla Onscreen Keyboard (and optionally Tecla Bluetooth Shield) (Jan</li> </ul>	



Time	Topic	Presenter(s)
	Richards, OCAD) <ul style="list-style-type: none"> <li>• <a href="#">CCF for Android</a> (Mats Lundälv, SU-DART)</li> </ul>	
15.15-15.45	Coffee break	
15.45-17.00	<a href="#">Desktop applications (demos) with discussion</a>	chair: KUL (Prof. Jan Engelen)
	<ul style="list-style-type: none"> <li>• GnomeShell Magnifier (Jan Richards, OCAD)</li> <li>• <a href="#">Concept Coding Framework for LibreOffice</a> (Mats Lundälv, SU-DART)</li> <li>• <a href="#">Odt2braille</a> (Christophe Strobbe, KULeuven)</li> <li>• Odt2daisy (Christophe Strobbe, KULeuven)</li> <li>• Accessibility Checker for LibreOffice (Christophe Strobbe, KULeuven)</li> <li>• <a href="#">eSpeak TTS Engine</a> (Language Enhancement) (Jerry Dimitriou, SILO)</li> <li>• OpenGazer (Patrick Welche, UCAM)</li> </ul>	
17.00-17.15	End of workshop	



## Conference Programme: Day 1 Morning (with links to presentations)

Time	Topic	Presenter(s)
08.30-09.30	Registration	
09.30-09.45	Welcome	Jan Spooren – EPR
09.45-10.15	<a href="#">AEGIS concept and realisations</a>	Maria Fernanda Cabrera Umpierrez – UPM
10.15 – 11.00	Personalities' address	
	Mr. Paul Timmers, EC	
	Ms. Helga Stevens, Belgian MP	
11.00-12.00	Opening exhibition by Personalities + coffee	
12.00-13.00	Round-table with stakeholders	
	Karel Van Isacker (Chair)	
	<ul style="list-style-type: none"> <li>• Peter Korn – ORACLE (Technical)</li> <li>• Gregory Smiley – NOKIA (Industry)</li> <li>• Jon Azpiroz – VFE (Industry)</li> <li>• Wim Moeyaert – Werkgroep Vorming en Aktie (end-users)</li> <li>• Clayton H Lewis – Coleman Institute for Cognitive Disabilities (Research)</li> <li>• Gregg Vanderheiden – NPII/Cloud4ALL (Research)</li> </ul>	
13.00-14.00	Lunch (+ Exhibition)	



## Conference Programme: Day 1 Afternoon - Parallel Sessions 1 & 2 (with links to presentations)

Time	Topic	Presenter(s)
14.00-16.00	Parallel sessions 1 & 2	
	<p><b>Session 1: Mobile applications – Jon Azpiroz – FVE (Chair)</b></p> <ul style="list-style-type: none"> <li>• Ann Decorte: <a href="#">Blueassist And Bluecall Phone: Social Innovation And Care Reform Realized Through Assistive Technology</a>; Ann Decorte, Liesbet Billiet, Johan Calu, Marieke De Smet, Geert Vandewalle</li> <li>• Jan Richards: <a href="#">Tecla Access A Mobile On-Screen Scanning Keyboard For Android</a>; Jorge Silva, Jan Richards</li> <li>• Jon Azpiroz: <a href="#">Enhancing Text Conversations With Real-Time Text Technology</a>; Jon Azpiroz, Elisa Martín-Caro, Maria Fernanda Cabrera, Silvia De Los Ríos</li> <li>• Lisa Åström: <a href="#">Deploying Mobile Total Conversation For Person-To-Person Communication, Emergency Service And Relay Service Access</a>; Erik Zetterström</li> <li>• Helena Mitchell, Ph.D: <a href="#">Planning For Accessible Emergency Communications: Mobile Technology And Social Media</a>; Helena Mitchell, Phd, Deedee Bennett, Salimah Laforce</li> <li>• Peter Korn: <a href="#">Light Weight Ui Toolkit</a>; Peter Korn</li> <li>• Miguel Páramo: <a href="#">Developer Tool For Creating Accessible GUIs In Android Mobile Os</a>; Miguel Páramo, Juan Bautista Montalvá Colomer, María Fernanda Cabrera-Umpiérrez, María Teresa Arredondo Waldmeyer</li> </ul>	
	<p><b>Session 2: ACCESSIBLE Workshop – Kostas Votis – CERTH-ITI (Chair)</b></p> <ul style="list-style-type: none"> <li>• Jan Vystrcil: <a href="#">Accessibility Issues Simulation For Mobile Applications</a>; Jan Vystrcil, Zdenek Mikovec, Marek Fronc, Jiri Drbalek</li> <li>• Shadi Abou-Zahra: <a href="#">Web Accessibility Guidance, Evaluation Methodologies, and Research Explorations</a>; Shadi Abou-Zahra</li> <li>• ACCESSIBLE Project will demonstrate its various accessibility assessment tools for mobile, web and desktop. <ul style="list-style-type: none"> <li>○ Disability Impairment Approximation Simulator – DIAS</li> <li>○ Web accessibility assessment Tool – WaaT</li> <li>○ Web Service accessibility assessment Tool – WebSaaT</li> <li>○ Mobile Web accessibility assessment Tool – MobileWaaT</li> <li>○ Description Language accessibility assessment Tool – DLaaT</li> <li>○ Mobile Impairment Simulation Tool – MIS tool</li> <li>○ Development and Evaluation Web Portal</li> </ul> </li> </ul>	
16.00-16.30	Coffee break (+ Exhibition)	



## Conference Programme: Day 1 Afternoon - Parallel Sessions 3 & 4 (with links to presentations)

Time	Topic	Presenter(s)
16.30-18.30	Parallel sessions 3 & 4	
	<p><b>Session 3: International Research and initiatives – Jutta Treviranus – IDRC (Chair); Gregg Vanderheiden – NPII</b></p> <ul style="list-style-type: none"> <li>• Gregg Vanderheiden: <a href="#">Creating A Global Public Inclusive Infrastructure (Cloud4ALL &amp; GPII)</a>; Gregg Vanderheiden, Jutta Treviranus, Jose Angel Martinez</li> <li>• Jan Vystrcil: <a href="#">Developer’s Support For Creating Accessible Applications</a>; Jan Vystrcil, Zdenek Mikovec, Ondrej Havelka, Radek Bien, Pavel Slavik</li> <li>• Jean-Marie Vanhove: <a href="#">Universal Design Of Information And Communication Technology. A Dream?</a>; Vanhove, Jean-Marie</li> <li>• Christophe Strobbe: <a href="#">European Accessibility Requirements For ICT Procurement – The Status Of Mandate 376</a>; Christophe Strobbe (Presentation only)</li> <li>• Lindsay Evett: <a href="#">The ETNA Project: European Thematic Network On Assistive Information Technologies</a>; Lindsay Evett, David Brown, David Colven, Andrew Lysley, Renzo Andrich</li> <li>• Mark Van Assche: <a href="#">How Can Local Investment In Accessibility Be An Investment In The Future?</a>; Mark Van Assche</li> </ul>	
	<p><b>Session 4: ARIA and Developer needs and wants – Jan Vystrcil – CVUT (Chair) / – Kostas Votis – CERTH-ITI (Co-Chair)</b></p> <ul style="list-style-type: none"> <li>• Kostas Votis: <a href="#">Providing An IDE For Creating, Simulating And Assessing Accessible Applications</a>; Theofanis Oikonomou, Dionysia Kontotasiou And Dimitrios Tzovaras</li> <li>• Jan Vystrcil: <a href="#">How To Create Real Accessible Aria</a>; Jan Vystrcil, Zdenek Mikovec, Miroslav Karsulin, Karel Simek, Petr Spacek, Pavel Slavik</li> <li>• Jayant Mahajan: <a href="#">Attaining Accessible Web Presence – Our Experiences</a>; Dhananjaybhole, Shirang Sahasrabudhe, Vivek Gaikwad, Dr.Sanjeevsonavane</li> <li>• Eugene Loos: <a href="#">Gaining Access To Information At A Municipality Website A Question Of Age?</a>; Eugène Loos</li> <li>• Franck-Olivier Perrin: <a href="#">A Case Study In The Design Of Educational Widgets To Support The Concept Of An Adaptable Personal Learning Environment</a>; Voula Gkatzidou, Elaine Pearson</li> </ul>	
18.30-19.30	Cocktail (+Exhibition)	





## Conference Programme: Day 2 Morning - Parallel Sessions 5 & 6 (with links to presentations)

Time	Topic	Presenter(s)
08.30-09.00	Registration	
09.00-09.45	<a href="#">Key-note speech</a>	Jan Albers (former EPR president and CEO of Foundation Rehabilitation Limburg, NL)
09.45-10.15	Coffee break (+ Exhibition)	
10.15-12.15	Parallel sessions 5 & 6	
	<p><b>Session 5A: OSS and standardisation – Prof. Jan Engelen – KULeuven (chair)</b></p> <ul style="list-style-type: none"> <li>• Christoph Lange: <a href="#">A Meta Ontology Language To Be Standardised: OntoLogY Integration And Interoperability (OntoLOp)</a>; Christoph Lange, Till Mossakowski, Christian Galinski, Oliver Kutz</li> <li>• Miguel Sanchez: <a href="#">Influence Of WCAG Rules On Academic Websites Rankings: A Correlation Study Between Accessibility And Quantitative Webometrics</a>; Miguel Sanchez-Cerviño, Enrique Orduña-Malea</li> </ul>	
	<p><b>Session 5B: Accessible content – Prof. Jan Engelen – KULeuven (chair)</b></p> <ul style="list-style-type: none"> <li>• Christophe Strobbe: <a href="#">An Accessibility Checker For Openoffice.Org And Libreoffice Writer</a>; Christophe Strobbe, Bert Frees, Jan Engelen</li> <li>• Gregg Vanderheiden: <a href="#">Video Relay Service Practices And Policies Around The World</a>; Christian Vogler, Jeff Mcwhinney, Philip Harper, Antti Raike, Gunnar Hellström, Gregg Vanderheiden</li> <li>• Jan Rottier: <a href="#">ADIBIB – A Customized Digital Library For Students With Impairments In Written Communication</a>; Dirk Lembrechts, Jan Rottier</li> <li>• Martine Vallee: <a href="#">Accessibility To Broadcasting And Telecommunications: The Canadian Experience</a>; Martine Vallee</li> <li>• Jan Richards: <a href="#">Accessible Digital Office Document (ADOD) Project</a>; Jan Richards, Sabrina Ruplall, Jeroen Baldewijns</li> </ul>	
	<p><b>Session 6: Desktop applications – Patrick Welche – UCAM (chair)</b></p> <ul style="list-style-type: none"> <li>• Jayant Mahajan: <a href="#">Explore ORCA As A Possible Alternative To Commercial Screenreaders</a>; Jayant Mahajan, Shrirang Sahasrabudhe, Dhananjay Bhole</li> <li>• Leena Chourey: <a href="#">Enhancing Orca For Document Navigation For Visually Impaired</a>; Leena C, Bhat D, Aparna R, Sasikumar M</li> <li>• Mariolino De Cecco: <a href="#">A Joint Force-Position Measurement System For Accessibility Quantification</a>; M. Kirchner, M. Confalonieri, A. Paludet,</li> </ul>	

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Time	Topic	Presenter(s)
	<p>F. Degasperi, M. Da Lio, M. De Cecco</p> <ul style="list-style-type: none"><li>• Edwige Pissaloux: <a href="#">Vision For Assistive Technologies</a>; E. Pissaloux, A. Carbone, Ch. Veigl, Ch. Weiss</li><li>• Mats Lundälv: <a href="#">Graphic Symbol Support In Open/LibreOffice Shaping Up Graphic Symbol Server And Inline Symbol Font Display Based On The CCF</a>; Mats Lundälv, Sandra Derbring, Lars Nordberg, Annika Brännström, Bengt Farre</li></ul>	
12.15-13.30	Lunch (+ Exhibition)	



## Conference Programme: Day 2 Afternoon - Parallel Sessions 7 & 8 (with links to presentations)

Time	Topic	Presenter(s)
13.30-15.30	Parallel sessions 7 & 8	
	<p><b>Session 7: User needs and wants – Karel Van Isacker – EPR (Chair)</b></p> <ul style="list-style-type: none"> <li>• Karel Van Isacker: <a href="#">Inclusion Stops Where The Beneficiary Cannot Afford Or Understand ICT Based Solutions</a>; Karel Van Isacker, Anna Evangelinou, Eleni Strati, Mark Delmartino</li> <li>• Silvia Baldiris Navarro: <a href="#">Authoring Tools Features To Support E-Learning Resource Creation Fixed To Accessibility Guidelines: From A Critical View</a>; Ludy Gélvez, Juan Sáenz, Silvia Baldiris, Ramón Fabregat</li> <li>• Carla De Winter: <a href="#">Accessibility Review Of Open Educational Resources</a>; Carla De Winter</li> <li>• Christophe Strobbe: <a href="#">Accessible Course Materials For Students With Dyslexia</a>; Nadia Diraä, Bert Frees, Jan Engelen</li> <li>• Jo Daems: <a href="#">ICT-Inclusive, A Train-The-Trainer Package To Support Teaching ICT-Skills To Pupils With Intellectual Disabilities</a>; Jo Daems, Ellen Torfs, Ann Hannes, Joan De Boeck, Jan Dekelver</li> <li>• David Brown: <a href="#">Evaluation Of Haptic Ria Maps And Other Navigational Support Systems For People Who Are Blind</a>; David Brown, Lindsay Evett</li> </ul>	
	<p><b>Session 8: Accessibility overall – Maria Fernanda Cabrera Umpierrez – UPM (chair)</b></p> <ul style="list-style-type: none"> <li>• Abdul-Aziz Al-Mouhissen: Enabling The Disabled To Fly; Abdul-Aziz Al-Mouhissen (Presentation only)</li> <li>• Aglaia Katsigianni: <a href="#">Map Of The City Of Drama Greece: Aglaia Katsigianni</a> (Presentation only)</li> <li>• Giuliano Pirelli: <a href="#">Safe And Secure Trip To And Through The Ideal City For All New Technologies And Challenges For People With Disabilities</a>; Giuliano Pirelli, Carlo Eugeni</li> <li>• Juan Diego Gomez Valencia: <a href="#">3D Scene Accessibility For The Blind Via Auditory-Multitouch Interfaces</a>; Juan Diego Gomez, Sinan Mohammed, Guido Bologna, Thierry Pun</li> <li>• Guillermo Peris Fajarnés: <a href="#">Cognitive Navigation And Object Detection System For Blind People</a>; Larisa Dunai, Guillermo Peris-Fajarnés, Teresa Magal-Royo, Beatriz Defez</li> <li>• Umar Shoaib: <a href="#">Language Resources For Computer Assisted Translation From Italian To Italian Sign Language Of Deaf People</a>; Davide Barberis, Nicola Garazzino, Paolo Prinetto, Gabriele Tiotto, Alessandro Savino, Umar Shoaib, Nadeem Ahmad</li> </ul>	



Time	Topic	Presenter(s)
	<ul style="list-style-type: none"> <li>• Branislav Mamojka: <a href="#">Applications Of Optically Actuated Haptic Elements</a>; Branislav Mamojka, Peter Teplicky</li> <li>• Christian Radek: <a href="#">Digital Barriers: Set Up And Operation Of A National Helpdesk</a>; Christian Bühler, Christian Radek, Birgit Scheer, Wolfgang Tigges</li> </ul>	
15.30-16.00	Coffee break (+ Exhibition)	

### Conference Programme: Day 2 Afternoon - Concertation Event (with links to presentations)

Time	Topic	Presenter(s)
16.00-17.30	<p><a href="#">Concertation event</a> with FP7 or related projects on accessibility:</p> <ul style="list-style-type: none"> <li>• <a href="#">AsTeRICS</a></li> <li>• <a href="#">GUIDE</a></li> <li>• <a href="#">HaptiMap</a></li> <li>• MyUI</li> <li>• <a href="#">VICON</a></li> <li>• <a href="#">eAccess+</a></li> <li>• <a href="#">ETNA</a></li> <li>• <a href="#">ATIS4all</a></li> <li>• <a href="#">ACCESSIBLE</a></li> <li>• <a href="#">CARDIAC</a></li> <li>• <a href="#">VERITAS</a></li> <li>• <a href="#">Cloud4All</a></li> <li>• <a href="#">WAI-ACT.</a></li> </ul>	<p>Jose Angel Martinez Usero – FONCE (chair)</p> <p>Maria Fernanda Cabrera Umpierrez – UPM (chair)</p> <p>Karel Van Isacker – EPR (chair)</p>
17.30-18.00	<p>Wrap-up of conference</p> <p><a href="#">Towards the future</a></p> <p>Award ceremony for:</p> <ul style="list-style-type: none"> <li>• Best presentation in the spirit of AEGIS</li> <li>• Best paper in the spirit of AEGIS</li> <li>• Best poster in the spirit of AEGIS</li> </ul>	Peter Korn – ORACLE
18.00	End of conference	



## Opening address by Helga Stevens, Senator and Flemish MP

AEGIS International Conference – Brussels – 29 Nov 2011

Dear Ladies and Gentlemen,

First of all I would like to thank Mr Jan Spooren of the European Platform for Rehabilitation for inviting me to open this important conference. I am very honoured by this.

“Accessibility Reaching Everywhere” is the theme of this international conference. It is an important theme and it concerns everyone, but in particular disabled people who are often confronted with numerous barriers. Notwithstanding great advances in technology and ICT, barriers have not yet been taken down fully. It is important that inventors and developers of new technologies bear this in mind and do everything possible to make technology and ICT as inclusive as possible. Only then we can achieve a barrier-free world, a world that is truly inclusive.

In this context I would like to applaud the efforts of the AEGIS consortium which since 2008 has been developing an Open Accessibility Framework – comprising open accessibility interfaces, user interface components, developer tools, end-user applications and prototype accessibility solutions for desktops, rich Internet applications and mobile devices. I hope all this long and hard work has led to great results. I am not a nerd or a technology freak, but I do know that technology can make a great difference in the lives of people. Of utmost importance is that technology is kept “simple”, however complex it may be underneath. By simple I mean that you don’t have to read a thick book to be able to use e.g. a mobile phone or a smart phone.

Of course, it is a challenge to make technology accessible to everyone. I am grateful that organisations, companies and universities have joined forces together such as the AEGIS consortium to make this possible. I do firmly believe that we always have to try to make sure that state of the art technology is also accessible for disabled people so that they can also make full use of new technological advances. I would also like to take the opportunity to thank the European Commission, DG Information Society for their important financial contribution to this project.

This consortium is a good example of what social profit organisations, universities, businesses and governments can achieve together. Together we are all working towards the goal of an inclusive, accessible and open society. The road is still long and often bumpy, but the only way to get there is through cooperation and determination.

ICT is a powerful tool, we could see that in the Middle East where new technology and the new social media have helped to overthrow authoritarian regimes. We cannot afford that disabled people are left out of the ICT world. For deaf people for example the webcam feature has made communication more easy. Another interesting application of new technology is video sign language interpreting enabling sign language interpreters to take



short interpreting assignments at a distance from a call centre, thus increasing efficiency and lowering costs.

I am looking forward to receiving the results of this AEGIS consortium and I do sincerely hope that this will inspire the Belgian government and other governments to take follow-up action where necessary. I am sure that the European Commission will monitor the results of this research project and take forward issues which need further action, regulatory or otherwise.

You can count on me to keep accessibility issues high on the national/Belgian and Flemish agenda. I know all too well that this is not a sexy theme, but it does matter for a lot of people. Disabled people are too often confronted with inaccessible technology which means that they are excluded. People often think that inclusive technology is expensive. That is sometimes true. But it also costs money to exclude people on the basis of disability. Exclusion is also expensive in an indirect way. Because excluded people cannot contribute to society, they cannot 'give back' to society. Therefore we are obliged to those people to do everything possible so that they are a full and equal part of our information society. Knowledge and information is power and that is also true for disabled people.

I still remember when I got my first mobile phone, that was in 1996 or 1997 and it is amazing to see how many different smart phones there are now at the moment. And how cheap some have become. I am looking forward to what the future will bring and I am sure you will be part of it!

**Helga Stevens, Senator and Flemish MP**



## 1. Session 1: Mobile applications

This session focused on the many mobile applications that have been developed with a focus on accessibility. Starting from a very practical application through the Blueassist and the Bluecall phone, the session, explored the more assistive support that can be provided for an optimal mobile usage via the Tecla and Real-Time Text solutions. The session also highlighted the role a mobile device can have during emergencies. It was finalised by addressing the developers tools behind the accessible applications, both for Java and for Android based devices.

### 1.1. Blueassist And Bluecall Phone: Social Innovation And Care Reform Realized Through Assistive Technology

**Ann Decorte<sup>1\*</sup>, Liesbet Billiet<sup>2</sup>, Johan Calu<sup>3</sup>, Marieke De Smet<sup>4</sup>, Geert Vandewalle<sup>1</sup>.**

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#### Abstract

**BlueAssist dare to connect**, is an icon that builds bridges between people and gives them more confidence in asking people for support and giving support. With this BlueAssist, the user can request help from a co-citizen. Many BlueAssist-instruments can be developed. Nowadays it is available on BlueAssist-cards, in BlueCall Phone and as an app for smartphones.

**BlueCall Phone** is a very user-friendly software for a smartphone with four functions to support daily life: a simplified telephone function, a calendar with sound signals and pictures, a simple photo album to share experiences and to enable telling conversations to others and a BlueAssist-function. BlueCall Phone meets the principles of universal design and is adaptable to the needs and ability of the user.

#### Keywords

Accessibility of communication, autonomy, design for all, inclusion, social capital

#### Introduction

The idea of BlueAssist and BlueCall Phone is developed bij NPO Ithaka, state-aided as a day-care centre for adults with intellectual disabilities. Over the years Ithaka has experienced that excessive professionalism and heartfelt care lead too much towards learned helplessness [1]. Care reform was necessary and Ithaka made a paradigm shift from care-orientation towards support-orientation [2]. Ithaka evolved from a day-care centre towards a coaching centre and coaches nowadays people with intellectual disabilities to learn “to dream, to dare and to act”. Complete independence is often too difficult, therefore Ithaka chooses interdependence, rather than a complete professionalising of care and creating



dependency. BlueAssist supports the user to appeal to passers-by when they do not understand a situation or information. BlueCall Phone supports daily life. Through these assistive devices society and especially communication is more accessible.

## Blueassist, Accessibility Of Communication By Appealing To Passers-By

### *Invisible Barriers*

For years, European policymakers have been investing in physical accessibility of public space to increase the mobility of physically disabled persons, by means of inclined planes, elevators, sound-signals, information in braille, kneel buses... These interventions are necessary to overcome visible barriers people experience.

Inaccessibility of communication is less visible, less measurable and less tangible than a physical barrier but it is a big problem for a growing group of people to participate independently in social life. In Flanders, 800.000 adults cannot deal with the usual ways of information and communication [3]. These are people of all ages and from all layers of society, who find themselves forced to limited self-development and constrained participation in society. Research [4] shows that overcoming one or two barriers is feasible, but the presence of more barriers often ensures that people drop out in their pursuit of performing a particular action independently. Since diversity is growing and population is ageing, working on accessible communication is a sensible effort for policy makers and actors on the ground. The Flemish minister of mobility, Hilde Crevits, described this in a distinct manner during the presentation of BlueAssist: "For years we have been investing in 'hardware' to make public transport more accessible. Now we have to work on the 'software'. It will cost less but it needs serious effort and permanent attention."

### *Interdependence as a Third Way*

Since the seventies, European policymakers have been influenced by the lobby efforts of the independent living movement to invest in physical accessibility. They strived and still strive for a living arrangement that maximizes independence and self-determination to assert that people with disabilities have the same civil rights, social position and life choices as people without disabilities. The aiming for independence was an answer to the dependent position of people with physical disabilities. Nowadays "assisted living" is a step forward to realize this independence and has become a booming economic activity.

Of course, there are limits to making society fully accessible especially the accessibility of communication. John, for instance, is at the station. A clear information board with readable text, in the right colours, will still be unreadable for him, since he does not read that well. To translate written or heard information into the right action to attain his goal, is even more difficult for him. We can train many routes with John. However, what to do if something unexpected happens? John cannot go to the library independently because of this risk? There are so many people in the station who are able to read and understand the information and who could assist him. After all this would give him much more independence and make him less dependent on support from professionals and family.

Interdependence is a third way between the antipodes dependence and independence. This interdependence can be created by building networks in the daily life of people and by receiving support from others if they cannot cope. In this way they can participate in society

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more easily which leads in its turn to more freedom, self-development and quality of life. Interdependence means that one can appeal to someone else for a very short time to be able to go on. Further, interdependence corresponds with the citizenship, proposed by the UN Convention. People broaden their horizon, participate more in society and undertake things more often by taking initiative, by taking responsibility and by appealing to co-citizens to make society accessible for them.

### *A Tangible Utopia [5]*

Being able to dream, dare, act and to want more, by appealing to others. The concept seems simple but how to realize this? NPO Ithaka has searched for ways to make this utopia tangible. It is not easy for everyone to put into words an understandable demand for aid. For instance in the case of John mentioned above: How can he explain what he wants? How can he appeal to the social capital of all those people around him? There are barriers to coming to someone's aid as well. Our society has taken care of persons with intellectual disabilities too well, so to speak. Therefore, we see them less commonly on the streets and they only go out with assistance. Society has become more complex and individuals know each other less. All these elements have contributed to our unlearning of how to come to someone's aid spontaneously.

NPO Ithaka created the social innovation BlueAssist to support the interaction between help seeker and potential helpers. By means of a BlueAssist-icon and messages on different platforms, for example a BlueAssist card, a BlueAssist application for smartphones, a function key on a BlueCall Phone, they can ask strangers for assistance. John will always experience barriers in communication but BlueAssist helps him to overcome these barriers. BlueAssist is a practical example and functions as a catalyst for inclusive processes as described by the UN Convention for people with a disability.



#### **Example of a BlueAssist-message on a card and an application**

BlueAssist is an example of the socializing of care. The icon symbolizes the evolution from “dependence” to “interdependence”, of looking at possibilities instead of only disabilities. The icon BlueAssist helps to awake the necessary confidence to ask for help and to come to someone's aid. The visibility of the icon helps to start up a conversation, hence the baseline “dare to connect”.

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With BlueAssist, people who experience barriers have more dreams and dare to undertake actions. Consequently, many things, that seemed unthinkable and inaccessible before, become possible: to go into town on their own, to go to the supermarket, to buy a compact disc or take the bus. This completely changes their lives and illustrates perfectly the socializing of care that the Flemish government aims at: “to take part in society as far as possible and to be extraordinary and separate as little as possible” [6]. Many people subscribe this vision but do not find practices to turn this utopia in real actions. It still takes a lot of work to turn our old habits of “well taking care of” to “support and coach”. BlueAssist contributes to enabling everyone to do what seems evident for most of us.



**Interdependency to overcome invisible barriers, BlueAssist builds a bridge.**

Having enough confidence to make contact is the first barrier to overcome, but of course, there has to be an understandable question as well. According to the application of BlueAssist, the nature and flexibility of a demand can differ. This can vary from a question on a small card to an application on a smartphone, the so-called assistive technology.

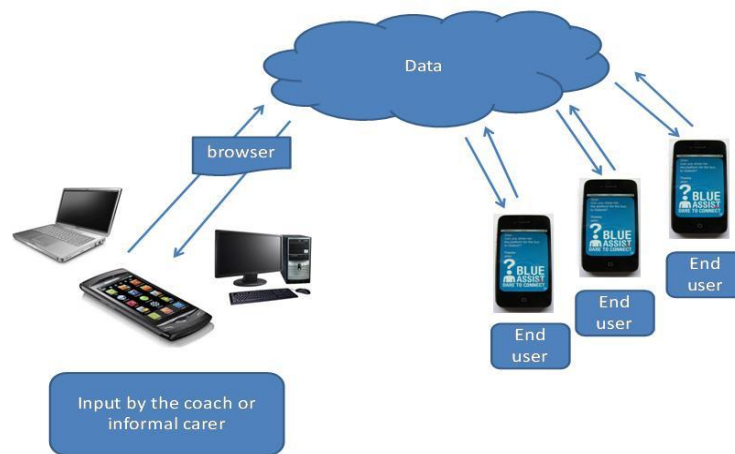
### **Bluecall Phone As Assistive Technology**

#### *Making Use of Existing Technology*

In Ithaka BlueCall Phone was created to integrate the social innovation BlueAssist and other functions to support daily life. The coaches of Ithaka did not want to create new devices or new instruments. They wanted to integrate the necessary assistive needs in existing



technological solutions that were easy to carry and easy to handle. A study in 2009 by a student [7] identified that it was possible to have a central system to direct different end-users at the same time. At that time the possibilities of iPhone were the most user-friendly.



### Framework for the synchronisation of BlueCall Phone

In January 2010 Ithaka had a preliminary design of BlueCall Phone to test. After a long period of testing, adjusting and evaluating the effect of the application on the quality of life for the user [8] and the efficiency in use, BlueCall Phone evolved from best practice to evidence based practice. Based on the feedback [9], the developer redesigned continuously BlueCall Phone which resulted in a prototype of BlueCall Phone. This prototype is tested in other care centres in Flanders and the Netherlands (in total 25 users) and in August 2011 a demonstration model of BlueCall Phone was available.

The demonstration model exists of two software packages. On the one hand there is the software to use the website in order to get access to the data in the cloud, to fill out the forms and to direct the smartphone of the end user. This is written with common tools for web development (php, java-script, jquery, html, css). The forms are dynamically built and each form is checked on its correctness before saving. On the other hand there is the software for the application. This is written in xcode for Iphone. The data is available in the cloud and there is an automatic update each time when the end user opens the application.



**Input by the coach in a simple form and supported by an extra screen to show how the message will appear on the smartphone of the user.**

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### *Integrating assistive tools*

The coaches, persons with an intellectual disability and their ring of carers decided that 4 assistive tools were important to support their daily life and should be integrated in one assistive device:



#### **a calendar function**

In Ithaka there is no overall schedule or general supply anymore where participants can enrol. Everyone in Ithaka has his own schedule and activities inside or outside Ithaka. With the calendar function the user can carry about his own day structure. Some get sound signals whether to start or end an activity, for some the schedules are worked out in detail (brush teeth, put on a jacket and go to dentist) for others an overall signal that they have to leave for the dentist within a quarter is enough. It is even possible that the user has to touch a button that he has seen the instruction. In that case the coach or informal carer gets a signal when the activity is not confirmed.

E.g. For Mary the calendar is very important. She has no sense of time and cannot read. Before she used BlueCall Phone, she had a 24 hour-clock in her apartment, an agenda with pictograms, a magnetic board in Ithaka and an alarm clock to give her signals. In BlueCall Phone she gets a signal and sees immediately what is the next activity. She even has chosen her own pictogram or photo to explain her what she has to do. It took several days for Mary and the coach to arrange her agenda but now she can use it most of the time independently and asks the help of the coach when new items must be added.

E.g. Jessica wants an overview of her daily activities, not only for today but also for tomorrow and next week. She controls her own agenda by looking which activities are finished (red colour) and which are the next activities (green colour). Such a visual display of her activities gives her confidence to live on her own.



#### **a simplified phone function**

For those who cannot read or have difficulties in using new technology, there is a simplified phone function. By scrolling through pictures, they touch the photo and come into contact. The coach can change the list into a ranking which is logical for the user.

E.g. Peter likes to phone to his family. He tried to use a mobile phone but it was too complicated for him to use the different buttons and menus. With the BlueCall Phone he only has to choose the right photo to get into contact.



#### **a simplified photo function**

Some enjoy to take photos. They only have to open the function and touch the screen. The photos are available on the smartphone and in the cloud. Those who can write or the coach can add a name to the photo and it goes automatically to the list in the phone function. Most



users use the phone function as a reminder to tell stories to others or as a scheme to fulfil a certain task.

E.g. Sarah enjoys talking about what she has experienced but it is very difficult for her to communicate. With BlueCall Phone she often takes pictures of what she does and has seen during the day and in the evening she can tell her parents what she has been doing during the day. Her parents can ask questions about the photos and in that way Sarah can share her experiences with others.

E.g. When Ian wants to presents himself to others it is easy to show where he lives, what he does in his leisure time, his dog and family.

E.g. A written shoppinglist is often too difficult. For some users independent shopping became possible with a series of photos or pictograms they had selected.



### **BlueAssist, asking others for help**

BlueAssist is a totally new function and has been explained in the first section.

E.g. Bjorn is anxious to take the bus because the bus often takes off before he has taken a seat. It is difficult for him to explain this when entering the bus. With the BlueCall Phone he shows a BlueAssist-message whether the bus driver wants to wait until he is seated. The driver recognizes the icon and takes into account the message.

E.g. Peter is used to take the tram to his work. He knows the way but twice he was in a situation he did not understand and was not able to ask others for help. Peter is not able to analyse the problem and he cannot solve the problem on his own. Peter knows how to use his BlueCall Phone. He can give a signal to his coach by pushing the globe-button. The coach gets a signal and sees on a map where Peter is standing. He can also show a general BlueAssist-message to a passer-by. "Hello, I'm Peter. I don't know what to do. Can you push the green button to call my coach and explain her what happened? Thank you."

### *Design for all*

BlueCall Phone is not only designed on an on-going basis, it is also designed according to the principles of universal design as advised by the Flemish Administration of Equal Opportunities. BlueCall Phone is a process, a service and an instrument which is functional in a large number of various situations. The principles of universal design are:

1. Usable for everyone

BlueCall Phone is not designed for people with an intellectual disability only. Coaching from a distance through BlueCall Phone can be introduced to support other target groups and in other settings than professional care.

2. Flexible in use.

One could state that the software of BlueCall Phone is an empty box. A simple structure is designed which can be customised to the personal needs of the end user. Users do not



have to adapt themselves to the system. Together with the coach, the user can choose when and how to use BlueCall Phone.

### 3. Simple in use

The simple and intuitive use of smartphones is even made more simple by introducing a linear structure. The menu has only one level and a simple interface.

### 4. Clear information

The information on BlueCall Phone can be customised. All alerting signals, photos and pictograms available on the internet or personal computer can be used.

### 5. Possibility to make mistakes

Through the linear structure mistakes are hardly possible. If the user touches a wrong message or photo, he only has to push one button to return to the main menu.

### 6. Restricted effort in use.

To use BlueCall Phone the user has to prevail 4 actions: to push the on/off button, to swipe, to push an icon or photo and to push the button to return to the main menu.

The task for the coach is more complex but no instructions are needed to use it for someone who has used a personal computer before.

### 7. Adequate form

BlueCall Phone is handy and an assistive device which is not stigmatizing. One can use it everywhere one needs it and can be carried in the pocket. Many testers were very proud to possess and being able to use a smartphone. It is a symbol for them that they belong to regular social life.

## Perspectives

BlueAssist is a social innovation to realize a clear vision on accessibility of communication, supportive care and interdependency. A new non-profit association is founded to make sure that the icon will be acknowledged, used and recognized in Europe.

BlueCall Phone is an assistive tool as a result of this clear vision and a dynamic interaction between users, coaches and developer. At the moment BlueCall Phone is available for iPhones and in autumn 2011 it will be written in Java for smartphones which work on Android. There is an agreement with the University of Tampere (Finland) to translate BlueCall Phone to Windows Phone 7 in spring 2012.

Any language can be used for the end-user. The software and manual for the coach is at the moment only available in Dutch but can easily be translated on request.

BlueCall Phone has the support of Flanders' Care (an initiative of the Flemish Government) to start a demonstration project in January 2012 in Flanders. The knowledge centre Vilans



took the initiative to start a demonstration project in the Netherlands in 2012. More information [www.bluecallphone.be](http://www.bluecallphone.be) and [www.blueassist.eu](http://www.blueassist.eu).

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## 1.2. Tecla Access A Mobile On-Screen Scanning Keyboard For Android

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### Abstract

Mobile devices pose an accessibility challenge for people who are unable to physically manipulate them. Although external switch access has been used to mitigate this problem in other types of systems, two gaps remained in the context of mobile devices: (a) the communication of external switch events and (b) the translation of switch events into meaningful commands that fully control the device. This paper details our work on the Tecla Access<sup>1</sup> project, a mobile switch access system that seeks to address both gaps simultaneously. Particular emphasis is given to Tecla Access's overall architecture, scanning features, current challenges, and future development plans.

### Keywords

mobile accessibility, mobile access, switch access, Tecla access shield, powered wheelchair, environmental control unit, ECU, appliance control unit, ACU, physical impairment, alternative input, assistive technology, AT, wireless, Bluetooth, user input, input method, single-switch, electronic aid for daily living, EADL, dual switch, mobile on-screen keyboard, Android accessibility, Android input method

### Introduction

Over the past decade, mobile devices have revolutionized the lives of billions of people worldwide [1]. These devices are a gateway to an ever-increasing array of digital resources and communication channels that can increase productivity, strengthen social networks, facilitate entertainment and leisure, and enable instant access to online products and services. However, people with moderate to severe mobility impairments have been mostly left out of this revolution because no end-to-end solutions exist for enabling access by people who are unable to hold and manipulate a mobile device independently.

In spite of renewed efforts to ensure accessibility features are built into mobile devices, and the lessons previously learned in other contexts, such as personal computer access, device manufacturers have often assumed the typical interaction paradigm of a fully dexterous user. This approach has often led to critical architectural decisions that prevent full access to products through alternative input devices such as external ability switches, the most common and flexible method of accessibility for people with severe mobility impairments.

The Tecla Access project was conceived within this context, with the objective of building an alternative access pathway for ability switch input into current mobile devices. The first operational result of this project is an alternative access pathway to Android-powered devices. This paper aims to provide a technical overview of the architecture of the system, a description of its current features, and a summary of the challenges and opportunities that will shape the future of the project.

<sup>1</sup> "Tecla Access" was previously named "Tekla".

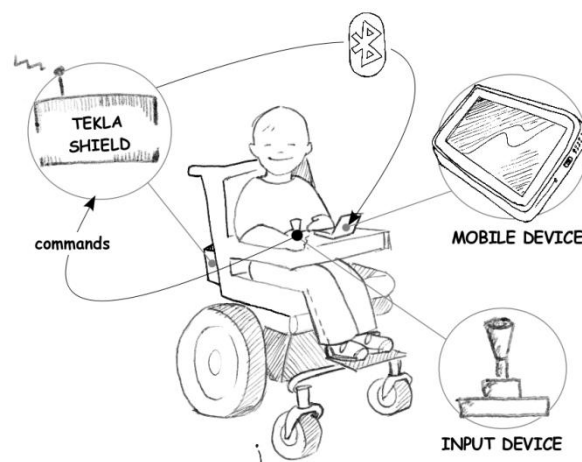




## Architecture

Depending on the nature and severity of their impairment, people with mobility impairments may face different kinds of challenges when attempting to access their mobile devices. Furthermore, the barriers they encounter may be more significant in some contexts or activities than in others. Thus, depending on the needs and preferences of each individual as they relate to their particular goals, different types of technical aids or assistance may be employed.

In the context of desktop computer access, on-screen keyboards are most useful when they are used in combination with alternative input methods such as head-trackers, trackballs and ability switches. The Tecla Access project focuses on facilitating access to mobile devices by users of standard ability switches and in particular, powered wheelchair users because such users already travel with what is likely to be a well-adapted switch interface, which they employ to drive their wheelchair. Leveraging this existing switch setup enables access to mobile devices through the same familiar interface. Figure (below) depicts a schematic diagram of such a use case.



**Schematic diagram of Tecla Access user case**

The Tecla Access system is composed of:

- The **Tecla Access Shield**, an open-hardware, standards-compliant Bluetooth device that enables connection of powered wheelchairs and external ability switches to Bluetooth-enabled devices, and
- The **Tecla Access App** (currently only for Android), an open-source, free-to-download client application that receives switch events from the Shield and translates them into actions and command sequences on the target device.

### The Tecla Access Shield

Up to 90% of the external ability switches and powered wheelchair connections currently available comply with the Simple Electrical Transducer (SET) Standard, originally created by the TRACE Centre at the University of Wisconsin–Madison [2]. Since this standard was developed primarily to encourage compatibility of physical plugs and connectors across vendors, it does not provide specifications for the transmission of switch events through modern communication protocols, such as USB and Bluetooth, that are employed by mobile devices. Therefore, it was necessary to create a device capable of interfacing the

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widespread SET-compatible switches and powered wheelchair connectors, with communication protocols that can act as user input to a mobile device.

The result is the Tecla Access Shield, which may be plugged directly to the standard appliance control unit (ACU) port of a powered wheelchair for up to 4 switch inputs, with two additional independent ability switches, for a total of 6 switch inputs. These switch inputs are then filtered and processed by an on-board micro-controller, which, in turn, relays the events to an on-board Bluetooth module capable of broadcasting switch events through a virtual serial port, using the serial port profile (SPP/RFCOMM) at a 115200 baud rate.

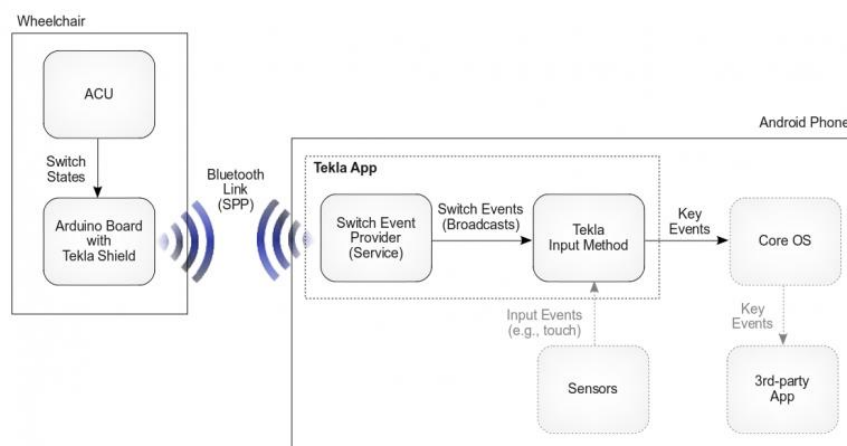
The Bluetooth profile implemented on the Shield is supported by all mobile device platforms with the current exception of the iPhone (which implements an incompatible proprietary version), as well as by all major desktop operating systems (i.e., Windows, Mac OS and Linux). Thus, the Shield may be effectively act as an abstraction layer providing a standard and consistent way to communicate switch events from the highly adapted interfaces switch users employ, to modern electronic devices.

### The Tecla Access App

Together with the Shield, the Tecla Access App may be used to access and control Android-powered smartphones. The App has two main software components:

- The Tecla Input Method (IME) is the user-facing component responsible for interpreting user intent (through an on-screen scanning keyboard) and correspondingly generating the custom keyboard events required for control of the target device. The IME integrates tightly with the operating system (OS), enabling access to most of its functions, and
- The Switch Event Provider (SEP) is a background service responsible for managing the Bluetooth connection with the Tecla Access Shield as well as broadcasting switch events to the IME and other 3rd-party applications.

Figure (below) depicts the architecture of the App and its interactions with the Shield as well as with the host OS.



**Architecture of the Android Tecla Access system. The Switch Event Provider is a service that receives switch events via Bluetooth from the Tecla Access Shield and broadcasts them to the OS.**

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As stated above, the SEP manages the connection with the Shield. The SEP is also responsible for managing the logic that facilitates end-to-end accessibility, making alternative access truly independent. When a switch event is received from the Shield, the SEP is able to determine whether to send it to the host OS or to consume it. This allows, for instance, for switch events to automatically wake up and unlock the screen when in sleep mode without inadvertently executing a command. This architecture also allows for personalization of switch actions (including ignoring switches all together) as the SEP may act as a mediator that interprets user intent before the switch events reach the host OS. Finally, the SEP is also capable of remembering and automatically connecting to a previously paired Shield, which not only increases the robustness of the wireless link as the Shield may be automatically re-connected, without the need for manual intervention, after an accidental disconnection, but will also facilitate switching control between multiple switch interfaces (e.g., if a user moves from a switch setup in their wheelchair to a switch setup in their bed).

The IME is the main user-facing component of the App. As depicted in above Figure, the purpose of the IME is to receive switch events from the Shield or from the mobile device's own touchscreen sensors (when in full screen switch mode) and translate them into meaningful instructions to be transmitted to the host OS.

Here, it is important to note that the Tecla Access system relies primarily on the built-in input redundancy of Android-powered devices, which allows for full navigation of the user interface through a keyboard-only interaction. This redundancy typically extends to built-in system applications as well as any 3rd-party applications that employ the standard widget library provided through the Android SDK. Thus, the primary role of the IME is to emulate keyboard events that accurately reflect user intent.

In order to interpret user intent, while at the same time allowing for access with as little as a single-switch input, the Tecla IME extends the built-in on-screen keyboard (soft input method) to allow for command and character selection via scanning. Although the rationale and technical implementation details of switch scanning methods go far beyond the scope of this manuscript, it is important to note that scanning in all its variants is currently the common practice for facilitating switch and alternative input access for people with mobility impairments [3].

Next Figure shows screenshots of the Tecla IME in various states. For user interface navigation (left), the IME presents an unobtrusive navigation keyboard capable of emulating directional (D-Pad) key events. This allows for selection and activation of any active element on the screen. Moreover, once the user enters a field or widget that requires text input this is detected automatically by the OS and a full scanning QWERTY keyboard (middle) is displayed in response. Finally, for those users who have enough dexterity to hold a mobile device, but who have difficulty targeting active elements on the screen, a full screen switch mode (right) is also provided that turns the entire touchscreen into a single-switch.





**Screenshots of the Tecla IME for Android. From left to right: settings and user interface navigation keyboard, full self-scanning QWERTY keyboard for text input and full screen switch mode for single-switch access without an external switch.**

In addition to the three main components of the IME introduced above, the App also exposes preferences that may be modified to accommodate a variety of users. In its simplest form, the App allows for all the alternative input settings to be turned off, thus facilitating use by people without disabilities, who may use the IME as they would normally employ any other IME available on their handset.

### Scanning Features

In order to perform an action on a touch-based interface, users must select and activate the element that represents his or her intent. Users who have enough dexterity to use their fingers can simultaneously select and activate the desired screen element by touching it. However, for users who cannot use their fingers to control a touch-based screen, the selection will not typically be performed at the same time as the activation.

Scanning refers to the process by which a user selects the element he or she wishes to activate. For users with mobility impairments, this process typically consists of a sequential highlighting of active elements on the screen. Such highlight acts as a heads up display indicating to the user which element is in focus to receive activation or input from the IME.

Currently, the Tecla IME allows for the following two types of scanning methods:

- Direct user scanning, which relies on the availability of two or more switch inputs, and
- Self-scanning, typically used with single- or dual-switch interaction.

It is important to note that both scanning methods refer to the ways by which any given user may be able to access the on-screen keyboard, not the user interface it controls. In other words, “direct user scanning” should not be confused with “direct user navigation”, which would allow for direct access to the user interface without the need for an on-screen keyboard. The latter, although possible in principle, is not currently available on the App and would require a minimum of 5 switches to be used effectively. This latter requirement arises from the fact that sequential navigation on the Android platform is neither linear (i.e., the ability to move selection in a single linear sequence through all active elements regardless of

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their on-screen arrangement) nor wrapping (i.e., when selection moves from the last item in the list it returns to the first). If these properties were available, it could reduce the switch requirements of direct user navigation to a single-switch and provide a more intuitive interaction that would not require control via an on-screen keyboard.

### Direct user scanning

Direct user scanning consists of allowing the user to navigate through the sequence of active elements manually. This modality requires at least two switch inputs: one for scanning and another one for activation. Direct user scanning has the advantage of allowing the user to navigate the sequence of possible actions at his or her own pace, which in most cases will increase the rate of commands a user can generate, when compared to a single-switch scanning method.

### Self-scanning

Self-scanning consists of automatically navigating through the sequence of highlighted elements, which allows for single-switch access to the IME. In its simplest form, self-scanning requires a single parameter that controls the speed at which the active elements on the screen are sequentially scanned.

The App currently exposes preferences that allow users to select the type of scanning they are most comfortable with, as well as the speed at which the scanning will occur, should they choose to enable self-scanning.

## Challenges

While the Tecla Access system does currently enable control of Android mobile devices via alternative access to built-in applications as well as 3rd-party applications that comply with best design practices, some challenges remain.

### Non-linear highlighting

As described above, the Android platform does not provide a way to scan active elements on the screen in a single linear sequence. Instead, the elements are scanned according to their screen arrangement, which typically follow a grid pattern. Furthermore, once the edge of the grid is reached, the scanning does not wrap-around. Thus, a minimum of four different input events are required just to select an active element on the screen. Should linear and wrap-around scanning become available, this requirement could be reduced to a single-switch.

### Inaccessible overlays

An important current challenge in providing full access to Android mobile devices is the fact that some pop-ups and overlays ignore input from the IME. There is no clear justification for this and that it goes against the otherwise consistent keyboard redundancy of the Android platform. It may, therefore, simply be an accidental omission caused by an assumption that such overlays would never be accessed by any method other than a device's touch-screen.

### Custom widgets

Finally, as is the case on many other platforms (web, desktop, etc.), Android developers are free to create custom widgets for their applications. Since these widgets are less likely to take into account accessibility, applications using them are likely to be less accessible via the Tecla Access system than those using only the built-in Androids widgets. This is especially



apparent with games, which often involve entirely custom environments that completely lack keyboard redundancy.

## Future Plans

The Tecla Access system has garnered the interest of many rehabilitation centres interested in experimenting with potentially more affordable open-source alternatives to proprietary assistive technologies. This has provided a unique opportunity to understand the needs and priorities of clinicians and potential users alike. At the same time, commercialization of the Shield by Komodo OpenLab has allowed the project to evolve from an academic proof-of-concept implementation to a pre-commercial prototype providing an end-to-end solution that may be evaluated in context. This presents further opportunities for identifying and solving not only the technical, but also economic and contextual barriers that have prevented systems like Tecla Access from being developed in the past.

Several of the community-proposed features that will be added in the near future include:

- Word prediction and completion, which will increase the rate of input for all users,
- Inverted scanning, which consists of pressing a switch to start the self-scanning and then selecting the element on release. This will provide a wider range of configuration options for people who may present involuntary tremors in addition to targeting difficulties, and
- Accented characters, which will enable access to non-English characters allowing users to generate input in different Latin languages.

## Acknowledgement(s)

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### 1.3. Enhancing Text Conversations With Real-Time Text Technology

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2. Polytechnic University of Madrid, Spain

#### Abstract

For many years, Deaf and Hard of Hearing persons have sought alternatives to traditional voice telephony that could be accessible to their needs across desktop and mobile communications devices. Such communications access would not only be helpful for everyday communications with family and friends, but provide access to communicating with the hearing community, to emergency services, and to the information needed to be an active member in today's Information Society.

The AEGIS project has developed an open source real-time text solution for mobile devices that will help to improve the communication of the deaf and hard of hearing personas. This user-centred work includes multiple deliverables, including a survey of existing real-time text protocols, methods and specifications, drafting requirements for real-time text application software for use on mobile phones, developing a prototype real-time text application software and conducting technical, interoperability and user testing of prototype real-time text solutions.

#### Keywords

Design for All, real-time text, instant messaging

#### Background Of Text Communciations

During the last decades the communications of deaf users have been evolving as the Information and Communication Technologies (ICT) have provided newer and more efficient ways for communication.

One of the first revolutions for text communications was the appearance of the device for the deaf (TDD) or teletypewriter (TTY). It is an electronic device for text communication via a telephone line with a similar size of a typewriter and an LCD display that shows what the other user has typed. To use these devices, both users should have compatible devices and they should be connected to a telephone line.

One of the main problems of the TTYs is that there are many different text phone standards. The original standard is the Baudot code that is very common in the United States. In Europe, different countries use different protocols. For example, V.21 is found in the UK and several Scandinavian countries. Other protocols used for text telephony are EDT, DTMF, V.23, etc.

The TTYs usage is restricted to the home or work environments because they depend on the availability of a land line. The SMS messages solved that issue, providing the possibility to send and receive messages from mobile phones. Until the advent of SMS messaging on mobile phones at a reasonable cost deaf people didn't have a common medium of instant



communication among themselves and with hearing people. Nowadays everybody is able to send text messages and deaf texters can join hearing texters to communicate among themselves with other deaf.

It makes sense that so many Deaf people have adopted SMS as a preferred communications channel around the world. It is text-based, easy to use, affordable and mobile. The vibrating function of the handset alerts the user about a message. Unlike other technology designed specifically for Deaf people, such as teletypewriters (TTY), it does not require each party to have bespoke equipment or rely on an expensive, time-intensive and intrusive intermediary to translate messages back and forth [1].

Despite all the advantages of the SMS messages, there are some important issues that are not solved by this technology. The SMS can be delayed for minutes until they reach the other user or they can be lost and never reach the receiver. Deaf users value the SMS because it is used by all users and it is an interoperable technology. However, they need more interactivity in their text communications.

The appearance of Instant Messaging (IM) for mobile devices gives response to some of the problems of SMS. IM provides more interactivity for text communications as the users can exchange messages faster and more efficiently. These messages are also cheaper than SMS messages and therefore users are able to have longer conversations. The main problem with SMS is the lack of standardization. There are a lot of different IM providers: BlackBerry, MSN, Google, AOL, Yahoo, ICQ, Face Book, WhatsApp,... Therefore, the users are very dependent on which IM is most used by their friends. It is difficult to find IM clients that can be used for different IM providers.

Deaf users like IM for its interactivity, the possibility for both parties to type at the same time and the ability to display emotions through the use of emoticons [2]. However, IM is not as interactive as the voice communications of non-hearing impairment users. Users still have to wait until the other user has finished typing and that means that there are delays in the conversations and that they cannot interrupt each other. That is why real-time text appears to improve the text communications.

### What Is Real-Time Text

Real-time means that something occurs within a fraction of a second. For example, a voice conversation between two or more people happens in real-time. As it is being spoken, the sound of one person's voice is received immediately by the other.

Real-time text (RTT) is conversational text that is sent and received on a character by character basis. The characters are sent immediately once typed and also displayed immediately to the receiving person or people. This allows text to be used in the same conversational mode as voice. RTT can be used on its own to enable conversations using text or it can be used together with voice and video conversations to replace or support voice and to transfer additional information like numbers, currency amounts, spelling of words, it can be anything that needs to be communicated.

Real-Time text is important as an alternative to voice communication, especially for people with disabilities who have difficulty hearing or speaking. RTT allows a more natural, bi-





directional flow of conversation to take place compared with the technology of instant messaging or mobile phone text messaging.

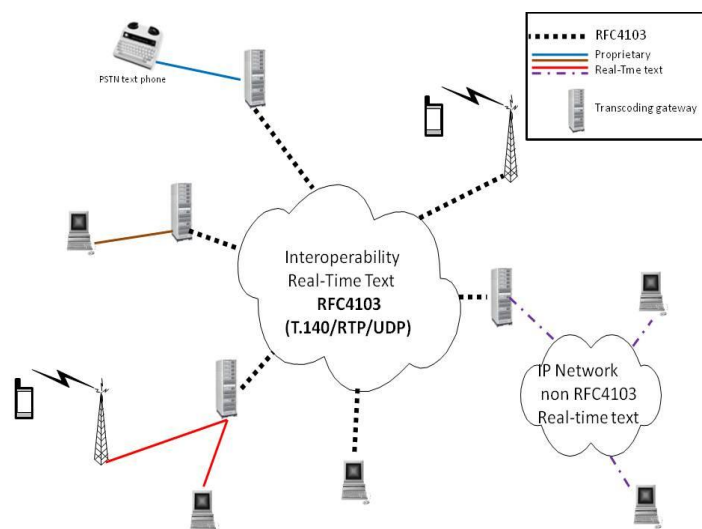
### Real-Time Text Protocols

The AEGIS project aims to promote standard and interoperable solutions, and the adoption of these standards is crucial to ensure the integration of the AEGIS developments with current and future solutions.

A market research was carried out in this project to identify the media stream protocols, client applications, RTT protocols and other features that are used in a total of 14 applications for communication in real time text have been studied. This market research identified the combination SIP + ToIP + T.140 as the de facto standard that will facilitate the interoperability of this technology. If AEGIS did not use this option, it should had to provide a gateway that acts as a portal between the proprietary solution and the combination of SIP + ToIP + T.140. Clearly it seems more reasonable to provide the interoperability directly than developing both a proprietary solution and a gateway that provides interoperability.

The main requirement that ToIP imposes is a maximum delay of 0,5 s before sending the text that has been typed by the user. This requirement increases the data traffic and could not be optimal for mobile devices (that normally try to reduce the required bandwidth). However, the maximum bandwidth that SIP, ToIP and T.140 require is just about 3 kbps, which is not very demanding, if it is compared with the 7 Mbps speed that is available in several mobile networks of different countries.

Figure (below) shows the interoperability that can be achieved using SIP + ToIP + T.140, and how gateways are required for interoperability with TTY and other networks that are not based on the RTT standards.



**Real-Time Text Protocols [4]**



## Real-Time Text For Mobile

After the selection of the real-time text protocols, a mobile client prototype has been developed using this technology. The application is based on J2ME because the wide availability of the application is one of the most important requirements. Roughly 78% of the mobile phones sold in 2010 were inexpensive feature phones that run the Java Micro Edition (Java ME) environment [3]. With this decision, the application will be compatible in mobile devices with different OS such as Symbian or BlackBerry.

The functionality of the application is similar to an instant messaging application. The user should login with a user name and password to start using the applications. Once registered, the application provides three main functionalities: make / receive real-time text calls, see the call logs and manage the RTT contacts (see Figure below).



**Home screen**

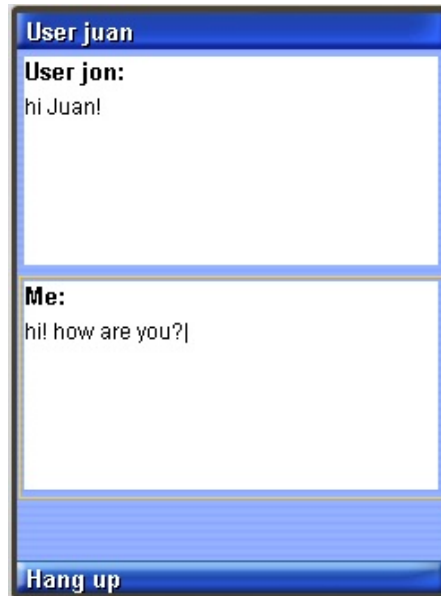
In order to make a call, the user should press the call button from the home page. A second page will offer two options (i: select an existing contact from the contact list or type directly the RTT address of the other user (“Enter user”). If the user decides to type the RTT address of the user, a new page will allow the user to type the login of the other contact (Figure below).



**Making an RTT call**



Once the call is accepted by the other user, two text boxes will appear (next Figure), the upper one will show what the remote user is typing and the lower box will show what the user of the device is typing. It should be noted that the concept of call is different to instant messaging. The other user should accept the call before the text conversation takes place. This concept is closer to the phone calls where you are sure that the other user is receiving the information.



RTT conversation

## User Testing

Within the framework of the AEGIS project, three evaluation phases were planned along the whole life of the project in four pilot sites: Spain, Belgium, Sweden, United Kingdom. The use of a user centred design methodology and the iterative evaluation ensures the optimization of the application, trying to accomplish all the preferences of the users. Currently, the second evaluation phase is being carried out. The feedback of the users in the four pilot sites is serving as an important input for the developers of the application.

So far, with the results obtained from this evaluation phase, the Real-Time-Text application seems to be a helpful solution for deaf and people with hearing impairments and to fulfil their expectations for a faster way of communication. One of the major difficulties found is the usability of the chat divided window, since users find that sometimes is confusing to follow the conversation. They would prefer a chat based window which differentiates each user conversation with different colours. Users have also showed their preferences of integrating the application with other applications, such as the agenda or instant messenger, instead of running it just as a standalone application.

As main advantages, users find that the real-time communication provides a quite fluent conversation, and, since the application is developed for mobile devices, it is a very useful solution that is portable and allows users to communicate faster than with other applications.

Additionally, other usability studies have been carried out related to Real-Time Text applications, such as BlackBerry Real.

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## Acknowledgement

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## 1.4. Deploying Mobile Total Conversation For Person-To-Person Communication, Emergency Service And Relay Service Access

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### Abstract

This paper describes experiences and early results from the deployment of a mobile Total Conversation application in the REACH112 project. Mobile Total Conversation allows anyone to communicate regardless of disability and is a step closer to equal access as set out by the United Nations Convention on the Rights of People with Disabilities.

### Keywords

Total Conversation, mobile, emergency service, video conference, real-time text

### Introduction

The United Nations Convention on the Rights of People with Disabilities [1] requires equal access to telecommunications. The convention has been ratified by 99 countries [2], still equal access to mobile telephony is not available for many of those who are disabled. These individuals have been confined to using SMS or in some cases 3G video telephony.

This paper describes the new opportunities for functional equivalence made possible by the latest generation of smart phones. The Telecommunications RERC at Trace Centre has developed a Total Conversation application for Android using the Total Conversation standards for real-time text, video and audio in the same call. This paper describes experiences of and early results from deploying the application in the REACH112 project [3].

### Total Conversation

The purpose of Total Conversation is to enable communication for all. Mobile phones and modern telecommunication networks have advanced to the point where it is now possible to deploy Total Conversation on most high end phones. The simultaneous use of audio, video and real-time text allows all users to find a suitable method for communication.

Video can be used for sign language or lip-reading for those who are deaf, hard of hearing, deaf-blind or late deafened.

Audio can be used for voice conversation according to the user's capabilities.

Real-time text can be used by everyone to convey information that is tedious to convey in other media. It can also be used to support other media in the call for example; through a captioned telephony service or in some cases to type a word instead of speaking it for someone with a speech impairment. For deaf blind users it could be used to receive text while the response may be sent in sign language.

### Standards

Total Conversation is based on open standards and is defined in [4]. As in most open IP telephony systems today the Session Initiation Protocol (SIP) [5] and RTP [6] is used. H.263

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[7] and H.264 [8] should be supported for video. H.263 is widely implemented and the newer H.264 offers better video quality with less bandwidth. G.711 [9] is recommended for audio since it is widely supported and offers good quality. Real-time text should be implemented by RFC4103 [10] and T.140 [11]. It provides character by character transmission, giving the user a sense of a real conversation. For good communication in sign language the video resolution should not be below QCIF (176 × 144) and 20 frames per second (fps) is recommended [12].

Total Conversation is included in the IP Multimedia Subsystem (IMS) [13], the emergency service standards from the Internet Engineering Task Force (IETF) [14] and the North American Emergency Number Association (NENA) [15].

### User requirements

For a good user experience the minimum video resolution should not be below QCIF (176 × 144) and 20 frames per second (fps) to allow for good sign language communication [12]. The end-to-end delay should be less than 400 ms for audio and video to maintain a good user experience. For real-time text the end-to-end delay should be below 1s [12]. To maintain good conditions for lip-reading the synchronization delay between audio and video should not be longer than 100 ms [12].

### Network requirements

The minimum bandwidth needed to support Total Conversation in mobile networks with the recommended protocols H.263 (video) in QCIF resolution at a minimum of 20 fps, G.711 (audio) and T.140 (real-time text) is 264 kbps (bi-directionally) with QOS (no interruptions or delays in transmission). The same requirements for end-to-end delay and audio-video synchronization as stated above apply.

### Reach112

In REACH112 the mobile Total Conversation client is used during a one year pilot in Sweden together with a fixed Total Conversation hardware client and a Total Conversation software client. Users are able to communicate with; other Total Conversation users in their home country and four other European countries, their local Video Relay Service (VRS) and emergency services (112).

### International Interoperability

In REACH112 extensive testing has been performed to verify and achieve international interoperability between project partners in Sweden, Spain, the Netherlands, France and the UK. Due to the well-defined standards used in Total Conversation only minor bug fixes were necessary to achieve interoperability between the clients except for the Netherlands where a gateway was developed to transcode between a proprietary text format and real-time text used in Total Conversation. Using Total Conversation as a common set of protocols for interoperability proved very successful.

### Calling by number

To allow users to easily call each other; calling by number was implemented (as opposed to previously using only SIP addresses). For the numbering system the original intention was to use the public ENUM root e164.arpa [16], it would in theory enable anyone to call REACH112 users, even users on the PSTN.



Unfortunately the support for the public ENUM system is limited today and a private ENUM was implemented in each pilot. The advantage of a private ENUM system is that it is easier to block unwanted SIP traffic that is becoming a problem for both enterprises and individuals. This is achieved by signing peering agreements with partners and white listing their traffic. The drawback is that users can only call other users with whose Total Conversation operator their operator has an agreement with.

### Mobile Networks

Deploying Total Conversation in mobile networks differs from fixed networks in a number of ways, this section discusses lessons learned.

#### Packet loss

Mobile networks are more prone to packet loss than fixed networks or even wireless networks. This has a number of effects on Total Conversation clients in or communicating with a device in a mobile network. The robustness of the clients become more evident as packets are lost.

Audio works well in most conditions, there are well tested strategies for how to handle packet loss.

Real-time text, if used with redundancy can also handle packet loss fairly well. Should irreparable packet loss occur it is vital that it is indicated to the user.

Video experiences most difficulties, especially in implementation that only sends a complete frame at the start of the conversation, then only changes compared to the last frame are transmitted. If packet loss occurs after the initial complete frame a new complete frame must be requested, there are currently two methods to accomplish this; by sending the request in a SIP INFO packet or in RTCP [17]. Both types of these requests can in turn be lost and delay video restoration further. Because of the two different methods to request a complete frame it is recommended to periodically send complete frames, unless bandwidth is very limited

#### Net neutrality

Some mobile operators block data traffic in various ways, because they feel that it interferes with their business model. Commonly incoming traffic is only allowed on a port that has been opened from the device and ports regarded are closed after a period of inactivity. This affects the port used for Session Initiation Protocol, to keep it open a short time to reregister can be used or the SIP proxy can periodically send a message to the device to keep the port open. Others may block SIP traffic completely. There are services emerging allowing the user more freedom, for example a fixed IP address, but they are not wide spread.

#### Battery life

The call time and stand-by time may be limited by the power demand due to potential heavy CPU load during video calls. Some mobile networks may hinder call control signalling to be sustainable without special methods, see "Net neutrality" above. These methods may have a negative impact on battery life.



### Data roaming

When travelling abroad the cost of a voice call may increase 5 to 10 times, but the cost of a Total Conversation call might be 100 times or more expensive due to the high costs of data roaming.

### Front-side camera

Unfortunately only some smart phones feature a front-side camera, which is pre-requisite to a usable sign language conversation. Furthermore how these cameras behave in an Android environment vary from model to model, more often than not requiring specific tweaking of the source code. The camera's angle of view and light sensitivity should also be considered as these factors have a high influence on the user experience.

### Processing power

Currently only the newest, most powerful, smart phones can handle Total Conversation. This is unfortunate as these devices are also the most expensive. However with the rapid development of mobile devices today this will likely quickly turn into a non-issue.

### Person-To-Person

Mobile Total Conversation provides a significant increase in the quality of life for deaf persons. Currently they are limited to SMS or 3G circuit switch video telephony. The communication experience of the latter can be compared to a bad voice connection where you have to speak very loud, slowly and constantly have to ask the person on the other end to repeat. Mobile Total Conversation provides the same call quality as a mobile voice call.

As an added bonus it is easier for those who are not fluent in sign language to communicate directly with a deaf person through real-time text without the need for a relay service.

### Relay Service Access

Total Conversation is compatible with many existing relay services and calls can easily be made through these. Gateways exist that can channel calls to and from relay services that do not support Total Conversation, for example analog text telephony relay services or services based on ITU-T H.323.

Through the use of ENUM a phone number will be provided to users to automatically route calls through the service to their mobile Total Conversation client, a remedy to the lack of voice calls placed to relay services. A variant of this system called the Ten-digit numbering system has been implemented in the USA.

### Emergency Service Access

To be able to quickly contact emergency services it is important that the same device used for everyday communication is used to call the emergency service. In a stressful situation users are not likely to remember how to use other devices. The same emergency service number should also be used for all citizens, for equality and because it could be hard to learn a new number if you become disabled.

Using a mobile Total Conversation client can allow the user to contact the emergency service on the national number in a number of ways; direct using only real-time text, via a relay service or, as in the Swedish pilot of REACH112, in a three-party conference with the relay service and the emergency service operator (see next Figure).

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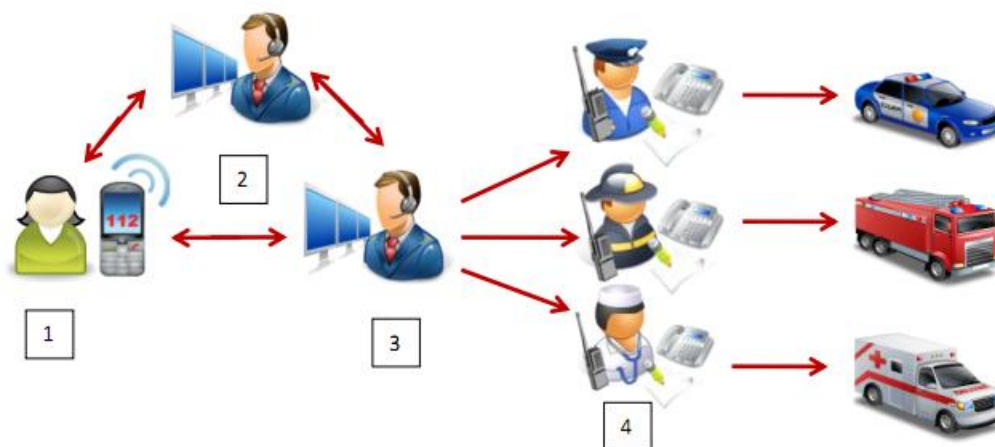


Before the REACH112 project many users felt hesitant about contacting 112. When interviewed one user said:

"I thought it would be faster if a hearing person called 112, if I call to video relay it is not 100% sure that they will answer, and also they have limited opening hours."

Because of testimonies like this Omnitor and SOS Alarm felt that it was necessary to operate a 24/7 Total Conversation relay service to support the project.

The service is separate from the Swedish National Relay Service and half of the cost was financed by Omnitor and SOS Alarm to show the benefits and capability of the system.



**REACH112 Swedish pilot call flow. 1. User dialling 112 2. Sign language interpreter 3. Emergency service operator in a stage 1 PSAP (1, 2 and 3 are in Total Conversation conference) 4. Stage 2 PSAP**

Early results indicate total call processing using the REACH112 system used in Sweden takes about four minutes, this slightly longer than for voice calls but considerably faster than the 14 minutes needed for the SMS system currently in use.

## Conclusions

Total Conversation is a proven concept to achieve interoperability between users, users and relay services and users and emergency services. It provides an unrivalled mobile communication experience for those who are disabled, allowing everyone regardless of disability to communicate. Emergency service access can be greatly improved by using Total Conversation.

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## 1.5. Planning For Accessible Emergency Communications: Mobile Technology And Social Media

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### Abstract

The Rehabilitation Engineering Research Centre for Wireless Technologies (Wireless RERC) Wireless Emergency Communications (WEC) project team developed prototype software for wireless devices based on regulatory requirements and conducted a series of field tests to explore the effectiveness of receiving mobile emergency alerts. Incorporated into the process were surveys that assessed how people with disabilities and emergency management used various forms of media to send and receive emergency communications. Presented are the WEC R&D findings to enhance accessibility of the Emergency Alert System (EAS), Commercial Mobile Alert System (CMAS); and explore access to popular mainstream communication modes (mobile social media).

### Keywords

Emergency alerting/information, communications, social media, accessible, Internet, CMAS, EAS, emergency management

### Introduction

Historically, vulnerable populations have been disproportionately affected during disasters. In many instances an individual's vulnerability can seriously impair not only their ability to prepare for a disaster but also to cope with the aftereffects of disasters [1] [2]. Previous research on support for the elderly and people with disabilities in the Southeast United States has shown (with the exception of Florida) that many states barely mention these demographics in their emergency plans [3]. While implementation of emergency alerting systems has been documented, there is still no consistent standard in practice to issue warnings or alerts across municipalities or states. The result of this gap is that communications to the elderly and people with disabilities are insufficient.

Wireless information and communications technologies (ICT) are important for people with disabilities and the elderly [4], as evident in the recent increase in ICT use among this population. Research on the use of social media has found that individuals over 65 have doubled their utilization of social media sites in one year (2008-2009), representing the largest increase of any age group during the same time period [5]. Results of the Wireless RERC's survey of user needs found that wireless technologies such as text messaging have become a key mode of communication for the deaf and hard-of-hearing and that a majority of people with disabilities indicate that accessible wireless communications would be useful during an emergency [6]. Both mobile emergency alerting and social media platforms fall into this category [7].



Since 2004 the Federal Communications Commission (FCC) has been working to modernize the Emergency Alert System (EAS) given the move from analogy to a digitally-based alert and warning system in the United States. They have sought public comment on how it could be more effective and accessible for warning the American public [8]. As a result technical standards and protocols to enable commercial mobile service (CMS) providers to send emergency alerts to their customers was developed and the Commercial Mobile Alert System (CMAS) will become commercially available in 2012 [9] [10]. The WEC technical team developed several prototype systems to study the experience of individuals with disabilities receiving these emergency alerts on mobile phones. Accessible prototype systems included conventional mobile phones using Short Message Service (SMS) and web services to deliver alerts, as well as prototype software with various features to address the needs of users with sensory disabilities.

Concurrently, research on multi-format platforms revealed that social media has emerged as tools used in emergency communications [11] [12] [13] [14]. Social media has already been used in the 2007 Virginia Tech shooting [15], 2007 California wildfires [16], 2010 Haiti earthquake [17], 2010 Hawaii tsunami warning [18], 2011 Australian floods [19], the Egyptian civil unrest/revolution of 2011 [20] and the 2011 Japan earthquake and tsunami [21]. Early in 2011, Craig Fugate, Administrator of the Federal Emergency Management Agency [22] (FEMA), attested to the usefulness of social media [23].

### **Wireless Emergency Communications And Accessibility**

As evident from the list of emergencies in the previous section, wireless technology and social media are becoming a means by which we stay connected, informed and in some cases warned during disasters. The federal government and wireless industries are currently exploring this evolution and working toward deploying solutions in mobile emergency alerting.

#### ***Mobile emergency alert field trials and findings***

A series of 12 field trials were undertaken to examine the accessibility of mobile emergency alerts. EAS message formatted trials are referred to herein as the “WEC method” because EAS messages are not currently sent to mobile devices in accessible formats. The WEC method was used in the first nine trials as follows; “The National Weather Service has issued a Tornado Warning for Test County until 10:15 am.” The SMS message was limited to 160 characters and contained a hyperlink to a web page containing the alert’s full content, formatted for accessibility and mobile viewing. The CMAS message format was used in the three CMAS field trials as follows: “Tornado Warning for Atlanta until 3 pm EST. Take shelter. NWS.” CMAS messages were limited to 90 characters with the EAS attention signal and vibration cadence, and did not include a hyperlink. In both EAS and CMAS tests, the mobile devices were loaded with client software capable of presenting alert content with accommodations for blind / low vision (text-to-speech) and hearing impaired users (specific vibrating cadences). Simulated emergency alerts were sent to each participant’s mobile phone; an observer monitored for system failure and usability problems. Before and after each test, participants completed a questionnaire to gather data on their experience.

Two focus groups were conducted to assess if American Sign Language (ASL) video enhanced the understanding of textual alerts for people who are deaf. Participants



conversant in ASL and comfortable reading English, were presented with conventional text alerts, as well as text alerts coupled with video clips presenting an ASL translation.

The majority of participants in both the “WEC method” trials (95%) and the CMAS trials (85%) received alerts via television (TV). In the pre- and post- test questionnaires for EAS, 92% confirmed information by turning on their TV. In the CMAS tests, 100% said they would confirm by turning on their TVs, indicating a link between CMAS (phones) and EAS (TV/radio) for obtaining and verifying emergency information. Ninety percent of EAS and 93% of CMAS trial participants indicated an interest in a mobile phone alerting service. Participants noted that although television was the prevalent method, it was not the preferred method because the information was not consistently accessible (lacks captions, video description and/or ASL interpreters). The attention signal was often not heard by a person with significant hearing loss, who would need to be looking at the television at the time the alert began scrolling or they would miss all or part of the emergency information. If a person’s primary language was ASL, some English text might be lost in translation. Anecdotal evidence reveals that EAS alerts via television broadcasts are inconsistent in their use of audio. People who are blind or have low vision will hear the alert signal, but often, the text crawl is not presented in an audio format; and when directed to news outlets for further information, video description is rarely available and news persons often direct viewers to “look here” when pointing at maps or “read the website or phone number at the bottom of the screen.” Despite FCC efforts to modernize the EAS, accessibility barriers still exist, in part because the viewer must rely on additional information sources to gather all the salient details.

More than 78% of all participants using the WEC method, stated the wireless emergency alerting system was an improvement over other methods they currently used to receive emergency warnings and alerts. Of deaf and hard of hearing participants, 72% considered the alerting of the accessible client software to be an improvement. The lower satisfaction of the WEC method with this population appears to be due in part to the accessibility features of the mobile devices not being sufficient in addressing their particular accessibility needs. Of blind and low vision participants, the percentage shoots up to 83%.

In the CMAS tests, 81% of visually impaired participants and 64% of participants with hearing impairments found the CMAS alerts to be an improvement. Post-test discussion, revealed that the WEC method received higher rates of approval because more detailed information could be provided, versus the very limited information allowed by the 90 character restriction and hyperlink prohibition prescribed by CMAS rules.

All ASL focus group participants agreed that ASL video alerts would be a useful tool for people that are deaf and literate in ASL. Some participants felt that the combination of text and ASL together gave them a fuller understanding of the message than either on its own. One surprising result of the evaluation was the difficulty of understanding some phrases typically used in NWS alerts, such as “take cover” or “low-lying area”; these idiomatic expressions do not translate well into Deaf English or into ASL, therefore the word choice used in text or ASL alerts should be carefully considered and vetted amongst this population.



### *Social Media's potential for alerting people with disabilities*

According to Harris Interactive, 65% of U.S. adults use social media (2011). The Red Cross conducted a survey entitled Social Media and Disasters [24], which found 16% of respondents have used social media to obtain information about an emergency and 69% of respondents felt emergency response agencies should monitor and respond to postings on their social media sites.

A recent Wireless RERC survey on the use of wireless technologies and social media by people with disabilities for emergency communications [25], identified similar trends in receiving, verifying and sharing alerts (2010/2011). Despite reports that social media platforms are not fully accessible to people with sensory disabilities [26] [27], approximately two-thirds of the respondents indicated use of social media. Facebook was the most widely used to receive and verify a public alert and 23% of the respondents have received an alert via one or more social media sites. Although desktop computers and laptops were the primary means to access social media (41% and 31%, respectively), 25% of respondents use more than one type of device (e.g., desktop and cell phone) to access social media.

	Received alert	Verified alert
Facebook	11.6%	8.6%
Twitter	4.6%	2.5%
Listservs	4.2%	2.1%
Yahoo	3.8%	2.3%
YouTube	1.3%	1.0%
MySpace	1.3%	0.7%
Google Buzz	1.2%	0.8%
LinkedIn	0.0%	0.6%
Foursquare	0.3%	0.3%

**Social media outlets used by respondents with disabilities to receive and verify alerts.**

	Percent
Desktop only	23%
Laptop only	12%
Cellphone only	3%
Desktop and laptop	6%
Desktop and cellphone	7%
Laptop and cellphone	7%
Desktop, laptop, cell	5%
<b>TOTAL</b>	<b>63%</b>

Devices	Yes (%)
Desktop computer	41%
Laptop computer	31%
Cellphone	22%

### **Do you access social media on the following devices? (exclusive/nonexclusive)**

A survey conducted by the FCC's Emergency Access Advisory Committee (EAAC), asked "Do respondents use a mobile phone, Smartphone or computer for media or text-

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messaging;” options included “social networking services such as Facebook or Twitter [28].” Eight-nine percent stated they used mobile social sites, with 41% using it almost every day [29].

To ascertain if there was a connection between social media use by the public and its use by emergency management entities, an assessment of the use of social media by states and municipalities was conducted. Each city/municipality and state website was analyzed to determine whether social media platforms were used for emergency alerts; only places that specifically used social media in an emergency alerting capacity were counted. Social media platforms were categorized under either general public safety or emergency alerts. The term “emergency alert” refers to departments such as the Department of Emergency Management and Department of Emergency Preparedness. Of the 100 largest cities in the United States [30], 45% of cities and 74% of states use social media to disseminate emergency information. These usage rates set a precedent and expectation amongst the American public to be able to receive emergency information via social media. As Craig Fugate of FEMA observed “Rather than trying to convince the public to adjust to the way we at FEMA communicate, we must adapt to the way the public communicates ... We must use social media tools to more fully engage the public as a critical partner in our efforts [31].” Included in this should be people with disabilities, but our research indicates that there is not widespread acknowledgement within government of the communication needs of people with disabilities during emergencies.

In addition, we evaluated whether or not government services were targeting or mentioning people with disabilities. Some cities/municipalities and states had website links for people with disabilities in conjunction with emergency planning, but only a couple of sites explicitly correlated social media, emergency communications, and people with disabilities.

	Local	State
Social Media targeting people with disabilities	2%	0%
<b>People with disabilities mentioned with emergency communications emphasis</b>	<b>11%</b>	<b>24%</b>
People with disabilities mentioned w/emergency services emphasis, no communications emphasis	38%	50%
People with disabilities emergency services not mentioned	49%	26%

**Government Services and People with Disabilities**

### Mainstreaming access for all: Reaching Everyone

Features of mainstream technologies, designed initially for people with disabilities, have frequently demonstrated features that are usable for all, and consequently have been adopted by the general public [32] [33]. Exemplars of this include closed captions and audio books [34]. Closed captions and audio books are widely used by the general public, the



former in loud venues such as bars and airports, and the latter as entertainment during road trips or household chores.

Accessibility features employed specifically for people with sensory disabilities can be beneficial for all end-users depending on their access and functional needs at any given time. A deaf person and a person in a loud environment have similar access and functional needs regarding access to information, a blind person and someone temporarily blinded by smoke trying to evacuate a building have similar environmental access and functional needs. Designing and planning for the access and functional needs of people during an emergency will cast a wider net, encompassing many different types of people in a myriad of situations, whether a permanent disability, or temporary one.

WEC field test participants without a disability still wanted the audio format of text alerts, a loud attention signal and strong vibrating cadence. When asked about environmental impact on receipt of alerts, these same participants stated that noise in the environment (“people talking”, “noise in the area”) made the audio hard to hear. If only one format had been provided, the alert information may not have been accessible, and if the attention signal was not simultaneously sound and vibration, they may have never been aware of an incoming alert. This is as true for our field test participants with sensory disabilities, as it was for those without. The WEC prototype brought assistive technology functionality to a mainstream device; seamlessly incorporated so no action need be taken by the end-user to upload an application or software. The same device could be used, without modification, by a person with or without a disability to receive mobile emergency alerts.

The development of accessible mobile social media for the purpose of emergency alerting should be a key policy objective. Facebook and Twitter presently are not required to be accessible; despite this, users with disabilities are finding ways to access the content, utilizing screen reader software or web applications to render the content in accessible formats. Government utilization of social media before, during and after emergencies to communicate with the public suggests that built-in accessibility of social media websites will become more pressing. “One of the challenges we face as a nation is ensuring not only that our technological prowess empowers ALL Americans to lead better and more productive lives, but also that we harness these tools to preserve and protect the lives, property, and public safety of ALL citizens by making them universally accessible and usable [35].”

## Conclusions and recommendations

At present, initial receipt and verification of alerts are still most often through the television, but as discussed, television has accessibility barriers. Among social media Facebook is currently the most popular amongst users with disabilities, however, research on state and local emergency response agencies indicates that Twitter is predominately used for emergency alerts and communications, revealing a disconnect between where citizens seek information and where agencies disseminate information. In concurrence, more research is needed to determine the factors that inhibit greater use of social media by people with disabilities to receive alerts; and reluctance of some emergency managers from using this medium to disseminate alerts.

Given these factors, redundancies and alternative sources should be put in place to ensure that people with disabilities receive the full alert and links to additional information. One





recommendation from the research conducted would be for agencies to place social media links for alerts in a prominent place on the home page of city emergency services websites, including, but not limited to police, fire, emergency management departments; as well as on the website home page of state departments that service the needs of people with disabilities and seniors. This redundancy would capture more users, as well as offer them multiple platforms such as Facebook and Twitter by which to receive the alerts.

In summation, the use of social media is increasing as well as the use of wireless devices, hence the more channels available for receipt of emergency information and alerts, the more likely a person with a disability will be able to select an option(s) that is most accessible for their use during emergencies. An informed public, taking correct action during an emergency can reduce the burden on emergency services/emergency response personnel. Incorporating social media outlets in the development of emergency communications systems and plans makes good strategic sense, and can become instrumental in preparedness, mitigation, response and recovery.

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## 1.6. Light Weight Ui Toolkit

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### Abstract

In order to effectively participate in the Information Society, people with disabilities need accessible communication technology. Legal requirements in the United States [1] and emerging worldwide [2] codify this requirement. While several accessible mobile phones have appeared on the market in the last few years, they are higher end smart phones - they aren't sold in the volume and price points that represent the majority of handset sales worldwide. Particularly given that the overwhelming majority of people with severe disabilities live in the developing world where the market is dominated by low-end feature phones, it is important that these mobile phones also be accessible.

As part of the AEGIS project, Oracle and several AEGIS consortium partners are developing prototype solutions for low-end feature phones by adding accessibility features to LWUIT - Oracle's Light Weight UI toolkit [3]. LWUIT has become the de-facto standard for writing Java ME applications and supports much of the UI concepts needed for accessibility.

In this paper, we describe the work being done within AEGIS, and the progress made to date in LWUIT for the blind for users with low vision, and for users with other disabilities.

### Background – the need for mobile accessibility

The mobile phone market has exploded worldwide, with 5.3 billion mobile phone subscriptions at the end of 2010 (reaching 77% of the worldwide population). Also at the end of 2010, there were 1.7 million new mobile subscribers each and every day (20 every second!) [4]. More than half of this growth has come in the developing world, where there are more than 3.8 billion mobile phone subscriptions.

In a growing number of countries, mobile phones are the primary way users interact with the web and Internet. This is already the case today in Egypt, India, South Africa, Ghana, and Kenya [5]. e-commerce on mobile phones is also rapidly growing, as well as mobile banking services.

Because of this mobile device penetration and the growing shift toward utilizing mobile phones for information, communication, and commerce, it is critical that the mobile phone ecosystem be accessible to people with disabilities. While the specific percentage of disability varies from country to country, generally there is a higher incidence of disabilities among the population in the developing world – where there are fewer resources available to help disabled individuals.

Likely because the bulk of mobile phone sales are in the developing world where there is less disposable income, inexpensive feature phones remain the bulk of mobile phone sales – 1.36 billion mobile phone were sold in 2010, and less than 300 million of those were smart phones. At the same time, in 2011, over 85% of new mobile phones will be able to access the mobile web (a number above 90% in the U.S. and Western Europe).

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## State of the art in accessible mobile phones

In the last few years a succession of smart phones have been made accessible to users with a variety of disabilities, including most notably blind and low-vision users. The core functions of the low end feature phones based on the Symbian platform, and for the Windows Mobile 6.x smart phone platforms, have been accessible for a number of years to blind and low vision users through the use of 3rd party commercial mobile screen readers and screen magnifiers [6] which use reverse-engineering techniques to make the basic phone features accessible.

More recently several advanced smart phone platforms have become accessible to blind and low vision users: BlackBerry phones can use the new Clarity themes for some vision impairments, and the commercial Oratio screen reader enables blind use of BlackBerry – providing access to all apps built using the BlackBerry user interface components. The Apple iPhone 3GS and iPhone 4 include built in Zoom functionality and the VoiceOver screen reader which work with all applications built using the iOS user interface components. Android smart phones based on Android OS version 1.6 and later include the TalkBack screen reader, work with the optional Eyes-Free shell, and work with the commercial Code Factory Mobile Accessibility screen reader – again all providing access to applications built using the stock user interface components.

## Importance of Java technology feature phones

As noted above, roughly 78% of the mobile phones sold in 2010 were inexpensive feature phones. Most of these phones run the Java Micro Edition (Java ME) environment – it is on more than 3 billion mobile phones. Java also remains one of the most popular programming environments – there are over 9 million Java developers worldwide – and there are many thousands of Java mobile applications available for Java ME phones.

Furthermore, the Java mobile environment continues to grow in capability – all while reaming within a very small memory and processor foot print that enables mobile phone manufacturers to sell in huge quantities at low prices. For example, the latest releases of the Java ME Lightweight UI Toolkit (LWUIT) provide a very rich set of user interface components, including the ability to play rich video media and display xhtml web content. The Oracle Java Wireless Client includes all of the capabilities to run a mobile phone user interface, as well as APIs for using all of the hardware on modern mobile phone handsets – like Bluetooth, mobile media, SIP, 3D graphics, telephony, mobile sensors, RFID and near field communication hardware, geo-location, etc.

The combination of a huge market of existing and continuing sales of inexpensive Java mobile phones, the pressing need for accessibility, the powerful and growing capabilities of Java ME feature phones, and the large base of talented Java developers mean that this environment remains a very important accessibility focus, and represents a unique opportunity to bring accessible ICT to many millions of people with disabilities worldwide.

## AEGIS Open Accessibility Framework

The AEGIS [7] project has developed the Open Accessibility Framework [8] which defines a set of six steps for building an accessible environment. In summary, these six steps are:



- [1] Define what “accessible” means for the environment. This includes defining a navigation / manipulation scheme for the user interface, defining theme behavior for vision impairments, and defining the platform’s accessibility API
- [2] Implementing this definition of accessible on the stock user interface elements / components
- [3] Provide developer tools that assist developers in using the accessible stock user interface elements to create accessible applications
- [4] Include support in the platform for accessibility – including implementing the navigation / manipulation scheme, theme support, and accessibility API
- [5] Develop accessible applications
- [6] Develop assistive technologies

We are addressing all six of these steps for the Java ME platform as part of the AEGIS project. Specifically for developers writing LWUIT applications, we have:

- The existing keyboard navigation / manipulation scheme for LWUIT, with a few extensions for navigating HTML content in the xhtml component (OAF step 1)
- Defined an initial set of accessibility themes for LWUIT (OAF step 1)
- Defined an initial mobile accessibility API (OAF step 1)
- Implemented that initial mobile accessibility API for LWUIT (OAF step 2) and tested our high contrast and large print themes for LWUIT (OAF step 2)

Separately, we have begun work on a set of prototype modifications to LWUIT Resource Editor to help developers use LWUIT to create accessible applications (OAF step 3), are developing a set of accessible LWUIT applications, and are building prototype assistive technologies to run on Java mobile devices and with LWUIT applications running on Android.

### Our technical work

Because inexpensive feature phones remain very important in much of the worldwide mobile marketplace, it is critical that adding accessibility support to Java mobile and LWUIT not add significantly to the existing Java ME/LWUIT RAM and processor requirements – so that these feature phones can remain inexpensive and thus affordable to people with disabilities worldwide. The requirement leads to a set of technical constraints, which in turn lead to the specific prototype implementation we have built.

### Constraints

Java ME is designed in part to run on inexpensive feature phones with severely constrained microprocessor, RAM, and ROM footprints. These are phones with as little as 2MB of RAM, several hundred KB of ROM, and processor speeds measuring in the tens or perhaps low hundreds of MHz. Such devices are being sold for less than \$50 – without a subsidizing 1-2 year service commitment.

In order to enable the greatest number of people to have access to an accessible mobile phone, it is critical that adding accessibility support have a very minimal impact to the RAM, ROM, and microprocessor speed requirements. Furthermore, since the overwhelming majority of mobile phone users don’t need a screen reader or other assistive technologies, it is likewise critical that there be virtually no impact to RAM, ROM, and microprocessor speed



requirements when an assistive technology is not running – even when the applications may be specially designed to accessible.

Separately, it is important that enabling accessibility support, and installing any assistive technologies (AT), be very easy – without compromising the integrity of the security environment. This should be the case whether the AT is developed in Java for running alongside the Java ME app inside the runtime, or native AT running outside the Java runtime.

Finally, it should be easy for application developers to add any necessary accessibility metadata to their applications – such as alternate text for images or programmatic linkages between labels and the fields they are labelling – while incurring only a very minimal increase in the size of their applications for this metadata.

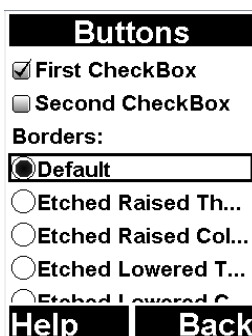
## Our implementation

### Keyboard operation

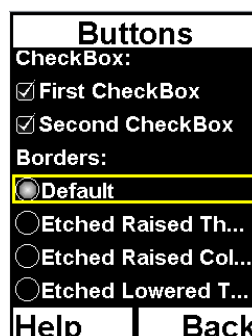
As LWUIT is design to be used on a variety of phones, both with and without touchscreen displays, the LWUIT user interface navigation / manipulation scheme can be driven completely from the mobile phone keyboard, including a pair of soft keys. Every LWUIT user interface element can be navigated to and within via the mobile phone keyboard. The sole exception to this is that non-link, non-form elements within the xhtml container cannot by default be navigated on a character-by-character or word-by-word fashion from the keyboard, as there is no user interaction capability with that granularity. Our prototype accessible xhtml implementation does not addresses this yet.

### Theme support

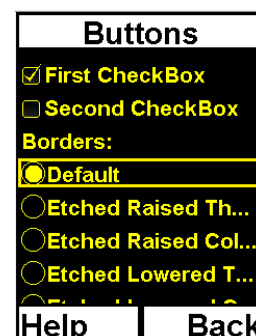
LWUIT is designed to be theme-able (or skin-able). However, the focus of this support was for changing the branding/UI expression for a variety of different looks and audiences. As part of the AEGIS project, we have developed a set of themes optimized for users with a variety of vision impairments. These include: standard size and large print themes in black on white, white on black, and black with yellow.



LWUIT buttons: high contrast black on white



LWUIT buttons: high contrast white on black



LWUIT buttons: high contrast yellow on black

Because these themes are optional, they would only be installed for those users that need them. For the vast majority of phones, there will be no memory, storage or performance impact.



## Accessibility API

As part of minimizing the impact of implementing accessibility support on LWUIT, the Accessibility API is implemented using the “Broker pattern”. A separate class that knows both LWUIT and the accessibility API is loaded into the runtime of the LWUIT application (while a different one could be loaded for other UI toolkits like LCDUI in the future). In this fashion the assistive technologies doesn't need to know any LWUIT API details, and application developers and toolkit writers can create accessibility support for custom components and non-LWUIT components. At the same time the LWUIT libraries and APIs don't have to grow – in memory or flash – in order to implement these new accessibility APIs. The only requirement is that LWUIT provide a way to associate accessibility metadata with LWUIT components – which is already does with the LWUIT `putClientProperty()` (and corresponding `getClientProperty()`) call. This ClientProperties mechanism means that applications need only put key: value pairs into the client properties of those few components that need additional information – such as the alternate text for an image or a description of a dialog box – which is a very minimal memory footprint increase for accessibility.

This contrasts with the Java SE Accessibility API (in the package `javax.accessibility.*`). Here the Java Accessibility API itself is part of the Java SE platform, and the Swing implementation is embedded in the individual Swing components as inner classes. This adds tens of kilobytes to the size of the Swing classes both on disk and in memory. Furthermore, adding alternate text to an image or a description of a dialog box involves creating a complete new inner class with all of the accessibility data fields populated in memory – which further adds to the processing and RAM footprint of the accessible Swing application.

## Accessibility API getters, setters and metadata – via the Broker

The getters of the accessibility API provide all of the static information needed by assistive technologies. This includes things like the name (and where appropriate) the description of each component, its location on the screen, what role it has (button vs. checkbox vs. dialog), what its parent/container is and what child objects are contained within it, etc. There is also a collection of optional getters that are only implemented where appropriate – things like the minimum, maximum, and current value of a slider (which doesn't make sense for a text label).

The Broker class implements these getters, and in most cases the Broker uses its knowledge of LWUIT to provide the correct information directly. For example, the Broker knows that a component is an instance of `com.sun.lwuit.Button`, and therefore it will return an `AccessibleRole` of “button” for that component. Likewise it knows how to retrieve the text being drawn in the button (via the `com.sun.lwuit.Button.getText()` method) and so will return that as the `AccessibleName` of that button.

Sometimes, however, the developer needs to explicitly provide the information that would be returned by the Broker. These are the setters. Perhaps the button has no text because it is an image only button (and had the developer set text via the `com.sun.lwuit.Button.setText()` method, it would have been drawn which is not what was desired). Perhaps the developer has a custom LWUIT component which has a different `AccessibleRole` from what would normally be provided by the Broker in the superclass. In these cases, the developer should simply call the `com.sun.lwuit.Component.putClientProperty()` method with the appropriate

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key & value for the accessibility property in question – as per the LWUIT accessibility documentation. The Broker's logic always first checks for the presence of this metadata, and only falls back on LWUIT calls if it isn't present.

In addition to the “standard” metadata that provides overriding information for the Broker to use instead of what it finds out from LWUIT directly, there is another very important use of `putClientProperty()` and accessibility metadata: relationship information. In order for an assistive technology like a screen reader to properly tell the user that the edit text field they have just arrowed to is labelled “Name:”, there needs to be a programmatic association between the label and the edit text field. `ClientProperties` are again used for this. However, since LWUIT has a method for association labels with components – the `com.sun.lwuit.Component.setLabelForComponent()` method – developers can simply use this. Other relations – such as grouping relationships – can only be set explicitly with the `putClientProperty()` method.

### Accessibility API event notification – via the Broker

Many assistive technologies are significantly event-driven. This is particularly the case for things like screen readers and screen magnifiers, which track what the user is doing and speak or magnify the user interface component the user is interacting with. These assistive technologies register for the events they need. When they receive these events, they make additional queries as needed, and then re-present information in an alternate form as appropriate: e.g. a screen reader speaking “Text field address editable” when the user arrows to the editable text field labelled 'address'.

As with the getters of the accessibility API, events are likewise handled via the Broker. AT register for events via the Broker, which in turn use LWUIT event APIs to register for those events that LWUIT supports. For events not currently exposes via LWUIT, the Broker uses an efficient polling mechanism (e.g. when a new screen or “Form” appears).

LWUIT developers don't have to do anything special to support events, unless they are creating components entirely from scratch.

### Current status of the prototypes

The prototype today runs in the JavaME emulator – using either the Java Wireless Toolkit version 2.5.2 or the Java ME SDK 3.0. It consists of an initial draft of Java ME accessibility API, a prototype implementation of that draft in the Broker class, an inter-process communications bus, and a simple sample mobile screen reader using cloud-based text-to-speech.

### The initial Java ME accessibility API

The initial accessibility API getters, setters, and events are modelled on those provided by the Java SE accessibility API, the `IAccessible2` API, and the GNOME accessibility API. It is intentionally a subset of those APIs, based on what we have found to be actually used in practice by the assistive technologies that are utilizing them. The metadata for roles, states, and relationships is drawn from the WAI ARIA specification, which contains probably the most up to date taxonomy for these.

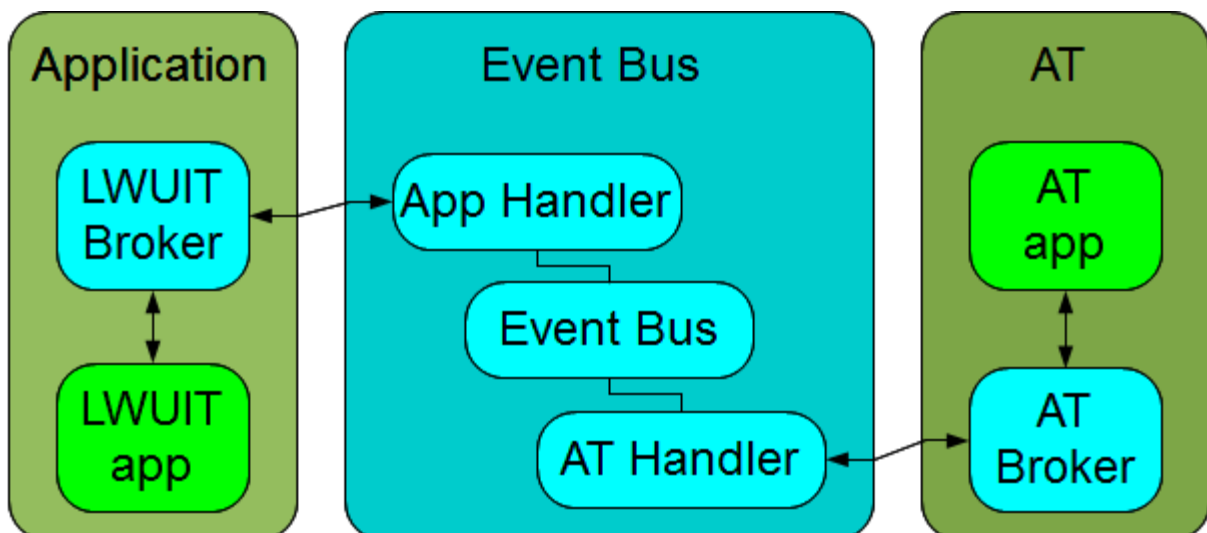
The prototype implementation consists of the following parts:



- the `accessibility.common` package, which consists of:
  - the metadata constants for roles, states, and relationships as drawn from WAI ARIA
  - the base `AEvent` event class and the specialized event subclasses
- the `accessibility.bus` package, which contains the classes needed for the inter-process communication accessibility bus MIDlet
- the `accessibility.at` package, which contains utility classes for use by developers of assistive technologies including the `ATBroker` and event listeners
- the `accessibility.app` package, which contains utility classes for use by developers of mainstream applications that are taking specific action to support accessibility in their applications

Today, these parts are put together as a set of Java ME MIDlet applications which run separately from one another. In the future we anticipate enabling them to run alongside one another, perhaps even in the same Java ME runtime.

These three MIDlets are the Application, the Event Bus, and the Assistive Technology or AT:



**Three MIDlets running in an accessible JavaME environment - the Application, the Event Bus, and the AT**

The Application is simply any LWUIT application, with the Broker loaded into the runtime to handle accessibility on behalf of it. The Event Bus implements communication between the Application and the AT, using TCP/IP today – and potentially the pipe protocol communication in the future. The precise communication mechanism is abstracted via the Broker, so neither the Application nor the AT need know about the implementation details. Finally the AT is the application re-presenting an alternate user interface that is accessible. It contains an instance of the `ATBroker`, and any event listeners needed for receiving and processing events. Through the `ATBroker` it makes all of the accessibility API calls it needs to.

#### *How the pieces work together*

In the current prototype, the first thing that must be done is launching the Event Bus MIDlet. This Java ME application opens two TCP/IP ports – listening respectively for messages

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coming from accessible applications (via the Broker class) or ATs (via the ATBroker class). For each pair of App:AT, it creates an AppHandler/ATHandler instance. It listens for AT queries, and forwards App events to the AT as requested.

Typically next the AT itself would be run. The AT creates an instance of the ATBroker, and informs it of the events it wants to listen for. It can then make queries in response to the events it receives (e.g. finding out information whenever it receives a Focus event), or whenever it wants to (perhaps in response to a user request to get an overview of the screen, or to move the text caret location or check a checkbox).

Finally, the application itself is launched. In the prototype today, the application explicitly loads the Broker class, and calls `Broker.init()`. The application may do more things to explicitly support accessibility – things like connecting labels to the fields they are labeling with `com.sun.java.lwuit.LWUITComponent.setComponentLabelFor()`, and of course explicitly adding appropriate metadata via `com.sun.java.lwuit.LWUITComponent.putClientProperty()` for any custom components.

### Related work

This paper is focused on the first two steps of the Open Accessibility Framework: defining “accessible” and implementing it on the LWUIT user interface components. In this section we briefly describe related efforts in AEGIS addressing the other 4 steps of the OAF for Java ME.

### *Helping developers create accessible apps: OAF step 3*

The LWUIT GUI Builder is an open source tool to help developers create LWUIT applications. It uses a “drag and drop” style palette, along with an integrated IDE to quickly create LWUIT UIs and applications. Another AEGIS activity involves modifications to the LWUIT GUI Builder to help developers create accessible apps. The main ways we are looking at helping developers are:

- Ensuring that all labels are connected to the fields they are labeling
- Ensuring that there is a reasonable focus traversal order
- Helping add appropriate accessibility metadata – such as a name and description to images

In addition, the sister project ACCESSIBLE has developed DIAS, the Disability Impairment Approximation Simulator. We are exploring ways to enable LWUIT developers to simulate their application running on a desktop using a variety of disabilities.

### *Platform support for accessibility: OAF step 4*

As noted above in the section “”, the Accessibility Bus and AT MIDlets must be loaded by hand, and the application must explicitly call `Broker.init()`. We are exploring ways of making this happen automatically as a user configurable option on Java ME.

### *Creating accessible apps: OAF step 5*

Because of the way we have implemented accessibility in LWUIT via the Broker, theoretically every LWUIT application can be an accessible application. In addition to opening up the existing world of LWUIT applications – at least those that use only stock LWUIT components – we are also developing a number of sample accessible LWUIT applications. This includes

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some slight modifications to the standard LWUIT UI Demo application, as well as several custom built applications in the AEGIS project to expressly address a number of disabilities including users with cognitive disabilities. These include a Contact Manager, a Messenger application, and a Real-time-text communications application.

### Creating assistive technologies: OAF step 6

Finally within AEGIS we are developing a prototype screen reader assistive technology that will work with accessible LWUIT applications. It will be an event-driven prototype, responding to events and other user actions and reading the various aspects of the user interface via text-to-speech.

### Conclusion

The full AEGIS Open Accessibility Framework is completely applicable to the memory and processor constrained environment of high volume, inexpensive mobile phones running the Java ME platform. By doing so, we can leverage state of the art accessibility techniques to build a rich accessibility environment that can deliver ICT accessibility to the billions of feature phone users worldwide.

The specific prototype approach we have developed – providing custom accessibility themes for vision impairments and using a Broker library to implement this accessibility API support for assistive technologies – should allow significant accessibility to be provided to existing LWUIT applications without needing to modify or even recompile them (so long as they are using only stock LWUIT components for their UIs). Further, our research demonstrates that annotating LWUIT applications with appropriate accessibility metadata – such as alternate text for graphics, and linking labels to the fields they are labelling – has only a trivial impact on the footprint of the accessible application.

Our research and prototypes demonstrate the ability of the Java ME platform and LWUIT to be a complete accessibility environment.

### Acknowledgement

The authors would like to acknowledge the financial support provided by the AEGIS Project which is funded by the European Commission.

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[7] Described at <http://www.aegis-project.eu>

[8] AEGIS deliverable D1.2.1 “AEGIS OAF and high-level architecture” should shortly be posted at [http://www.aegis-project.eu/index.php?option=com\\_content&view=article&id=12&Itemid=30](http://www.aegis-project.eu/index.php?option=com_content&view=article&id=12&Itemid=30)



## 1.7. Developer Tool For Creating Accessible GUIs In Android Mobile OS

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### Abstract

The Android OS (Operative System) is a powerful mobile open platform which allows designers and programmers to develop almost any kind of application. However the Android SDK (Software Development Kit) has some limitations when approaching accessible developments. This native lack of accessibility is something that can be fixed by providing a complete set of tools to enhance the accessible developments and simplify the GUI (Graphical User Interface) design process. This paper presents these set of tools and the enhancement of an open source tool called DroidDraw used to create GUIs.

### Keywords

Accessibility, Android, DroidDraw, framework, developer tool, mobile GUI.

### Introduction

Developers can create a wide set of solutions relying on the Android OS but unfortunately, the system was not created thinking deeply on accessibility. People with visual impairments could find very hard to interact with the Android applications and the system itself. Although the mechanisms provided by the OS and its SDK allow to develop accessible applications, yet exists a lack of a potent system-level accessibility mechanism and due to this limitation, applications developed without considering accessibility will not behave in that way even when the accessibility options are enabled. As the default accessibility mechanisms are not enough to offer a complete accessible experience, our aim is to propose and develop scalable, maintainable and efficient open source solutions to enhance the Android accessibility platform, trying to offer a complete accessibility framework to the Android application developers and designers that will improve the native Android capabilities and will make easy to create accessible applications.

### Accessibility On The Android Platform

Since the 1.6 version of the Android OS, the API included in the SDK has Text-To-Speech (TTS) functionality [1]. This TTS capability allows developers to integrate accessible components into their applications with more humanlike interaction.

Therefore it enables the development of screen readers or accessible user interfaces. These interfaces will allow people with visual impairments to interact faster and to control the OS and its applications. This interaction is an improvement, according to their capabilities, compared with the classical way.

The Android TTS library includes a powerful voice synthesizer that supports English, French, German, Italian and Spanish languages. These language packages can be also downloaded

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and installed by users. The device configuration will auto-detect the user language preferences and other device configurations. Since the Android 1.6 version the behaviour of the application can be also improved by creating an accessibility service for the operating system (OS) which is the main accessibility mechanism provided yet by the platform. The accessibility services provide not only spoken feedback, but also auditory (non-speech sounds) and haptic (vibration). These mechanisms, in conjunction with the capabilities of interface elements (e.g.: focusing states or associated textual metadata) provide a huge software support, setting the Android accessibility API limits on the devices hardware and the Android OS itself.

Another way to provide accessibility is offered by the gestures library. Gestures may be used in applications to improve accessibility as this allows users to interact with the device in other ways as when the user performs a gesture over the screen; the call back for the recognised gesture is performed.

Nevertheless these developments are not trivial. This API is specialised on giving non-visual feedback to users at application-level, but the OS itself is not natively designed to cope with accessibility. Other systems, such as iOS, are more advanced in this subject; therefore Android OS needs more support and further extension to provide more complex accessibility at system level, and thus better integration with the accessibility API. That means, in a nutshell, that developers can create accessible applications but if an application was not designed concerning accessibility, the system mechanisms are insufficient to deal with it.

### Accessibility Services On Android

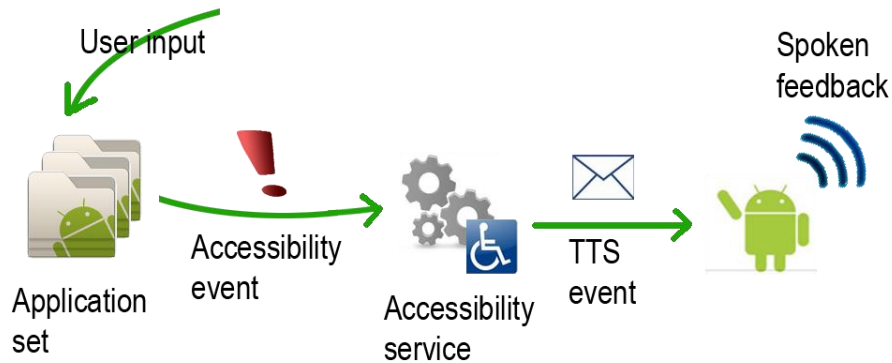
When designing accessible components, the first step to be performed is an accessibility service.

An Android service [2] is an application level component that has an internal working similar to the common Android activities (a main part of an Android application). Instead of having an associated view or interface, they provide other functionality running as background tasks which are usually bound on producing and/or consuming information. The services may work in conjunction with other activities, usually sharing a common thread, or like in accessibility services, running on their own being managed by the OS. The accessibility services act in a slightly different way as they have several special API calls designed just for them.

Usually, in an Android accessibility architecture, there are two main parts: the set of accessible applications and a common accessibility service. The applications will send messages (accessibility events) to the accessibility service and these events may include all the information necessary to provide the desired feedback. The accessibility service will catch all the events and treat them in any way the developer needs. Also this mechanism can be activated or turned off by users on demand.

This architecture provides a powerful resource for all the developers. A programmer can create an accessibility service which handles all accessibility events triggered by his/her applications, instead of working directly with the Text To Speech implementation.





### Accessibility service use case.

This accessibility service is a key component of the entire accessibility framework that it is being developed as the accessible behaviour of all the custom Android components being developed relies on this implementation.

### Developing Accessible Components

The Android platform provides enough resources to create custom graphical components from the native ones (such as buttons, text labels, etc...) or even new ones. All that customized components integrates perfectly on the Android applications and can be used later easily in different projects behaving as the programmer wants.

There are useful components that are not natively integrated into the Android SDK and all the other ones are not properly designed for accessibility even though they are all capable of accessibility. Hence it is interesting to provide some useful widgets that are not yet included in the current Android version; allowing other developers to create accessible applications using these accessible components.

### Accessible widgets

With these components, developers would save time and effort since are provided solutions to common problems.

Some of these widgets are:

- **Calendar:** This component is a simple scalable calendar. When it is instantiated it takes as reference the system date and provides spoken feedback to the user interactions with it. This implementation does speak the date, day of week, month and year of the selected date to the user. It can handle screen orientation changes and it also can be scrolled up and down when it does not fit in size with the screen height. It has also been designed taking consideration of some visual diseases so the background and fonts colours have high contrast between each other. All of the text fields are multi language.

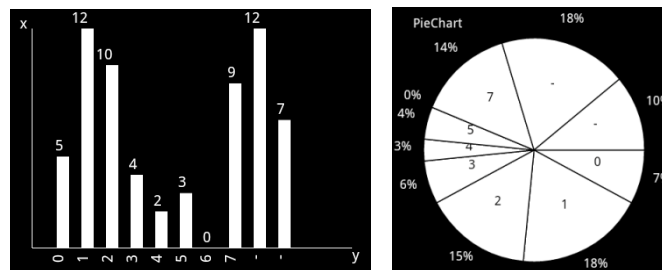






**Accessible calendar widget.**

- Charts: Other component that is usually useful and was not yet included into the standard Android platform is the graphical representation of numerical data. We have developed two different solutions, a simple histogram chart and a pie chart. Again, these components were designed thinking of having high contrast between its elements and the background. However, the colours of the graphical representation and fonts are both fully customizable. The accessibility of these components relies on its response to user interaction: when the user touches the chart, all the graphic data is spoken.



**Histogram and pie charts.**

- UISwitch: An iOS like switch component. It has two states (on and off) and that state can be switched by sliding its selector horizontally over it or just with a single click when it has focus. When its state is changed, it can also trigger an event if desired so the developer can catch that signal and act the way he wants.



**UISwitch appearance in both states**

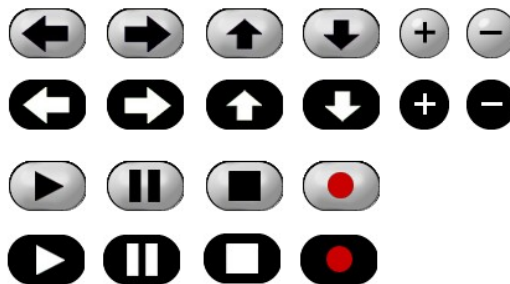
- Vertical progress bars: Other component developed is a vertical progress bar from which we can also create a vertical seekbar.





### Vertical seekbar

- Accessible buttons: There was implemented some custom button controllers with a related icon on them. These buttons should be used to control the action that its icon shows (e.g. Play, pause, stop media... previous or next, etc). These are also high contrast buttons with two related states. When these buttons are focused, then its selector makes their appearance to change to another contrasted image.



Custom button set and its selectors (in black).

### Accessible containers

It is desired to emulate the entire iOS system accessible behavior but unfortunately that is not possible since it is desired that the Android OS core remains unchanged. Modifying the Android kernel would make our solutions incompatible with the rest of Android versions, also the future ones.

So accessibility cannot be provided to applications that are not designed for it. The only option is to provide resources to make accessible applications.

The proposed solution is to create accessible component containers (layouts). With this mechanism, it is possible to provide an enhanced accessibility behavior of all the applications using it. This is a transparent, simple, scalable and innovative solution which will not cause any trouble for future developers. It would not affect the code performance and will give a very easy way to achieve accessibility for every Android native component, including the future ones.

The achieved objectives are:

- To provide a mechanism to the developers so they can program accessible Android applications by default without regarding about accessibility. The created solution provides all the accessibility mechanisms transparently.
- To provide accessible behaviour to the most important Android widgets.
- To assure the interoperability of the solution avoiding extending all these components or modifying the Android kernel or the OS itself, just using the default Android functionality.

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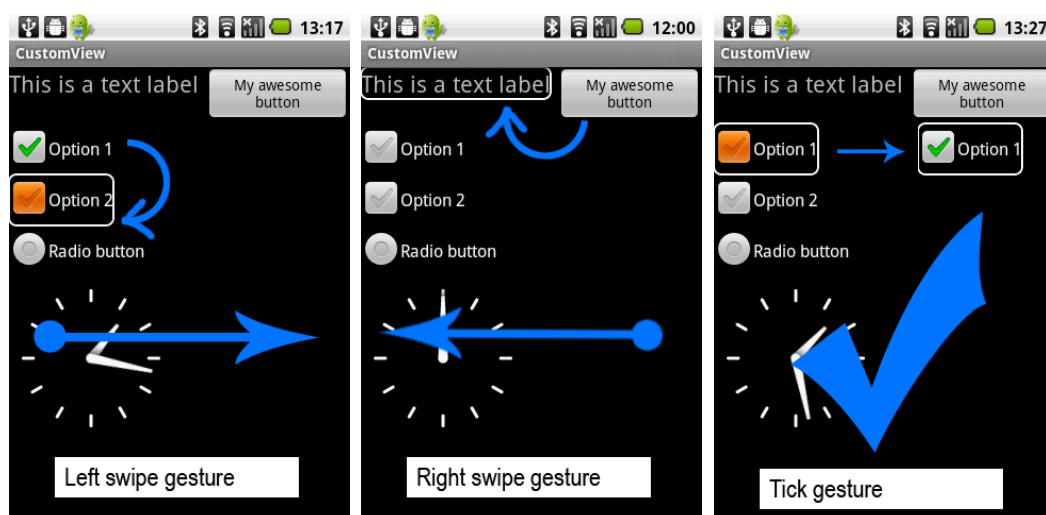


- To maximize the compatibility with the different Android versions of the OS; granting correct functionality from the 1.6 Android version to the current 3.0 version.
- To provide a scalable set of solutions, easy to extend and update to newer Android versions or newer Android components and also, providing multi language capability.

The accessible containers are simple implementations of an accessibility service bound with a set of widget container layouts. In this case, there are offered three different modified implementations of the Android RelativeLayout. This layout is one of the most flexible widget containers provided by the platform as it allows the GUI designers to locate the widgets within the screen almost where they want but in a relative position from the other widgets or the screen itself. So the result is usually a GUI which is multi resolution and multi screen size compatible.

These components behave as following:

- User touch inputs: If the user touches any component on the screen (e.g. a text label) this component will be marked as selected, its bounds will be remarked and the component description will be talked through TTS. If the component has some associated behaviour, as a button, the first touch will select the component and a second one will trigger the component's action.
- User trackball motions: There are also handled the trackball events of the compatible devices. With the trackball, users can navigate through the entire layout in a sequential order. The elements will gain focus as they are selected and a trackball push event will activate the selected widget action.
- Gesture detection: We also implemented a simple and usable motion event detector. With this mechanism, when a user input touch is hold, then a gesture pattern recognizing system starts working. It allows navigating through the layout when the user's device has not trackball. A swipe of the finger across the screen (from left to right or backwards) will select either the next or previous element on the screen. A "v" or tick shaped gesture will act as a click over the selected item.



**Gesture patterns examples and its actions**



## The Droiddraw Framework

After having developed some accessible components, the accessible containers and the accessibility service, it is time to put it all together into a framework and give the GUI designers a useful tool for creating not only accessible Android applications but also the GUI.

There exists an open source tool named DroidDraw which was created shortly after the first Android release by a freelance programmer named Brendan D. Burns [3]. As the first Android SDK versions didn't have a GUI creator, the DroidDraw tool main goal was to provide that functionality.

The DroidDraw tool has a blank canvas simulating a device screen. It also has the set of provided Android widgets than can be drag & drop into that canvas for composing a valid Android layout which can be exported later into a valid Android XML layout file. This file can be exported to an Android project including the provided resources, accessible components (widgets and containers) and the accessibility service.

With all that mechanisms, accessible containers, widgets and services provided, the improvement of accessibility on the Android platform is certainly approached. With this framework, developers can create powerful accessible applications easily.

## Experts Feedback And Conclusions

An expert Android developer focus group was carried to show the developed products and get the first feedback, opinions and impressions. The conclusions reached by the experts fits with the ones achieved by the promoters of this project so it is interesting to group these findings in the last part of this paper.

The expert focus group was composed by five Android developers and a 30 minutes guided discussion. Before they all shared their own opinions, a demonstration of the developed products was made and some of them also could interact with the prototypes.

Among the experts only three of them have developed accessible applications. This is due to the requisites of the projects they worked on. Creating an accessible application does cost more time and resources just because the developer has to design and code all of that functionality.

The provided framework mitigates this problem. However, the experts would like to have on hand by default these resources on the Android SDK instead of having to import all of them into their projects. This may cause the given solutions to have many developers avoiding to use it just for ease, leading into a limited spreading. In AEGIS project this tool will be deeply tested with developers in the different pilot sites, in the 3rd phase that will be held from January till May 2012.

Apart from that, the framework it is an interesting approach and those who need to develop accessible applications in the future will use it. The DroidDraw framework also works well but requires some time to get used to it and experts usually are capable of writing the GUI XML without assistance and at high speed. Some of the experts who have reached these skills would prefer to avoid using the GUI assistant although they would use the rest of the resources.



Finally, the next steps to take relies on fixing some minor bugs and performing a review with blind people who will give a better feedback as they are the target of the final products created with the framework.

As a final conclusion, we believe we have reached the proposed goals and we have made the better accessibility approaching allowed by the latest Android versions.

### Acknowledgement

This work has been carried out as part of the AEGIS (Open Accessibility Everywhere: Ground-work, Infrastructure, Standards) project co-funded by the European Commission under the Seventh Framework Programme funding for Research on e-Inclusion, grant agreement No. 224348.

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## 2. Session 2: ACCESSIBLE Workshop

This workshop started with 2 papers that addressed the accessibility evaluation of mobile, web and internet applications and services. After this introduction, the workshop demonstrated following applications from the ACCESSIBLE workshop:

- [Disability Impairment Approximation Simulator – DIAS](#)
- [Web accessibility assessment Tool – WaaT](#)
- [Web Service accessibility assessment Tool – WebSaaT](#)
- [Mobile Web accessibility assessment Tool – MobileWaaT](#)
- [Description Language accessibility assessment Tool – DLaaT](#)
- [Mobile Impairment Simulation Tool – MIS tool](#)
- [Development and Evaluation Web Portal](#)

### 2.1. Accessibility Issues Simulation For Mobile Applications

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#### Abstract

In this paper we have identified and analysed important accessibility issues typical for the world of mobile devices and we have compared them with common sets of accessibility guidelines. We have filled the gap we have identified, by means implementation of simulation tool that provides mobile application developers convenient way how to simulate these issues with any mobile platform. It is developed as a transparent layer that can be placed over the mobile platform simulator and provides effects such as reflection, finger occlusion, tremor or simulation of visual impairments like tunnel vision, blurred vision or colour blindness.

#### Keywords

Accessibility, Mobile application, Impairment simulation

#### Introduction

Importance of mobile applications is growing rapidly as it provides access to variety of very useful services. Moreover the penetration of mobile phones into everyday life is higher than any other ICT. Especially a smartphone became a useful assistant for everyday life. In particular the impaired users found it a very powerful supportive device in various situations. It is possible to say that every impaired ICT user is using at least mobile phone. Therefore it is necessary to keep in mind the accessibility of mobile applications in order to avoid exclusion of impaired users. Unfortunately the field of mobile applications and devices lacks sufficient effort towards their accessibility. Ignoring the accessibility of mobile applications and devices affects in the largest extent users with visual impairment who create a relatively large segment of the market. Therefore we focus primarily on this user group.

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## Problem Description

Lot of effort has been put towards the desktop application accessibility and some approaches and practices can be easily reused in the field of mobile devices and applications (e.g., importance of accessibility APIs to enable TTS for blind users or image contrast issues for low vision users). However the mobile environment brings new issues that are not present in the world of desktop computers and thus needs a specific handling (e.g., lighting conditions).

There are several well established sources of guidelines that describe the accessibility requirements for users with different kind of impairments. These guidelines should serve as a basis for building of the guidelines for the mobile applications accessibility. All these guidelines focus strictly on applications itself and does not take into account physical environment that also influences the accessibility in mobile environment. There are also tools helping with accessibility of web pages for mobile environment like the W3C MobileOK Checker [3].

Existing guidelines should be modified and extended by solutions targeting the specific issues of mobile applications and physical environments. An important source of guidelines that should be used primarily is set of W3C WCAG guidelines [1]. WCAG guidelines version 2.0 are organized according to four key principles: perceivable, operable, understandable, and robust [2]**Error! Reference source not found.** We will follow these principles.

Following the **perceivable** principle we concentrate on presentation of information in a way that user can perceive and understand it efficiently and easily. We need to provide good descriptions for all non-textual content. Functional elements (entities) need to be named according to what they are expected to do. Contrast between text and its background is important as well as a possibility of smooth increasing of the font size. The perception in the world of mobile applications is mostly influenced by the mobile device display quality (size, colours, brightness, contrast) and physical environment conditions (especially visual and acoustic). Very important problem is a combination of issues like sharp change of environmental lighting in combination with light sensitivity impairment of the user. All these situations can cause an accessibility issue.

The **operable** principle concentrates on possibility of interactions with all elements of the user interface. On the desktop lot of effort is put into the keyboard accessibility. In world of mobile devices there are typically reduced keyboards and recently the majority of newly developed mobile devices do not have any HW based keyboards. They are equipped with software keyboards only, that are much more complicated to use for users with low vision or blindness. Finally the design of operational HW keys (like home, back, search) is more often designed in a way that cannot be haptically perceived without activating their function. The SW keyboards, large touch screens and haptically unrecognizable HW keys represent a source of completely new accessibility issues.

The **understandable** principle concentrates on intuitive and consistent design of controls, good readability and understand ability of text (e.g., indication of language of given text). It is focused on the issues users are facing when filling forms and prevent creation of mistakes. If some mistakes are present, system should inform user about the error occurrence in a proper way and guide them to correct those errors easily. In mobile environment we are facing the problem of much higher number of interruptions of user's work (like interaction with



passing people) and necessity to perform several tasks in parallel (filling a form while crossing the street). If we imagine combination of these situations with user's impairment we will end up with very complicated situations that have to be checked against the accessibility guidelines.

**Robust** principle covers the last area. This principle concentrates on making applications robust in a way that they can be interpreted in a same way on a bunch of devices including special assistive technologies. In mobile world this is even more challenging task as there is a wide variety of mobile platforms which are developing rapidly.

All above mentioned principles could be applied in mobile phones world. There are cases that deserve a special attention. One example could be filling of the large forms on small displays especially when half of the display could be occupied by software keyboard. In cases where part of the display is covered when filling form there is necessity of good traversing order between items of the form. We have to ensure not losing the context and provide information which item is currently displayed and filled. This problem often occurs when layout of display is changed from portrait to landscape mode and vice versa.

In the following section we will focus on the specific issues of mobile applications when used in physical environment.

#### Issues specific for mobile world

In comparison to desktop computers or laptops that are usually used indoor (at home, in the office or in a restaurant), mobile devices are often used in different physical environments like in public transport, on the street, in the park, etc. Therefore we have analysed typical issues that can occur in these environments.

One of common problems is the low contrast of the user interface on the display. This situation is more painful especially when the display is on direct sunlight (see left side of next Figure) or the display reflects the surrounding landscape, or face of the user like in the mirror. The other problem with UI visibility is caused by changing reflections while moving, for example changing reflections of nice countryside when travelling in the bus or train. Finally if we take into account critical combination of environmental conditions and particular visual impairment we can identify other problematic situations. For example if there occurs a sharp change in the lighting conditions (like leaving a tunnel, strong source of light appearing accidentally behind the display) and the user suffers from light sensitivity impairment, it can take much more time till the eyes will accommodate to the new situation. This can lead to serious accessibility issues (like missing an important alert, impossibility to react in a given time).

The usage of the mobile devices on the move brings several other issues such as display tremor which makes especially small non-contrast text hard to read.







### Reflection on the display and occlusion of the display with finger

Another set of specific issues are related to the user interaction with the mobile device. Touch screen devices bring another issue in a form of occlusion of the display by interacting fingers (see right side of Figure). Information we are looking for is displayed under the finger and we simply do not see it. This occlusion can be even bigger if the user suffers from visual impairment like low-vision on one eye and blindness on the other one.

### Demonstrative Use Case

On the following use case we will demonstrate the importance and usage of the simulation tool. This is example of typical real life situation that can easily happen when visually impaired users use smartphones.

#### Mobile Instant Messaging client Use Case

Thomas is 25 years old musician, piano player. From his childhood he suffers from Retinitis Pigmentosa connected with tunnel vision which causes severely limited peripheral vision and very narrow view angle.

Thomas is traveling by train from his concert in Gainsborough home to the Sleaford. In the train he met a new friend Sebastian who saw him playing on a concert. They talk about music during the train journey. It was inspiring for both of them and they really enjoyed it. They found that they are from different towns and Sebastian would like to invite Thomas to take part on the concert in his city. Thomas was delight and suggested to exchange contacts for Instant Messaging (IM) to arrange all the things for organization of the concert.

So Thomas switched on his Android smartphone and he went through the menu to start IM application. After the application starts an automatic log-in he located and touched "Add contact" button. Sebastian dictated his user ID for IM service to Thomas. He typed it into the Add contact form and touched "Save" button. At that same moment the train was passing through the countryside where there was a bad and unstable GSM signal and the smartphone had lost the Internet connection. At the bottom of display phone showed for few seconds the "Toast notification" about problems with Internet connection and error with saving contact to the online server contact list.

Because Thomas was checking the user ID typed on the top of the display he did not see the notification because of the tunnel vision while concentrating on the different part of the display. He thought everything is saved correctly, switched off the smartphone and put it



back to the pocket. Next day he found that new IM contact of Sebastian was not saved and was really disappointed when he realized that he probably lost important business contact.

### How the simulation tool will help to discover the issue

The above mentioned problem with overseen toast message can be simulated by switching on the visual impairment effect for simulation of tunnel vision. With this effect applied the developer can easily detect the problem with overseen error message presented in a form of toast.

### Issues That Should Be Simulated

Some situations can be easily simulated by the developer but some not. For example the issues related to small screen can be evoked by usage of emulators or deployment of application to the target device. The dynamically changing reflections on the display, trembled display caused by ride on the bus is hard to simulate with the common tools. The changes of environmental light can affect also the ability of the visually impaired users to read the display. Simulation of different light sources and their intensity, dynamic changes and special situations (like moving reflections) cannot be easily simulated in the developer's office. Occlusion of the display caused by the finger touching the display while having visual impairment is very hard to simulate without any special simulator.

We have focused on these hard to simulate situations and developed a simulator which can easily provide an illusion of these situations to the developers. The list of situations that should be simulated is following:

- Physical environment issues
  - Static reflection
  - Dynamic reflection
  - Display tremor
  - Finger occlusion
- Visual impairments
  - Tunnel vision
  - Blurred vision
  - Color blindness
- Combined issues
  - Reflection + Finger occlusion
  - Light sensitivity + Dynamic reflection
  - Display tremor + Blurred vision

We tried to select the most important situations according to occurrence frequency and severity of accessibility problem.

### Simulation Tool

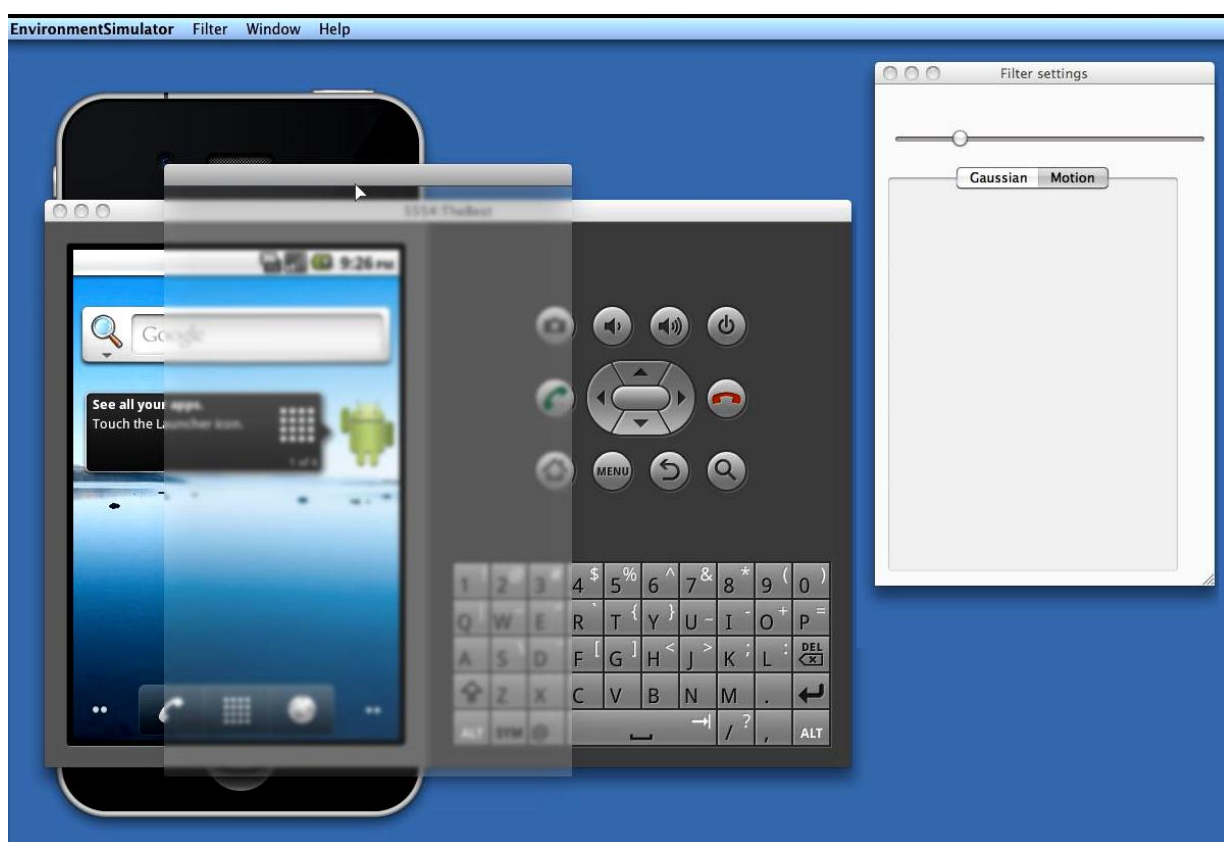
In comparison to the world of desktop and web applications there are many mobile platforms that are rapidly emerging and disappearing on the market and all the work related to accessibility can be easily lost with the discontinued mobile platform. Therefore it is essential to develop simulation tools which are as independent as possible on the mobile platform emulators and integrated developer environments.



We have developed a simulator - Mobile Impairment Simulation tool [5] – which is implemented as a standalone application. It is totally independent on the mobile platform for which the mobile application is being developed. The simulation is done by means of on-the-fly manipulation with the pixels rendered on the screen typically by some mobile platform emulator.

The simulator consists of 3 parts:

- Main menu bar (see top of below Figure) where it is possible to choose effects for simulation
- Filter settings window (see right side of below Figure) where parameters of effect can be adjusted
- Simulation window (see blurred part in centre of below Figure) where simulation effects takes place



**Screenshot of Mobile Impairment Simulator with blur effect placed over the Android emulator [6]**

You can notice different mobile platform emulators that are shown on above Figure (Android) and next Figure (Windows Phone 7 and iPhone).

Currently there are implemented several effects that covers a subset of situations described in previous section. These effects are:

- Physical environment effects
  - Static reflection

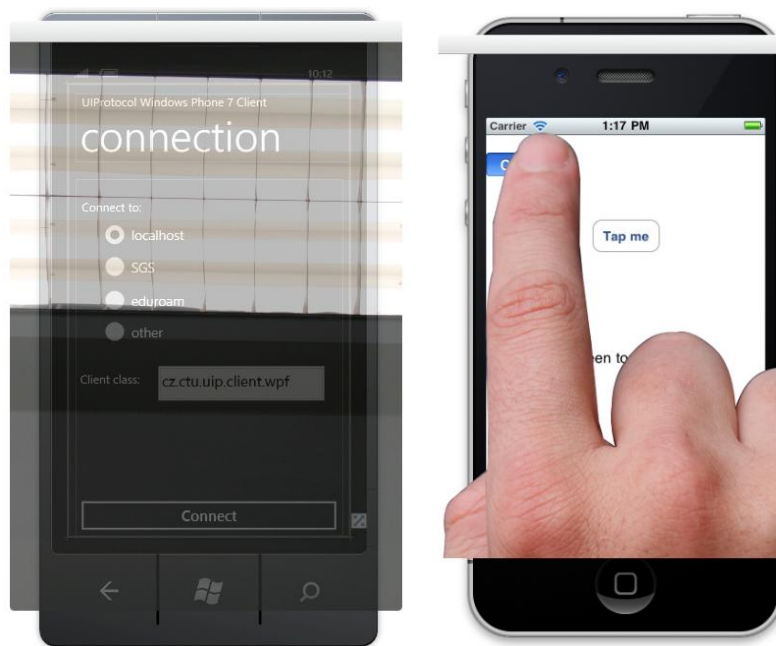
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- Display tremor
- Finger occlusion
- Visual impairments effects
  - Tunnel vision
  - Blurred vision
  - Color blindness

The static reflection effect provides preview of the mobile application when for example fluorescent lamps (see left side of below Figure) on the ceiling reflects on the display. Developer can easily adjust strength of the static reflection effect and check if the user interface is still readable. Finger occlusion effect is implemented by modified mouse pointer that is attached to the photo of index finger or thumb (see right side of below Figure). Usage of mobile device while walking or travelling by car or by bus brings tremor of the display and introduces text reading problem. Display tremor effect is simulated by random motion blur effect.

Many of these effects can be also used to check the usability of the visual design for users with no visual impairment.



**Screenshot of simulated effects - reflection of fluorescent lamp and finger occlusion**

Current prototype of the Mobile Impairment Simulator has been developed for Mac OS X and uses Cocoa framework [4] for rendering of effects. Most of the filters are implemented using Core Image, Apple image processing technology that leverages programmable graphics hardware whenever possible to provide near real-time processing. Core Image API provides access to built-in image filters for both video and still images and provides support for creating custom filters. Unfortunately this technology is very closely tied to Mac OS X environment and there is currently no similar multi-platform solution.



## Limits of this approach

As it was mentioned previously, Mobile Impairment Simulator is fully independent on any type of mobile platform emulators. There is no relation between the mobile platform emulator and Mobile Impairment Simulator. Static image rendered by mobile platform emulator is periodically sent to Mobile Impairment Simulator, where it is modified according to requested simulation effect. Therefore we do not know the semantics of the objects on the display (buttons, labels, input fields, etc.) thus issues like wrong tab-traversal cannot be simulated. This is limit of the approach we have used for simulation

On the other hand some kind of integration can be useful as it can make the development process smoother and faster. A useful extension can be an implementation of plugin for developer's IDE which will allow automatic start and comfortable parameterization of Mobile Impairment Simulator.

## Conclusion

In this paper we have mentioned several accessibility issues related specifically to the area of mobile devices usage. These issues are different from those we are facing in the area of standard desktop computers. We have introduced a way of effective simulation of these aspects and we have developed prototype of Mobile Impairment Simulation tool that can simulate these issues. Mobile Impairment Simulation tool will be subject of third phase of pilot tests with mobile application developers carried out within the ACCESSIBLE project.

In future versions of Mobile Impairment Simulator we are planning to implement more effects simulating visual impairments and dynamic changes of the physical environment. The dynamic reflections can be simulated by using video sequences with reflections in the simulator window. To provide independence on the host operating system we will implement Java based version of the Mobile Impairment Simulator, so it will be possible to run it on any operating system.

## Acknowledgement

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## 2.2. Web Accessibility Guidance, Evaluation Methodologies, and Research Explorations

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### Abstract

The W3C web accessibility standards have existed for over a decade yet implementation of accessible websites, web software, and web technologies is lagging behind. This fact is largely due to lack of knowledge and expertise among developers and fragmentation of web accessibility approaches. It is an opportune time to develop authoritative practical guidance and harmonized approaches, and to explore challenges and opportunities in future technologies in an open collaborative setting. The EC-funded WAI-ACT project addresses these needs through use of an open cooperation framework that builds on and extends the existing mechanisms of the W3C Web Accessibility Initiative (WAI).

### Keywords

Web accessibility, web development, web accessibility testing and evaluation, web accessibility policies, web accessibility research and development.

### Introduction

WAI-ACT – “Cooperation Framework for Guidance on Advanced Technologies, Evaluation Methodologies, and Research Agenda Setting to Support eAccessibility”, addresses critical areas of advanced accessibility support through activities that build upon the strengths of past web accessibility work, harmonizes existing work, and helps shape a research agenda in coordination with key stakeholders in Europe and internationally.

The project addresses the need for expanded European and international cooperation on the development of accessibility solutions for people with disabilities; for consensus-based, authoritative technical guidance to accelerate implementation of advanced technologies; for internationally harmonized evaluation methodologies; and for a coordinated research agenda on eAccessibility.

WAI-ACT addresses these challenges through development of a framework for open, expanded cooperation among European and international stakeholders, technical guidance on advanced web technologies; an evaluation methodology for web accessibility; and a research agenda for eAccessibility. Technical guidance includes a repository of information on accessibility support in web technologies, application notes on authoring accessible web page components, and code samples for web applications. WAI-ACT will result in supporting resources that are desperately needed to drive web accessibility implementation.

### About The Project

WAI-ACT (IST 287725) is co-funded by the European Commission as a Specific Support Action under the IST 7th Framework Programme. WAI-ACT commenced on 1st September, 2011 for a duration of three years. It is lead by and builds upon the strengths of the existing

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World Wide Web Consortium (W3C) Web Accessibility Initiative (WAI) cooperation mechanisms to facilitate strategic European and international participation throughout the project. WAI-ACT project partners are:

- W3C Web Accessibility Initiative (WAI)
- Sticing Bartimeus Accessibility (SBA)
- Fraunhofer Institute for Applied Information Technology (Fraunhofer)
- Johannes Kepler University (JKU)

WAI-ACT work is developed in an open, non-exclusive collaborative environment to maximize participation and involvement from all stakeholders. WAI-ACT also seeks active exchange with relevant networks in Europe such as eAccess+, and coordination standardization activities such as EC Mandate 376.

### Cooperation Framework

Fragmentation of technical standards and implementation practices hinders effective development and deployment of accessibility solutions for people with disabilities. In particular, it leads to diverging or conflicting requirements and slows the development of solutions such as accessible websites, applications, assistive technologies, and mainstream browsers and tools with support for accessibility.

In contrast, active involvement of key stakeholders, including people with disabilities and older people, developers, researchers, accessibility experts, and other practitioners, in consensus-based development of accessibility solutions contributes to a common understanding of the needs, and to harmonized approaches for implementation. It accelerates implementation, research and the development of new solutions.

A first objective of the WAI-ACT project is to develop a framework for open international cooperation, including a cooperation forum that is open to all stakeholders; an open cooperation platform with tools and mechanisms to facilitate the involvement and participation in each area of WAI-ACT work; and outreach for the open cooperation framework to particularly promote involvement of European stakeholders.

### Open Cooperation Forum

The first element is an Open Cooperation Forum to support ongoing dialog, input, feedback, and dissemination and to build consensus on all areas of WAI-ACT work. Targeted participants include developers and practitioners, accessibility researchers and experts, people with disabilities and older users. Particularly during the first year, WAI-ACT invites initial contributions of perspectives on WAI-ACT work from related recent and current EC-funded projects in order to promote exchange and discussion. WAI-ACT welcomes additional inputs throughout the project.

### Open Collaboration Platform

A second element is an Open Cooperation Platform, to facilitate the participation of all stakeholders in each area of WAI-ACT work. This includes improved collaboration tools such wiki-based tools, review systems, and other community-based tools with specific mechanisms to support contributions and collaborative development, facilitate discussion, knowledge sharing, and contribution by all stakeholders including individuals from the public.

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## Open Cooperation Forum

The third element is Outreach in Europe to support the Open Cooperation Framework. This includes annually held open meetings in Europe, development of educational resources explaining the benefits and opportunities for active participation in and contribution to the WAI-ACT project, and active outreach to relevant organizations, projects, and individuals to promote awareness on WAI-ACT work and encourage participation, contribution, and input.

## Authoritative Guidance

Rapid advances in information and communication technologies (ICT) escalate the need for expanded and authoritative guidance to inform the implementation of accessibility in advanced technologies. In particular, there is a pressing need for information about the support for accessibility provided by different web technologies.

For instance, this includes information about support for captions in video formats, for keyboard navigation with particular browsers and assistive technologies, and for alternative text for images and other markup in document formats. Such data informs the development of techniques for leading edge web technologies such as W3C/WAI Accessible Rich Internet Applications (WAI-ARIA) and its intersection with W3C Mobile Web Applications Best Practices (MWABP) and other advanced technologies that are converging onto the Web.

Another part of the accessibility guidance needed is authoritative resources to guide developers in applying best practices and techniques that are backed by data on accessibility support. For instance, this includes guidance on applying accessibility in content, products, and services using advanced technologies such as AJAX [1], DHTML [2], and other forms of scripting, as well as on best practices on accessible common web components to help eliminate frequently encountered barriers that are a primary cause of exclusion of people with disabilities.

In parallel, there is a need for guidance for policy and decision makers to drive implementation of accessibility in organizations and governments. In particular, there is need for guidance on referencing and adopting W3C/WAI standards in different settings given the variety of contexts among organizations in individual EU Member States. Such guidance would help accelerate the implementation of web accessibility.

A second objective of the WAI-ACT project is to develop authoritative technical guidance on advanced technologies for web development, including a repository of information on accessibility supported uses of technologies for WCAG 2.0; application notes for addressing frequently encountered web accessibility barriers such as in images, tables, forms, and other web components; application notes with code samples on advanced technologies; an open W3C Workshop on referencing and adopting WCAG 2.0 to collect and share best practices; and guidance for practitioners on adopting and applying W3C/WAI standards and guidelines in practice.

## Accessibility Support Database

The first element is a repository of information on accessibility support in web technologies to guide the selection of technologies during the development of accessible websites and web applications. For instance, to help select web technologies that provide support for captions,





keyboard support, and support for text alternatives for images with certain combinations of browsers and assistive technologies. This repository will be provided using collaborative tools developed through the Open Collaboration Platform that facilitate public input and contribution, to continually expand the repository with updated and new information on accessibility support in web technologies.

### **WCAG 2.0 Application Notes**

The second element is application notes on authoring accessible web page components such as images, tables, and forms that conform to WCAG 2.0. Guidance on best practices in this area will help eliminate frequently encountered implementation faults, particularly by developers who are new to web accessibility, that are one of the main contributing sources of web accessibility barriers.

This also includes application notes and code samples for advanced technologies, to guide developers in best practices for implementing dynamic interfaces and widgets that use W3C/WAI Accessible Rich Internet Applications (WAI-ARIA), W3C Mobile Web Applications Best Practices (MWABP) and other advanced technologies, to support conformance to WCAG 2.0.

### **Workshop for Policy Makers**

The third element is an open W3C Workshop [3] on Referencing and Adopting WCAG 2.0 in Practice, to collect, discuss, and disseminate best practices on applying WCAG 2.0 in different settings. This includes participation from a broad set of key stakeholders in Europe and internationally. It also includes the development of a W3C Workshop Report that summarizes contributions and conclusions and that will feed into the development of practical guidance on adopting and implementing W3C/WAI standards.

### **Resources for Policy Makers**

The fourth element is practical guidance on adopting and implementing W3C/WAI standards to help plan and manage the implementation, retrofitting, and ongoing maintenance of accessible websites, through updating existing W3C/WAI resources to current standards and best practices and expanding these with conclusions from the W3C Workshop on Referencing and Adopting WCAG 2.0 in Practice.

### **Evaluation Methodologies**

A complementary need to authoritative technical guidance for implementing web accessibility is an internationally harmonized evaluation methodology for web accessibility. This is particularly relevant to support activities relating to adoption and implementation of WCAG 2.0 within different EU Member States as well as internationally.

More specifically, there is a need for an internationally harmonized methodology for evaluating the conformance of websites and web applications to WCAG 2.0. The methodology needs to be able to support self-assessment as well as organizational monitoring of accessibility, given diverse needs of SMEs and large enterprises; and it needs to support an authoritative interpretation of the standard so that it can accelerate implementation of authoring and evaluation tools supporting production of accessible websites. In Europe, this would contribute to meeting the goals of the Riga Declaration and



i2010 Action Plan. In practice, this would support improved benchmarking of web accessibility progress.

To facilitate more effective evaluation a new generation of web accessibility evaluation tools that support the new concepts introduced by WCAG 2.0 is needed. This includes semi-automated as well as fully-automated evaluation tools that support reviewers in carrying out different evaluations tasks and that support different technologies. In particular, tools that support reviewers with less expertise in web accessibility are needed to facilitate capacity-building of web accessibility evaluators, and to reduce the learning curve for web accessibility developers.

Similarly, guidance is needed to further support reviewers in carrying out web accessibility evaluation. This includes guidance on finding and selecting web accessibility evaluation tools that match the needs of the reviewer, for instance with regard to level of expertise, evaluation task, or integration into an existing development environment – as well as educational guidance to assist different reviewers in managing and carrying out entire evaluation reviews according to the evaluation methodology and other technical resources.

A third objective of the WAI-ACT project is to develop an internationally harmonized evaluation methodology for web accessibility, including an authoritative methodology for evaluating conformance to WCAG 2.0; guidance on developing automated and semi-automated web accessibility evaluation tools to support evaluation reviews; updated guidance on finding and selecting evaluation tools to support different evaluators to carry out different evaluation tasks; and an interactive guide for web accessibility evaluators to assist managing evaluation reviews.

### **Internationally Harmonized Methodology**

The first element is an internationally harmonized methodology for evaluating conformance of websites to WCAG 2.0 that defines a consensed approach and metrics for evaluating the conformance of entire websites, including web applications, to WCAG 2.0, to promote common interpretation and harmonized uptake of WCAG 2.0 among EU Member States and internationally.

### **Techniques for Evaluation Tools**

The second element is techniques for automated and semi-automated evaluation tools, to guide the development of a new generation of web accessibility evaluation tools that support WCAG 2.0, in order to assist evaluators with varying skills and expertise in web accessibility in evaluating websites, including web applications, for accessibility.

### **Guidance on Evaluation Tools Use**

The third element is guidance on finding and selecting web accessibility evaluation tools, to assist evaluators with varying skills and expertise in web accessibility in finding and selecting evaluation tools that are appropriate for specific situations and evaluation purposes through updating existing W3C/WAI resources to support WCAG 2.0, and through expanding these with additional guidance.

### **Interactive Guide for Evaluators**

The fourth element is an interactive guide to assist managing web accessibility evaluations, to aide evaluators with varying skills and expertise in web accessibility in carrying out

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evaluation through improving the educational quality and usability of resources on web accessibility evaluation.

## Research And Development

As the Web continues to evolve, new technologies are emerging in a rapid pace. For instance, telephony and voice technologies as well as video and audio media are becoming a core part of the Web “stack” of technologies. This convergence of technologies and media onto the Web is paralleled by rapid developments in mobile technologies such as processing power, internet access, voice recognition and text-to-speech functionality, touch-screen interaction, vibration alerts, camera and sensors integration, and many more features of mobile devices.

These trends present new opportunities and potentially also present new accessibility challenges for people with disabilities. For instance, the availability of advanced technologies in mainstream mobile devices and its resulting impact on human-computer interaction, such as increased use of gestures, location-based services, and augmented reality, present new opportunities for advanced and affordable assistive technologies. At the same time, content, services, and products such as applications provided on the Web need to include accessibility features to ensure that people with disabilities can equally benefit from these technological developments.

There is both the need and the opportunity to identify, explore, and thematically organize eAccessibility research topics to address new challenges resulting from the convergence of technologies and media onto the Web, to drive a common vision and contribute to future eAccessibility research and development.

A fourth objective of the WAI-ACT project is to contribute to a coordinated research agenda for eAccessibility and common visions on future research and development activities, including through holding regular teleconference seminars on eAccessibility research topics, such as digital TV, mobile Web, cloud computing, and supports for people with cognitive disabilities; and an annotated catalogue of web accessibility research topics and resources.

## Teleconference Seminars

The first element is holding regular teleconference seminars to explore eAccessibility research topics to bring European and international researchers and experts together through planning, organization of topics and speakers, and holding teleconference seminars on eAccessibility particularly on topics relating to the convergence of technologies and media with the Web and its impact on accessibility for people with disabilities.

## Repository of Research Topics

The second element is maintaining an annotated catalogue of eAccessibility research topics and resources to help inform researchers and experts on opportunities for research and development through collecting, assessing, and compiling eAccessibility research topics and challenges from the broadest audience possible.

## Conclusion

In this paper we introduced the WAI-ACT project, including the resources and tools to address the needs of different audiences for implementing web accessibility in practice. We



have shown that WAI-ACT is developing essential, authoritative, and practical resources to drive accessibility implementation in advanced web technologies. WAI-ACT also provides open collaborative tools to facilitate participation of all stakeholders, including the public, in the development of these resources as well as to invite discussion and exchange among anyone interested in web accessibility.

Particularly the accessibility support database will provide fundamental information for developers of rich web applications, mobile websites, and other advanced areas of web accessibility. It is at the same time a public repository of information using crowd sourcing techniques that provides new and exciting ways for the public to engage with W3C WAI developments. Also the planned WCAG 2.0 Application Notes demonstrate a practical approach to support the community in applying W3C standards in advanced implementations. WAI-ACT project places these and many other essential resources and tools in the hands of web developers to drive implementation of web accessibility now.

### Acknowledgement

This paper was written with contribution from the EC-funded WAI-ACT Project.

### References

- [1] Asynchronous JavaScript and XML (AJAX) is a programming technology for the Web
- [2] Dynamic Hypertext Markup Language (DHTML) is the use of scripts to create dynamic HTML interfaces
- [3] W3C Workshops are events with involvement of key stakeholders, typically to convene experts and other interested parties for an exchange of ideas about a technology or policy: <http://www.w3.org/Consortium/Process/events.html>

### More References

- [1] WAI-ACT Project (IST 287725) <http://www.w3.org/WAI/ACT/>.
- [2] World Wide Web Consortium (W3C) <http://www.w3.org/>.
- [3] W3C Web Accessibility Initiative (WAI) <http://www.w3.org/WAI/>.
- [4] W3C WAI Working Groups <http://www.w3.org/WAI/groups>.



### 3. Session 3: International Research and initiatives

That the research on assistive technology is not a one continent only approach was obvious in this session where initiatives from across the globe (USA? Canada, Europe) were presented that can have an impact worldwide. Emphasis was also on embracing universal design as much as possible in the product design, with the issue raised of regular consumer products such as the iPad and other devices that are being used to provide assistance.

#### 3.1. Creating A Global Public Inclusive Infrastructure (Cloud4ALL & GPII)

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#### Abstract

Access to the Internet and its information, resources and services is no longer optional. However, many people are unable to access and use these resources because they have difficulty or cannot use the standard interfaces presented to them by web content and web browsing tools due to disability, literacy or aging related barriers. For these individuals a physical connection to the Internet will not yield benefits without an interface they can use. In recognition of this, a European consortium, CLOUD4All, in conjunction with countries throughout the world are launching an effort to create a Global Public Inclusive Infrastructure to provide this.

#### Keywords:

Universal Design, Inclusive Design, Design for All, Digital Divide, Internet Access, Accessibility, Literacy, Ageing

#### Introduction

We have reached a point in our technical advancement where we are building information and communication technologies integrally into every aspect of our societies including education, employment, health, safety, shopping, recreation, social communication, even political participation and, in some place, voting. It will soon no longer be possible to avoid the use of technology or to live independently or productively without using it.

For those who cannot use information and communication technologies (ICT) directly special access features and assistive technologies have been developed. However, these do not address the full need of these groups.

1. Access solutions don't exist for everyone



- They are not available for all types, degrees & combinations of disability, or functional limitation
- 2. Current solutions won't work for all of the new technologies emerging
  - Cloud computing, Web 2.0, 1 million authors of next gen apps are creating new access challenges.
- 3. Access solutions are too complex
  - Not just for many users, but also public access points, companies, and even governments
- 4. Access solutions are hard to find & find out about
  - Many do not know that any solutions exist – so it doesn't occur to them to even search for one
- 5. Many can't afford the high cost of access solutions they need
  - Again, not just users. Public access points and even governments can't afford the cost for all who need them
- 6. In addition people need access to all the computers they encounter,
  - at work, home, community, etc. Not just one that is set up for them somewhere. Patching one computer doesn't work.

To address these problems a coalition of academic, industry and non-governmental organizations and individuals are coming together to promote the creation of a Global Public Inclusive Infrastructure (GPII). One of the core groups is a consortium in Europe that has come together and successfully secured an FP7 project titled «Cloud platforms Lead to Open and Universal access for people with Disabilities and for All» (CLOUD4All) to carry out research and development on some of the key pieces needed for such an infrastructure (CLOUD4All.info).

The purpose is to ensure that everyone who faces accessibility barriers due to disability, literacy or aging, regardless of economic resources, can access and use the Internet and all its information, communities, and services for education, employment, daily living, civic participation, health and safety.

CLOUD4All/GPII would not create new access technologies or services, but would create the infrastructure for making their development, identification, delivery and use easier, less expensive and more effective. To understand this – it is useful to use transportation as an analogy. A road system does not provide cars or transportation services but greatly enhances the ability of car companies and others to do so -- and provides an infrastructure that car companies themselves cannot do. Similarly, GPII will not develop assistive technologies or, by itself, provide accessibility. But it will provide an infrastructure that assistive technology and mainstream companies can use to more easily and less expensively develop, deploy, market, and support accessibility technologies and services internationally. An infrastructure that none of the AT or mainstream companies could provide for themselves or by themselves.

The GPII would provide an infrastructure that extended from the content and service providers (authors of Web and ICT content) to the devices used to access these content and services. It would build on existing ICT/Web/Cloud/Accessibility standards and work and provide additional infrastructure to make it easier to apply and use them to provide anywhere, any device, any content accessibility.

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The eventual GPII would be a software enhancement of the Internet/web infrastructure. It would consist of a number of components that work together to form the infrastructure enhancements needed to make our broadband infrastructure an inclusive broadband infrastructure.

### Components Of Any Solution

The problems cited above are emerging despite the attempts of researchers, companies and policy makers to address them. The problems simply have not been addressable using the model we have been using to date no matter how much effort is expended. The model has worked well for about 15% market penetration [2] with a stable technology landscape. But 15% penetration is not sufficient when access to technology is no longer optional, and we no longer have a stable technology landscape.

### Addressing Industry Needs

Industry is key to solving this, yet industry (mainstream and AT) has faced barriers in its attempts to address and grow the market. Any solution must therefore facilitate the private commercial sector efforts; help them reduce costs and grow their markets to cover as much as possible, while ensuring that those they cannot reach have access as well.

Any new approach must address the underlying commercial problems, such as:

- limited market penetration,
- the high cost of marketing, distributing and supporting assistive technologies,
- the high cost of developing new approaches,
- the high cost of just keeping existing technologies working with ever-changing ICT and web technologies,
- the difficulties faced by new innovators in developing alternate and innovative solutions and getting them to market, etc.

### Addressing Consumer Needs

The new approach also needs to make it much easier for users to:

- discover there are solutions to their problems,
- determine what types of access features or technologies would address their particular problems,
- locate specific solutions, and
- get these solutions delivered and set up on their computer(s).

Moreover, it needs to allow them to access and use these solutions not just on a single computer, or maybe two, but on all of the different computers and ICT that they must use (in different classrooms and laboratories, at home, at work, and the community, when traveling, etc.).

### The Global Public Inclusive Infrastructure (GPII) initiative

To address these issues, an international coalition of organizations and individuals is coming together and has proposed the development of a global public inclusive infrastructure (GPII). The GPII would consist of enhancements to platform and network technologies to create an infrastructure that would simplify the development, delivery and support of access



technologies and provide users with a way to instantly apply the access techniques and technologies they need, automatically, on any computers or other ICT they encounter.

Specifically, GPII aims to:

- Simplify accessibility for users, schools, public access points, organizations, companies, governments, etc.
- Increase built-in accessibility in those places where it is practical and effective, to provide ubiquitous access that is natural, doesn't have a stigma, and doesn't 'tax' individuals with disabilities by causing them to pay more to access the same ICT as their peers.
- Grow the market for assistive technologies and services, in order to serve more people, lower costs, and increase motivation to innovate and invest in accessibility.
- Facilitate international, public-private, private-private and cross-sector collaboration in order to lower costs, to reduce duplication and to accelerate innovation.
- Increase the number of new ideas and products that make it to market – and make it easier and much less expensive to market them internationally.

The goal of the GPII is to ensure that:

- everyone who faces accessibility barriers due to disability, literacy or aging, regardless of economic resources, ...
- can use broadband connected Information and Communication Technologies (ICT), such as PCs, mobile phones, embedded systems, etc...
- to access the Internet and all its information, communities, and services for education, employment, daily living, civic participation, health and safety.

### Origin and support for the GPII

The GPII initiative is a synthesis of ideas and efforts from many people and programs in the US, Canada, Europe and other countries. It is a concept that grew out of the Raising the Floor initiative, which is now coordinating the international efforts on GPII. Raising the Floor, a non-profit association based in Switzerland, is a coalition of academics, ICT industry (IBM, Microsoft, etc.), AT companies, practitioners and of course consumers (individual and in all of the above). There are currently about 80 programmers, designers, researchers, practitioners working on the GPII and its components -- and the participation is continuously growing.

Initial funding for the development of the GPII concept and components is coming so far from the US National Institute on Disability and Rehabilitation Research (NIDRR), the William and Flora Hewlett Foundation, the Canadian government, the Adobe foundation and the funders of the other participants in Raising the Floor.

The major components of the GPII Concept as it is currently conceived are shown below with highlighting on the areas on which Cloud4All will work.

The GPII concept is based on three pillar functions (or legs):

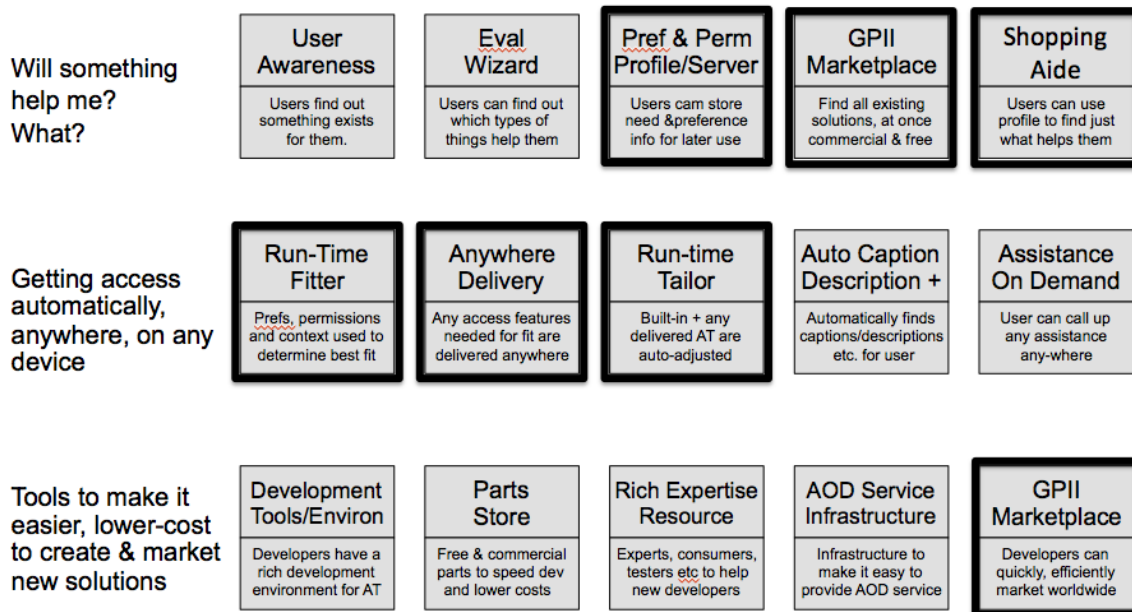
1. Providing a way for people to easily learn about, and determine what solutions/features would help them and then to store that information in a common, portable, private, and secure manner.

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2. Providing a way to use their stored preferences (and permissions) to invoke and configure the accessibility features, assistive technologies, and/or services that they need - anywhere, anytime, on any device they need to use.
3. Providing the tools and infrastructure needed to allow diverse developers and vendors to create new solutions for these different platforms and easily and cost effectively move them to market and to users internationally.



Components of the Global Public Inclusive Infrastructure grouped into 3 major threads or 'legs'. Components that CLOUD4All will be focusing on are highlighted.

### Profile-based Interface Design

Designing user interfaces for specific user profiles is not a new concept. Human-centred-design and user-centred-design are founded on this premise. However historically the user profile has been a profile that reflects a class of user or a representative persona (the user who is blind, the typical housewife). This presents a problem for individuals who do not fit into these profiles or whose unique needs are not expressed in the profile. Only a few disjointed efforts, primarily in the education domain, have increased the granularity of the profile to the individual user, making it possible to achieve one-size-fits-one.

Most of the state of the art has laid the groundwork for this area but is based on disability user groups (as a whole) or provide profiles only for a specific application domain and do not provide the individual personalization schema and tools (that can be applied across domains) that are needed for this work. Specific examples include:

- Personas as a design tool were initially introduced by Alan Cooper in 1999 [2] to humanize the design process, to build consensus in the design team and to measure the design's effectiveness.
- The BBC MyDisplay [3] uses pre-set themes that address common disability groups as groups.



- A number of EU projects have provided disability specific personas and ontologies such as the EU FP6 ASK-IT project [4] and the FP7 running projects AEGIS [5] and ACCESSIBLE [6] but again are mostly disability group oriented.
- Four European FP7 research projects (GUIDE, MyUI, VERITAS, VICON) have teamed up to form the VUMS cluster [7], to develop a common methodology for user profiling, including a user profile standard. These again are focused on user-profiling using disability groups - that provide information useful to this effort but do not provide the individual oriented profiling needed by this effort.
- FP7 OASIS project (Open architecture for accessible services integration and standardisation), has implemented appropriate ontologies describing common disability user groups and their needs in Ambient Assisted Living (AAL) environments,
- AccessOnTo [8] and Van Heijst [Van Heijst 2000] propose and use ontologies in the accessibility requirements specification process.

Beginning with a project entitled Web4All, research centred primarily in Canada has developed and advanced accessibility through individualized configuration. Web4All provided automatic personalized configuration of multi-user workstations using a personal profile stored on smart cards or USB sticks. The system was limited to workstations with the Web4All application installed [9]. Projects that have advanced this concept in the education and Web application domain include:

- The Inclusive Learning Exchange, TransformAble and the AccessForAll Infrastructure projects led by the IDRC provide one-size-fits-one design and delivery in the education domain [10].
- Fluid Project User Interface options enables personalized reconfiguration of Web applications [11].
- The Floe project is developing personalised learning infrastructure for Open Education Resource delivery globally and will contribute to Cloud4All [12].

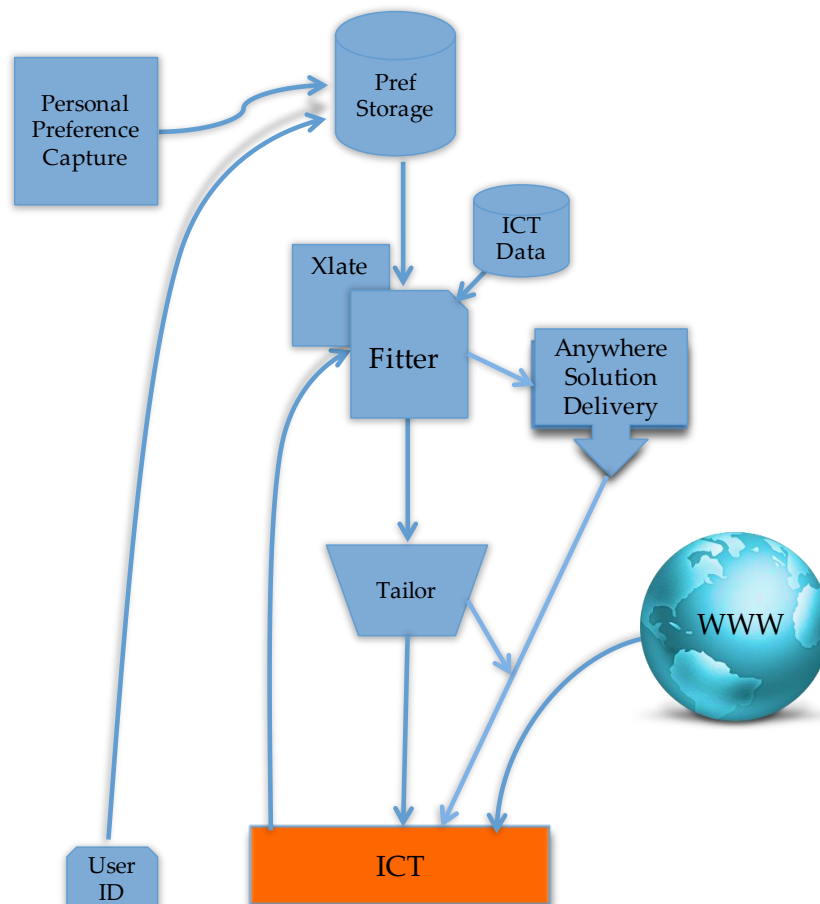
## Personalization Components of GPII/CLOUD4All

The core components to the personalization structure are:

1. Personal Capture Mechanism(s) (different types)
2. Preference Storage Mechanism(s) (cloud, USB, other)
3. Mechanism(s) for person to ID themselves to the server (but not necessarily to the device)
4. Fitter/Matchmaker that determines the settings for the ICT (based on settings and other factors)
5. Tailor/Launcher-Setting Handler that configures ICT (or content) to fit the user's needs (often part of the ICT itself)
6. The adapted ICT (including built-in features and built-in AT)

The core components of the basic GPII/CLOUD4All personalization structure are shown in below Figure along with notes on the general CLOUD4All proposed work.





**Core Components of the Global Public Inclusive Infrastructure to be worked on in CLOUD4All project.**

Work on each of the GPII components that is planned within CLOUD4All includes:

**Preference Capture:** Will explore increasingly dynamic methods for preference capture (expert evaluation, wizards from others, uploaded settings from ICT, user runtime adjustments, user behaviour /performance)

**Preference Storage:** Beginning by storing a standard set of generic preferences will then move up through more specific ICT and context related preferences. We will both use and (we anticipate) affect changes to preference storage (and use) standards. The stages of preference data we anticipate storing are standardized Generic Preferences, Data blocks containing settings from ICT (often in proprietary format) and Preferences stored for different contexts. There are also variations within each of these. The goal will be to advance the understanding of the preferences in complex environments and when they are important to be more precise and when close is sufficient and simpler mechanisms can be used.

**User Initiation:** We will try a number of methods for user activation. Some require nothing but memory and others no memory at all. Of key interest will be the privacy and security issues. How do we allow users to identify themselves to the preference server without identifying themselves to the ICT or network (if other users would not have to identify themselves). We will explore: URL activation, USB key based URL activation, Special data

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format (USB & Smart Card), facial recognition, visual codes (e.g. 2D barcodes) and more. We will also explore the implications of NFC phone and ring activation.

**Need to Translate Preferences:** Usually the Fitter/Matchmaker will need to translate preferences to match the ICT capabilities. Two of the types to be explore will be: Generic to ICT Specific & ICT settings to ICT settings (different manufacture & same manufacture with different versions).

**Need for ICT Info:** If ICT is identifiable but doesn't provide a feature description (which is likely to be common) – then a database of ICT features might be useful – and will be explored (describing features and settings, providing mapping from generic preferences and from other popular similar ICT).

**Context from ICT:** The Fitter/Matchmaker can do much more if it has context. We will explore the use of the ICT type/model, the ICT access features list, the technical environment, and the physical environment to enhance Fitter/Matchmaker functionality.

**Fitter/Matchmaker Functionality:** We will start with a very simple Fitter/Matchmaker function and expand its intelligence and precision over the course of the proposed work. The layers we envision to this process would be Fetch Generic and Translate, Fetch appropriate data block for this ICT from storage and apply, Fetch closest data block and Translate, use of real-time input from user (from custom control panel), Use of real-time context information to adjust fit, Use of real-time user behaviour to adjust.

**Tailor/Launcher-Setting Handler Functionality:** We will explore simple through advanced Tailors (Launcher-Setting Handler functionality). In this case the added functionality will not be intelligence (that is provided by the Fitter/Matchmaker) but rather increased ability to Tailor. The levels planned here include simple setting of access feature values to matching values provided from Fitter/Matchmaker (activating and setting up built in features), activating and setting up installed AT, launching needed AT, launching cloud based AT, run AT in cloud (virtual desktop), initiate a download of AT.

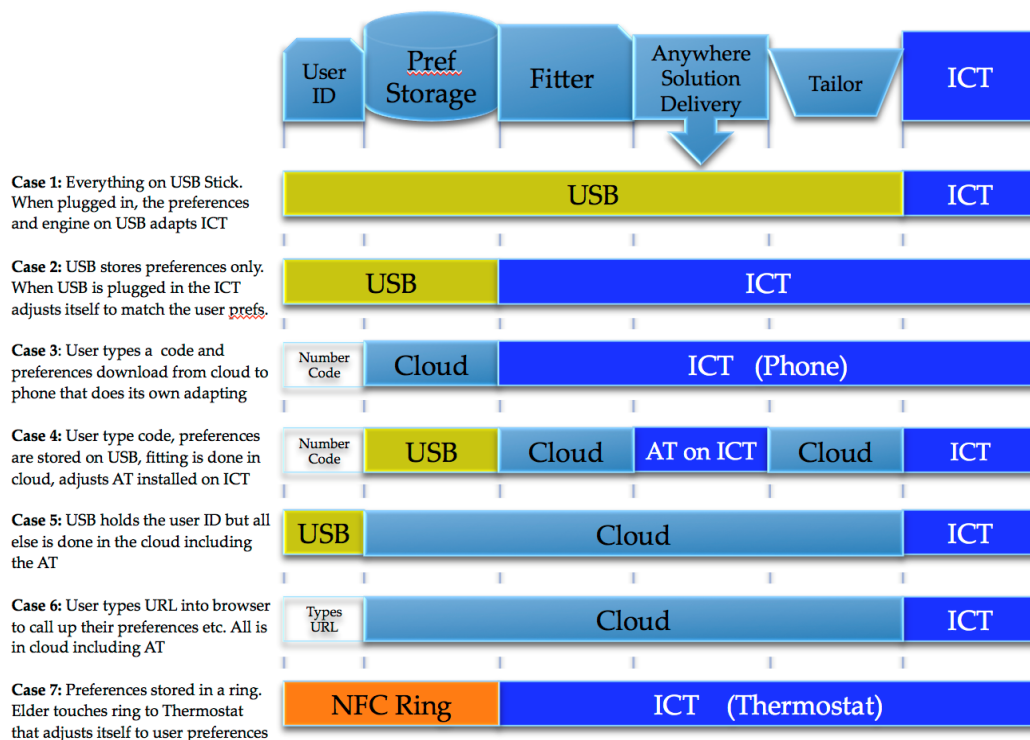
**Any Where Delivery:** When users need more access features than are built into the ICT, or installed on it, then the Fitter/Matchmaker may need a mechanism to provide those features, anywhere, on any ICT they encounter. We will explore the ability to deliver a range of different solutions including special Web apps, Cloud based AT and desktops, Run-without-install AT and Download-and-install AT. Not all technologies will support all approaches (i.e., a simple phone would usually not support a download and install approach); the goal is not to determine which is best but to determine if it is possible to create a system that supports all of these approaches so that a good fit that is technically feasible exists for each case.

It is important to note that these functions may exist in many forms and in many places. Next Figure shows that the functions can reside in the cloud, in a USB device, or even in the actual ICT device itself. 7 cases are shown.

- Case 1: Everything on USB Stick. When plugged in, the preferences and engine on USB adapts ICT.



- Case 2: USB stores preferences only. When USB is plugged in the ICT adjusts itself to match the user preferences.
- Case 3: User types a code and preferences download from cloud to phone that does its own adapting.
- Case 4: User type code, preferences are stored on USB, fitting is done in cloud, adjusts AT installed on ICT.
- Case 5: USB holds the user ID but all else is done in the cloud including the AT
- Case 6: User types URL into browser to call up their preferences etc. All is in cloud including AT.
- Case 7: Preferences stored in a ring. Elder touches ring to Thermostat that adjusts itself to user preferences.



**All elements are functions, not necessarily different software or hardware modules. Several functions may be provided by a single component depending on implementation as shown.**

### Still Early In Its Development

The GPII is still in its initial conceptualization and development phases. Although its basic concepts are based on past work and implementations, nothing like this has been done before: to bring together all of these concepts and attempt to apply them together, across different platforms and technologies, and in a manner that can scale to meet the growing and ever more diverse need. Cloud4All is the first big international project aimed specifically at advancing the concept of a global public inclusive infrastructure, building the knowledge base and algorithms needed, and evaluating the ability of the concept to work across platforms, technologies and applications. This effort will be key to testing this concept and, if successful, helping to move it forward toward reality. If we can substantially improve accessibility over the next ten years, we will open up access to, and improve the use of, ICT products and services in general (whether eCommerce, eGovernment, eHealth, eCulture, or Internet

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banking) and make opportunities available for the elderly and for people with disabilities. This can contribute to greater social inclusion, including better access to health and public services, improved employability and productivity, increased embeddedness for individuals in social relations and networks, and more.

### Acknowledgment

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## 3.2. Developer's Support For Creating Accessible Applications

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### Abstract

This paper presents two developer tools created that support the process of development of accessible applications. These tools were created within AEGIS Project. The first tool is targeted to developers not experienced in the field of accessibility and helps them with orientation in the variety of user disabilities. It makes easier the process of prioritization of existing accessibility guidelines in a way that suits the given target group and the application developed. The second tool provides direct support for accessible rich internet applications (ARIA) development. It is a plugin for NetBeans IDE and it offers palettes of accessible UI components that can be used to build the accessible application.

### Keywords

Accessibility, Rich Internet Application, UCD

### Introduction

During last years the penetration of ICT in the population increased significantly. The amount of information and processes that can be supported by ICT is enormous. This is a big chance for disabled people as it could offer them new and convenient communication channel and in such a way makes their life easier.

The problem is that recent technologies, as they are getting more and more sophisticated to satisfy common user, are at the same time becoming more inaccessible for impaired users. One of the examples of this issue is the rapid growth of complexity of rich internet applications (RIA) on the web.

### Problem Description

Development of really accessible application (RIA, mobile, desktop) is a challenging work even for experienced SW developers. There are several different specifications and guidelines for making the application accessible. Those documents are highly complex, extensive and their careful study requires a lot of time. This can be one of the reasons why are these guidelines so often not followed or ignored at all.

Applying all guidelines in order to make application fully accessible can lead to very problematic situations. First of all there is the time and cost restriction. Second there are situations where it is necessary to implement customizable solutions to provide satisfactory level of functionality to various groups of impaired user. To help the developers with the process of making the application accessible we have developed two tightly interconnected tools. The first one is called AEGIS Accessibility Advisor tool (Accessibility Advisor) and the second one is called AEGIS ARIA Developer tool (ARIA Developer).

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## Accessibility Advisor

AEGIS Accessibility Advisor (Accessibility Advisor) is a tool providing software developers with a support when developing accessible applications without having to study comprehensive materials related to accessibility guidelines and methodologies or publications about user impairments.

**3. Disability/Diagnosis**

Glaucoma  
 Macular Degeneration  
 Loss of Central Vision  
 Blindness

**4. Functional limitations**

**MAJOR** (related to the major impairment)

Binocular Acuity Of Distant Vision  
 Binocular Acuity Of Near Vision  
 Monocular Acuity Of Distant Vision  
 Monocular Acuity Of Near Vision  
 Perceptual Functions  
 Quality Of Vision  
 Seeing Functions  
 Visual Acuity Functions  
 Visual Field Functions  
 Visual Perception  
 Visual Picture Quality

**MINOR** (related to the minor impairment)

[show/hide other functional limitations](#)

**5. Available assistive technologies**

Braille display

**3.**

**Disability/Diagnosis**

Disability is defined as an alteration of an individual's capacity to meet personal, social, or occupational demands because of an impairment. Disability as an activity limitation that creates a difficulty in the performance, accomplishment, or completion of an activity in the manner or within the range considered normal for a human being. Difficulty encompasses all of the ways in which the performance of the activity may be affected. In the list given, there are also diagnosis listed.

*If you do not know concrete user's disability/diagnosis, you can leave this question empty. If you select some disability/diagnosis, appropriate functional limitations (in the next question) will be selected automatically.*

### Screenshot of Accessibility Advisor tool

This tool is primarily targeted to developers with no extensive knowledge in the field of accessibility (e.g. novice developers or freelancers). The developer defines the basic characteristics of the target user group and also specifies the application that will be developed. The Accessibility Advisor tool then generates a set of specific recommendations suited to described situation. In addition to these recommendations are also provided tips for accessible technologies and approaches (e.g. outcomes from AEGIS Project) that are following the “universal design” principle.

The whole process has been simplified into few steps of wizard where developer describes the limitations of the user, available assistive technologies and other important parameters. The whole process can be finished in a couple of minutes (see above Figure **Error!** **Reference source not found.**).

The output of this tool is divided into three parts:

- persona [1] (hypothetical user) corresponding to the defined user group
- interaction model graphically presenting the users interaction capabilities





- specific recommendations for development of an accessible application which are prioritized based on the selected target user group and application developed

The recommendations are generated based on very detailed ontology [3] of disabilities, assistive technologies and other related knowledge that has been modelled by Centre of Research & Technology – Hellas, Informatics & Telematic Institute (CERTH-ITI) within AEGIS project [2]**Error! Reference source not found.**

Usage of this tool allows the developers to avoid the most serious accessibility issues when developing any kind of software application in an easy and fast way.

#### Use case: Mike is developing for Paul

As a demonstrative use case of usage of the Accessibility Advisor let us imagine the following situation:

*Developer Mike is going to develop a web application for 58 years old Paul who works as a translator. Paul has problems with his eyes – he told Mike that he suffers for more than 10 years from severe Macular degeneration. He is not able to read any more so he is using some special equipment to control his computer. He had shown Mike how he is using special speaking software called Jaws. Mike has also noticed some special device in front of his keyboard, but he forgot to ask Paul what exactly that device was...*

The process of target group description represented by Paul in this particular use case will look as follows:

1. Mike will select type of the future application (web application).
2. Mike will define characteristics of the target group including impairments (visual impairment), disabilities (Macular degeneration) and available assistive technologies (Screen reader, Braille display).
3. Mike will specify basic types of interaction that will be required in his application (text reading, forms filling, selections, etc.).
4. Mike will specify the environment where the future application will be used (private buildings).
5. Mike will revise the summary of the filled in parameters.
6. Mike will start the evaluation process.
7. Mike will receive the recommendations.

The output of the Accessibility Advisor will be as follows:

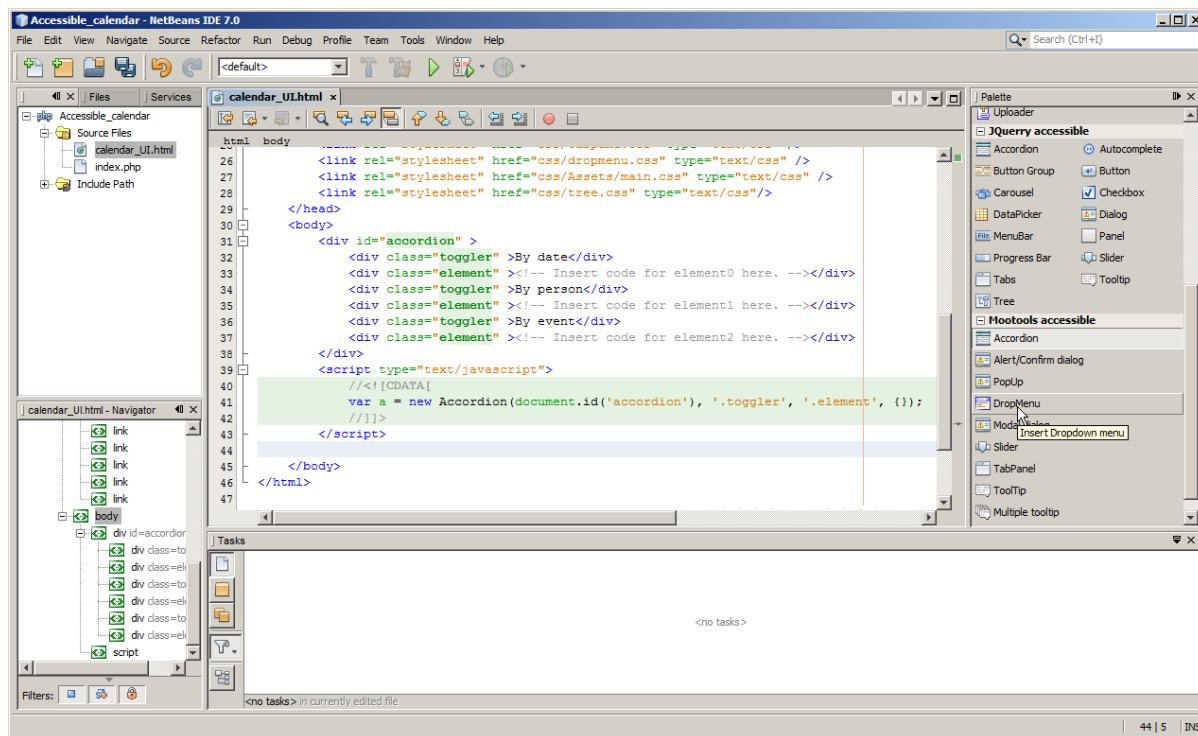
- Persona Paulina that is relevant to specified use case. This persona is chosen from a set of personas **Error! Reference source not found.**[4] created within the AEGIS project by K.U. Leuven covering wide range of impairments. The chosen persona is the most suited to the description provided by the developer through the Accessibility Advisor.
- Interaction model illustrating the influence of the user disabilities on the ability to interact with the developed application. The model is divided into three parts: User - where the disabilities are presented; Interaction - where the available communication channels are described; and Action - where the action with the application is



described. Model also takes into account the assistive technologies (e.g., Braille Display).

- Set of specific recommendations (Use an accessible UI toolkit library, Do not use Pop-ups, Do not use graphic links) and reference to general recommendations (WCAG 2.0, etc.).

The Accessibility Advisor helps Mike during the process of form filling by providing explanation and examples to all items. In this way Mike is able to identify the special input device (Braille display) he noticed in front of the Paul's keyboard. The whole process from the form filling until obtaining the report did not take more than 10 minutes.



NetBeans IDE with installed AEGIS plugin on the right side

## Aria Developer

The second tool - AEGIS ARIA Developer tool (ARIA Developer) - is trying to support the developer during the coding process. Incorporating accessibility into RIA applications requires specific knowledge when writing the HTML and JavaScript code. Some of the accessibility issues such as missing ARIA role attributes [7] or lack of keyboard operation features can be solved by using accessible components with integrated ARIA support. Other issues are related to the existence of complex inter-component semantic relations typical for RIA applications (e.g., complex menu structure, life regions, one component controls another one). To ensure accessibility it is necessary to cover all semantic relations between components by means of ARIA mark-up.

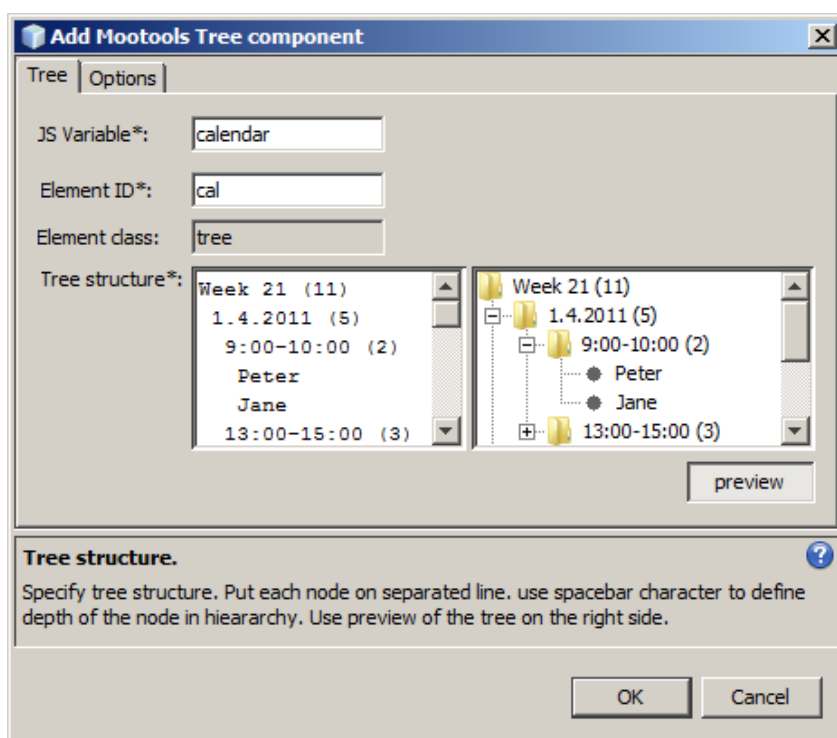
The ARIA Developer tool is developed in maximal cooperation with the end users (developers). In the very early stage of development we have created a mock-up of our tool, which was tested with the developers. After gathering the feedback from the developers a first prototype of ARIA developer tool was developed. It provides support of accessible WAI-



ARIA [7] enabled AEGIS component sets to avoid one group of accessibility issues mentioned above. It is standard NetBeans plugin working with NetBeans IDE in versions from 6.5 up to 7.0.

After installation of the plugin the standard palette with HTML components is enhanced by ARIA components from jQuery **Error! Reference source not found.**[8], MooTools [9] and Fluid infusion [10] accessible toolkits. These components have been also modified within AEGIS project [11] [12] (see **Error! Reference source not found.**).

Components can be dragged from the palette by mouse and dropped into the source code pane. This will open component setup dialog (see **Error! Reference source not found.**). In this dialog all properties of the future component can be easily adjusted and after confirmation of adjustments made the necessary HTML and JavaScript code snippet is inserted to the source code pane. Code snippets are pre-formatted and enhanced by guidance comments that are specifying areas where text content or other components should be placed.



**Component setup dialog of MooTools tree component**

Component setup dialogs are interconnected with online documentation of the components and contain simple help explaining each of the component properties. Required component properties are marked with star character (\*) after name of the property.

Several components are structured like Tree or MenuBar. The Component setup dialog for these structured components is providing a simple text editor that can be used for editing the internal structure of a component (see **Error! Reference source not found.**). New line creates a new item in the structure of tree component and each space in front of the text string shifts the item deeper in the hierarchy. Next to the text editor there is a preview pane where the final tree structure of adjusted component is instantly visualized. This means that

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plugin is generating necessary HTML structure formed by unordered list elements <ul>, div HTML elements <div> etc. that is later used by JavaScript functions to create final structure of the component.

All components can be also inserted by keyboard inside the source code pane. This can be achieved with help of standard NetBeans auto completion functionality that can be invoked by pressing a shortcut (Ctrl+SPACE). This feature is very handy for fast component insertion and could be also helpful for handicapped users having problem with drag-and-drop interaction technique.

Support provided by this plugin tends to ensure more comfort and efficiency when using AEGIS WAI ARIA enabled widgets and thus attract more developers to use these widgets instead of any other that are not enhanced with ARIA metadata.

## Testing

Both tools were iteratively tested with developers to ensure their acceptance, usability and efficiency. Feedback from these tests was considered in new versions of our tools.

### Accessibility Advisor testing

There were executed several usability tests during the process of Accessibility Advisor development. These tests were focused on the correctness of the main concept of the Accessibility Advisor and the ability of developers to use it. The UI was tested on representative group of 3 users – programmers with different level of knowledge in the field of accessibility. The testing revealed several minor usability problems in the UI and all of them have been fixed. The testing proved correctness of the concept of navigation and division of the form into tabs; orientation in the UI was easily understandable to each test participant. There were not found any problems in the concept of providing detailed information and help during the process of definition by the developer. All test participants evaluated the tool as usable and stated that the development of accessible applications will be simplified. During summer 2011 Accessibility Advisor is a subject of the 2nd pilot testing carried out within AEGIS project.

### ARIA Developer

Mockup of ARIA Developer was tested in the 1st pilot tests of the AEGIS project. This test was focused on two aspects: first how clearly are the issues presented and explained, second how the process of issue solving affects the development process. The clarity of the issues presented was evaluated as sufficient. The most urgent comments were related to the situation where too many accessibility warnings and errors reported overwhelm the developer and thus lead to ignorance of all the problems. The revealed issues should be carefully presented step-by-step (by means of some kind of priority filtering) rather than all at once.

These findings from this test were incorporated into the first prototype, which is prepared for testing with developers. Here we will focus on the flow of the development process and observe the developers ability to solve all accessibility issues that will appear.

## Discussion

Several approaches could be used for the way how selection of specific and most important recommendations that will fit the target group is carried out.

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### *Integration of third-party recommendation initiatives*

The level of importance of recommendations proposed by third-party subjects (e.g., Section 508 [5]**Error! Reference source not found.**, W3C **Error! Reference source not found.**[6]) is typically given statically without further explanation of the context where the level of importance is relevant. As the level of importance of the recommendations is context dependent (e.g. type of users impairment, characteristics of the ICT, actions required by the application used by the user) an awkward situation may occur, where the developers will implement the recommendation in wrong order by means of not following the recommendation with the highest level of importance in given context.

To solve this problem the recommendations should be enriched by semantic description which could be used by systems for automatic suggestion selection. These semantic descriptions will be used in the Accessibility Advisor tool.

For example in WCAG 2.0 there are 61 recommendations which are divided into three levels of importance (25 x A - most important, 13x AA, 23x AAA - less important). There are two ways how to add the semantics of the level of importance. First the semantics will be generated as an integral part of the recommendations. Second the recommendations will be integrated into "AEGIS Ontology" **Error! Reference source not found.**[2] by means of definition of new classes and relations.

The purpose of Accessibility Advisor is not to ignore all accessibility guidelines except guidelines that are relevant to specified target group but to stress the most important guidelines for the given target group. As an example we can pick the following WCAG 2.0 guideline that is on the less important Level AAA.

**1.2.6 Sign Language (Prerecorded):** *Sign language interpretation is provided for all prerecorded audio content in synchronized media. (Level AAA)*

Nice web application for deaf fishermen that is fully accessible on importance Level AA would not be as good for them as application that is accessible just on Level A if it meets some critical Level AAA guidelines like the presence of sign language interpretation (as mentioned above).

## Conclusion

In this paper we have introduced two tools for support of accessible application development that are being developed within AEGIS project.

In the following version of the ARIA Developer we will focus on visualization of semantic relations between designed components as it is important for efficient adding of ARIA attributes (e.g., landmarks, aria-described by) and thus elimination of important accessibility issues. Selective suggestions based on target group needs (gathered by Accessibility Advisor) could avoid long list of warnings that is typically provided by general validators.

Tools presented in this paper are on prototype level and currently are subject of second pilot testing with developers.



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### 3.3. Universal Design Of Information And Communication Technology, A Dream?

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#### Abstract

Disabled people's ICT access is heightened through assistive adaptations of mainstream ICT. However, this did not result in equal access for them.

Stakeholders should consider using the Universal Design concept in ubiquitous ICT. This concept is based on adaptability rather than adaptation. It requires user involvement in all development stages, standardisation and appropriate government policy.

It might not be possible to design ICT for all, anywhere, anytime. On the other hand actual innovations regarding the use of open source software and the construction of open public infrastructures are promising steps in the direction of universal ICT access.

#### Keywords

ICT, assistive technology, equal access, adaptability, universal design, user involvement, standardisation, digital literacy, open source, open public infrastructure.

#### Information And Communication Technology (ICT)

ICT covers all technologies used for assembly, storage, processing and transfer of data, images and sound in a dematerialised form. Besides personal computer and internet, it includes mobile phone, electronic pocket diary, digital television and all kinds of built-in ICT in everyday objects. [1]

#### The importance of ICT in society: ICT dependence is increasing

ICT is increasingly integrated in consumer electronics. Using a TV set, people can obtain information; receive care via telemonitoring, etc.

People are using online services for shopping, banking, etc. Also, public and basic services for employment, education (e-learning) and social care (telecare) are offered online.

#### ICT continuously increases efficiency

Computer power is growing exponentially. In 1970 an Intel 8008 processor had a capacity of less than 1 instruction p/s. In 2010 an Intel Core i7 EE was able to process 100 000 instructions p/s. Worldwide digital data double yearly. This development will increase given the growth of social networks and the use of technologies in developing countries. IT specialists can hardly cope with the increasing data. [2]

Communication/data transfer is increasingly being carried out wirelessly and digitalised through broadband technology.



It is expected that in 2020 15% of digital information will be available “in the cloud” stored on central servers accessible via the internet instead of via individual computers hard disks.

### **ICT is increasingly multifunctional**

The mobile phone became a platform for mobile internet. So-called smart phones combine a mobile phone, iPod and personal digital assistant. This allows to make calls, send messages and emails, listen to music, make pictures and play games. The size of these tools is diminishing. Control panels are simple but with buttons and mostly touch screen.

Along with these trends doubts arise concerning usability for all people.

### **Human – Computer Interaction**

The actual ICT consumer is an active user searching for personalized information, which he/she wants to receive anywhere, anytime and via a range of devices (TV, pc, games console, mobile media device). He/she creates his/her own information and content, can add apps (mini applications for music, pictures, notebook...). Service suppliers, including government, can make use of this active attitude.

## **Consequences of ICT evolution for citizens**

### **Opportunities in general: ICT for online participation and personal communication**

More ICT power, more data and transfer capacity, a higher multi functionality and mobile internet facilitate more applications and personalised interaction. When public services offer services online to a growing extent, these evolutions should increase participation in the digitalised information or knowledge society. Citizens receive information online, can download and return completed official forms (e.g. personal documents, income taxes), can contribute to the process of governmental policy and decision making by formulating complaints. Online communication is stimulated. Banks offer higher revenue for online saving accounts. Tax returns made online are handled sooner.

ICT based social media and networks are socializing.

But are all citizens ready for such an evolution?

Vulnerable people, for whom online communication is of help, mostly do not have computer availability.

### **Opportunities for disabled people: ICT raises inclusion**

People with motor impairments are given a way to greater independence. With domotics they are able to control their environment.

Broadcast access has been improved for people with visual impairments (audio description) and for people with hearing impairments (subtitling, deaf signing).

Alternative input facilities responding to individual needs (e.g. speech recognition or touch screens) strengthen an individualized interaction.

### **When ICT is not inclusive there is an exclusion risk**

Developments in ICT may include opportunities on societal participation/inclusion but are also the worst threat to exclusion. [3]





Online technologies, standard digital services and ICT tools are too often not usable for people with functional impairments:

- The European Disability Forum (EDF) states that only 2,6% of key public and commercial websites and only 5,3% of government websites in Member States are accessible [4].
- Information on government websites is often difficult to understand.
- Only few ATMs (automated teller machines) are adapted for people with visual impairments. This problem is important, considering that ATMs are also serving as ticket dispensers and public information terminals.
- The usability of remote controls of digital television sets is problematic. Buttons are not logically positioned; common symbols are not standardised.

Not having access to society means not being able to participate.

### **The ICT market: mainstream market versus market of assistive devices**

The so-called mainstream ICT is developed for the general public. Everyone is expected to be able to use the technology. However, as ICT-mainstream is rarely adapted or adaptable to their specific needs, people with functional impairments are not always able to use mainstream ICT products and services. They need to search for adapted appliances on the niche market of assistive technology (AT) where researchers have developed individual accessibility solutions for them.

### **The (in) accessibility of the market of assistive devices**

As they usually are more expensive, assistive devices are not always affordable for disabled people mostly belonging to the group of economically weak people. For example, a mobile phone with speech input costs threefold the price of its equivalent without this functionality.

Fortunately, many assistive devices are reimbursed by government. However, important differences in the national funding systems – a European study counted 45 public payment schemes in 29 countries – and the divergence of national legal obligations (certification standards) impede the free movement in the internal market.

Disabled person are users but not consumers on the AT market. Too often they are unaware of the available assistive devices and the governmental reimbursement policy. They only have partial influence in the acquisition (which mostly depends on the advice of professionals) and have no opportunity to try out the device.

### **Development of mainstream ICT is not demand driven**

Mainstream ICT is designed for "standard persons" excluding people with different physical, sensory or cognitive features. Matching product features with user characteristics is most frequently realized by the user adapting him/herself to the interface to the extent possible. Consequently, people unable to adapt are left out. [5]

Assistive technologies are "closed", not adaptable by other stakeholders and not compatible with new technologies. This may result in new editions being less accessible than old ones.

For instance, a general support for assistive technology does not exist for mobile phone or PDA's [6].



### ICT needs to focus on inclusion to prevent exclusion

Online basic and public services are too often not usable for disabled people. Development does not address their specific needs. To make mainstream appliances usable, expensive adaptations are needed, to be searched on a niche market that is not very accessible. Compensating governmental reimbursement is subject to complex divergent regulations. Furthermore, disabled people are mostly not involved in the acquisition process. Finally, AT is handicap-specific and not adaptable nor compatible with other technologies.

The promising evolution of ICT is in reality not that favourable for disabled people. It is necessary to guarantee e-inclusion through a policy tackling exclusion risks in the market, in research and development, with the consumer himself and at societal (legislative) level.

### E-Inclusion policies should tackle exclusion risks

#### Tackling exclusion risks in the market: awareness

Awareness of the mainstream market about disabled people's needs must be raised.

Suppliers will need to be convinced of the economic value of an inclusive market. By demanding accessibility requirements in public procurements governments can influence this.

#### Tackling exclusion risks in research and development: user involvement and standardisation

A 2010 European consultation lists as barriers for innovation: a.o. lack of standards, resistance of end users to new ideas and their lack of digital literacy, lack of evidence of benefits, unclear regulation, lack of or only partial funding of innovation, authorities not promoting innovation, non-involvement of end users. [7]

Standardisation, increasing digital literacy and user involvement are amongst these important issues of the (European) e-inclusion policy.

- User involvement: Mainstream ICT risks to exclude persons with functional impairments because it does not match with their specific needs which are best assessed by themselves. The expertise of disabled people should be used in the development stage of products and services. However, experience showed that finding users ready to be involved in research is not easy. Is this because of a lack of digital skills and not being familiar with the subject?
- Standardisation and interoperability: Making assistive technology adaptable and compatible with other technologies will only be possible with standardization, interoperability and connectivity for interfaces. That this is feasible has recently been illustrated by mobile phone manufacturers who agreed to develop standards for full compatibility of the 30 chargers now on the market.

The European Commission (EC) actually runs standard work programs for digital television, geographical navigation systems and mainstreaming AT and has given mandates to the important standardization organizations to establish accessibility standards (mandate 376 for accessibility requirements at public procurements).



### Tackling exclusion risks with the user: increase digital literacy

Only 45% of disadvantaged groups - aged 65-74, on low income, unemployed, less educated, disabled - have a sufficient level of digital skills to participate in the ICT society. This is less than the 64% of all Europeans [8]. To raise digital abilities several European countries worked out national action plans.

Society also has to provide users with accessible information about accessibility solutions.

### Results of e-inclusion policies

E-inclusion policies address the accessibility problems of groups with impairments, providing adaptations and/or adding assistive technology on mainstream appliances for every specific impairment. These measures did not realize an inclusive knowledge society:

- Although almost 25% of the European population has functional impairments (including elderly people) mainstream products are not adapted for them.
- Structural financial support, needed for the acquisition of the necessary but expensive AT, is not sufficient in many European countries.
- National inclusion action plans resulted in better material access to the internet, but vulnerable groups do not seem to use the increasing amount of online public services.

This situation does not fit with the democratic right of equal access to all information for all citizens. Being able to use ICT/consumer electronics is a condition to reach a level of quality of life; the capability to use networks for online services is a condition for participation at the information/knowledge society. A new approach is needed.

### Universal Design and ICT

ICT is universally accessible when it is usable without adaptations and compatible with every (new) technology. Developing products and services with the user in mind makes it possible to integrate all requirements in the design. This is the concept of Universal Design.

There are already promising developments on the market for a more universal access: system software providing the opportunity to enlarge text, to improve the contrast of the screen, to make a choice of access facilities (keyboard, mouse, speech...), keyboards giving access via shortcuts replacing the functions of the mouse. Wireless technologies (Bluetooth) make it possible to easily switch from one technology to another. Digital television no longer needs assistive technologies to provide subtitles, sign language and audio description.

### Need for a paradigm shift

The concept of universal design includes a paradigm shift: from making mainstream ICT accessible through adaptations, to designing adaptable systems with access functionalities usable by as many (different) users as possible: adaptability instead of adaptations, preferably pro-actively responding to participation problems.

Only if special requirements cannot be implemented in mainstream appliances – which is probably the case for severe functional impairments – add-on software and assistive technologies will be necessary, preferably through standard interfaces.



The universal design concept seems feasible considering the actual approach of an “Ambient Intelligence” environment with a multitude of intelligent appliances, offering useful functionalities in the physical and social environment of the user, adaptable to the context and activities and anticipating on the needs. The so-called Smart homes are examples of this. [9]

## **Include UD Concept In E-Inclusion Policy: Basic Principles**

### **Research and development**

There is no doubt that mainstream applications can be designed addressing most of the needs of the users with functional impairments and not only assistive applications for specific groups. It is a matter of taking into account the needs of these users in the designing stage.

Universal Design is based on full user participation. Users must be present in the whole design and development process as full participants, being paid, under a code of conduct for experiments. It seems sensible to recruit users with sufficient ICT interest and skills.

Technologists need also to understand how these users interact with ICT. The impact of the current internet and ICT developments, at technological, societal and economic levels, and their interrelations, cannot be understood without a genuine multidisciplinary approach, involving scientific disciplines, human and social sciences and professional domains (interaction design, ergonomics, artificial intelligence). (1)

Certainly to realize a universal access, standardisation will be a basic principle. The EC gave mandate to the standardisation organisations to include UD in the standardisation process.

### **Awareness Raising of the industry needs extra attention**

ICT industry tries to keep pace with the technological change offering new opportunities for citizens. It is somewhat strange that ICT companies overlook the growing group of non-users of ICT. On the mainstream market, accessibility is not a priority. Suppliers of AT are mostly small companies without the financial means to follow developments in mainstream technology. Thus, it is difficult to include accessibility in mainstream appliances.

Arguments must be put forward to convince the market of the economic impact of digital inclusion. Focus may be widened. Not only disabled or elderly people need inclusive ICT. For instance, people wanting to read their email or newspaper while commuting by car need auditory interfaces. In addition, they will need voice input to enter commands to the system, similarly to many people with severe motor restrictions

### **Policy basis**

Important international policy programmes mention explicitly the UD concept.

Article 4 of the UN Convention for the rights of persons with a handicap stipulates the general obligation to promote UD in the development of standards and guidelines, among others regarding access to information and services.

Digital Agenda Europe, launched in 2010 promotes social innovation by design.



Current EU regulation guarantees disabled people connection with the public network to make phone calls, send faxes or have internet access. Furthermore “directory enquiry” services, directories, public payphones and special help must be at their disposal.

### **A roadmap to introduce the UD concept within e-inclusion**

The report accompanying the Resolution (2007) 3 of the Council of Europe describes the introduction of UD in stages: adoption and decision on the UD concept in legislation, co-ordination of policies, implementation of UD. [10]

#### **Adopt and decide, political decision making**

UD within ICT must be put on the political agenda as has been done for UD in the built environment. Several countries have noticed a clear change from organising society through legislation to inviting the market to disseminate the UD concept. Is market competition the most effective way to introduce UD or must it be pushed through legislation?

Several Member States have adopted accessibility standards for the design of their public websites.

As the UD concept is applicable to all societal fields, every authorized sector needs to take its responsibility and incorporate UD in their ICT applications from a co-ordinated, intersectorial approach.

#### **Awareness and implementation**

In order for the UD concept to sufficiently infiltrate in society, all relevant stakeholders will need to be well informed. Some countries have established knowledge centres for universal design (Ireland and Norway) or for ambient assistive living (Germany).

In particular, researchers and designers should be made familiar with UD. The concept should at least be part of all ICT education and training programmes.

Innovative UD research can also be stimulated by the government by means of specific research programmes and/or incentives, e.g. through UD/ICT awards.

Digital literacy must be anchored in education and training system with focus on the most vulnerable groups.

### **Stepstones leading to fulfilling a dream**

Some promising initiatives may be steps to universal access of ICT.

**Open Source:** Upon acquisition the buyer of open source software can dispose of the source code and so indicate how to adapt the software. He/she then no longer depends on the original supplier. This creates opportunities for permanent improvements and developments. Furthermore, the open source solutions are free for the end user and solve the problem of affordability.

**A national public inclusive infrastructure:** Integrating all specific needs of people with severe impairments in a UD is considered very difficult, even impossible. Internationally, the opinion is dominant that universal access should be achieved for personal technologies at least for people with mild handicaps, but must be enforced for public technologies for all of them.



## Conclusion

Based on the previous project, “Raising the floor”, the University of Michigan has the ambition to realise a universal accessibility solution in the internet infrastructure. This will establish a National Public Inclusive Infrastructure allowing users to choose from different access elements and interfaces. Consequently, everyone will be able to use every computer with the necessary specific access functionalities.

It is essential to make every computer or communication device immediately appropriate for the user in his/her environment rather than to expect the users to adapt or install themselves the system they need. Only then will the internet be truly inclusive. [11]

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### 3.4. The ETNA Project: European Thematic Network On Assistive Information Technologies

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#### Abstract

Information and Communication Technology (ICT) has a significant contribution to make for people with disabilities, removing barriers to participation in everyday life. Ensuring access to ICT assistive products and services which provide the most appropriate solutions is not straightforward. Information can be unclear, not well distributed or simply absent. Comparative information is often not available. Information must be easily available to all the varied stakeholders involved, and be presented so as to allow meaningful consideration of the solutions available. ETNA is an EU-wide Thematic Network which will work for three years to establish a web portal of ICT-based assistive technology resources, solutions and related services.

#### Keywords

Accessibility, assistive solutions, Assistive Technology (AT), e-accessibility, ICT-based assistive technology, Information and Communication Technology (ICT), ontology

#### Introduction

The European Thematic Network on Assistive Information and Communication Technologies (ETNA [5]) is funded by the EU's ICT Policy Support Programme – Competitiveness and Innovation Framework Programme [5]. It will work for three years to establish a web portal of ICT-based assistive technology products, accessibility solutions and related services, co-ordinated by the Biomedical Technology Department (Polo Tecnologico) of the Don Carlo Gnocchi Foundation, based in Milano, Italy.

ETNA will facilitate and co-ordinate the implementation of the Portal which will also allow access to repositories of freeware, open source software products and tools for developers of accessibility and assistive solutions, or for mainstream developers who wish to make their products accessible; and will serve as a platform to share expertise, ideas, views, resources and field experience. Such a Portal will initially stem from the existing portal of the European Assistive Technology Information Network (EASTIN [4]); it will take advantage of existing repositories such as Open Source AT Software (OATSoft [7]), the ACE centre's SpeechBubble [8], and other Internet resources made available by the partners; it will be maintained in the long term through a collaborative effort of the partners, some of them being committed at national level to be information providers in the field of AT; others being committed as developers of tools and holders of expertise in the area of ICT assistive solutions. Some unique features of the EASTIN engine will be incorporated to ensure outreach across Europe. These include full multilingualism for all EU languages; the ability to

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integrate an unlimited number of different information systems, and the flexibility to cope with the temporary unavailability of any such system. The ETNA Thematic Network will help 1) make information on available AT and accessibility products and services easily available to the users; 2) connect developers, providers and suppliers of AT solutions from all over Europe; 3) connect developers and professionals (in the health, social services, and educational areas) with end-users of AT, thus injecting the users' viewpoint and allowing users' feedback; 4) overcome fragmentation in the AT market.

The partners of the consortium have been selected so as to accurately reflect the varied situations across Europe, to have knowledge of the existing wide range of products, resources, manufacturers, developers, infrastructures and shareholders, and current developments within these. ETNA is an EU-wide network involving 23 leading Institutions in 13 Countries. They include:

- Organisations committed to public information provision in AT and educational technology, many part of EASTIN
- Organisations specialised in research, development and application of ICT accessibility and assistive solutions
- Organisations of people with disabilities with significant experience of research and promotion of social inclusion through ICT
- Professional networks supporting the advancement of AT

There are six main stages of the project, to address the relevant issues:

- Identify information needs of all stakeholders, to specify requirements of the portal
- Inventory of existing EU resources, deciding what to include
- Classify the key features of ICT AT products through appropriate ontologies
- Classify authoring systems and developers tools through appropriate ontologies
- EASTIN portal upgraded to ensure unified and efficient access to all resources
- Field-test the portal, to evaluate effectiveness in meeting the identified needs, fine-tune the portal

The first two stages of the project have been completed. Stage 1 was addressed at the first workshop. After an initial, virtual, kick-off meeting, the partners met and interacted to become a functional network at this first workshop. The workshop considered the information needs: detailing and identifying the sub-domains of the ICT AT domain; identifying the main categories of stakeholders and their search needs; and from this identifying search profiles for the different stakeholders from their reasons to search the portal, and the types of information resources they expect to find. Thus the types of information to be covered to meet those needs become apparent. There are a wide variety of stakeholders with a variety of reasons to search the portal; five main categories were identified:

1. End-users
2. Professionals
3. Manufacturers/suppliers
4. Researchers/developers
5. Policy makers





All their varied reasons for searching the portal were discussed and detailed, and the resources to meet those needs were tabulated. The search profiles make clear the range of different types of information required and the many different types of resources needed. The documenting of all the reasons and needs for searching the portal enables many different aspects of the various resources to be available, and for the views and requirements of the various stakeholders to be disseminated more widely.

Finally the challenges posed by the results of this research were considered. There are significant challenges in a field which is rapidly changing and diversifying. For example, the fields of ubiquitous and pervasive computing are particularly dynamic at the moment, prompting significant developments in approaches to interface design and development (e.g., natural user interfaces); the merging of AT into mainstream devices, especially in the fields of mobiles phones and games interfaces, is particularly dynamic. In addition developments in accessibility, inclusion, social participation and the rise of digital natives means that requirements are changing. Because the technology is evolving so rapidly, social attitudes and expectations are also changing; social behaviour is shifting more and more to new modalities of approaching and interacting with technology. Consequently, information needs change, and the portal should be ready to meet these changes. Network communities are becoming a basic means of communication and interaction, and digital skills are growing. The portal should be a “virtual space” to facilitate and enable end users to find, consult and, wherever possible, download their desired products and try them out before deciding. It should allow the user options and opportunities to find their way according to their needs and preferences. Additionally, stakeholders and their demands shouldn't be fixed in static groups, but should be fluid as circumstances and requirements demand.

If well designed, the portal will be an empowerment tool for end-users, facilitating responsible, informed and effective choices of assistive solutions, and providing a powerful channel for circulating the end users views among other end-users, as well as professionals, manufacturers and suppliers, researchers and developers, and policy makers.

The second workshop addressed stage 2, considering the inventory of existing resources, and what to include. The workshop focused on exploring and classifying useful, varied, internet resources concerned with all the various aspects of ICT AT, analysing criteria for inclusion/exclusion and strategies for linking to the ETNA portal search engine; and finally possible quality indicators.

A preliminary inventory of resources was compiled by asking each partner to indicate what are the online resources they use in their work or they think could be interesting for the Thematic Network Portal. A form was circulated where each partner had to fill-in the names of the providers, a short description of the resources and services provided, the language(s) in which the resources or the services are delivered, the URL(s) and the language(s) of their websites. About a hundred resources were identified and collected on a worksheet that was distributed during the first ETNA workshop for further consideration. Based on the analysis of this preliminary inventory, a tentative classification of resources was prepared by the team of the project coordinator, and a tentative set of inclusion/exclusion criteria and quality indicators was proposed by the team of the work package leader.



The following categories of resources were identified and were considered at the second ETNA workshop:

- Product records
- Software applications
- Software source codes
- Articles
- Case studies
- Ideas
- FAQs (frequently asked questions)
- Projects (links)
- Forums
- Regulations
- News
- References

The workshop also considered alternative linking strategies for the portal. It concluded that the following would be a feasible strategy: when searching for information in the ETNA portal, the user will be presented first with all the resources that have been classified and organized according to the ETNA ontology. These will be provided dynamically by the EASTIN-like providers through their web services and by the central database. This process is language-independent. The user can then make a language-dependent search, in a google-like fashion, on other potentially relevant information, across the websites identified as “projects” among the found resources.

Criteria for selecting the resources to be included or excluded were discussed. These criteria aim to be clear and transparent to make it easy to decide if a resource is relevant and appropriate for the Portal. From the preparatory work and the discussion at the second ETNA workshop, the inclusion/exclusion criteria can be clustered around three categories:

- Process-related criteria, of relevance to the providers: the direct content providers need to be aware of the scope of the portal, the classification of resources and of its “rules”. This will typically mean being accredited by the portal and signing an explicit commitment to respect formats, rules, quality procedures.
- Technology-related criteria, for both the providers and the resources: accredited providers should provide the resources according to the ETNA format specifications.
- Contents-related criteria, that refer only to the resources: The resources to be found through the Portal must relate to ICT-based assistive products and eAccessibility solutions that are available in Europe, according to the definitions provided by Deliverable D2.2 “Map of information needs”. Any resources that fall outside this definition are not of interest for the Portal.

Regarding the contents-related criteria, the borders between assistive and mainstream are blurred, so that the criteria for inclusion/exclusion must endeavour to be flexible, in order not to exclude innovative mainstream products with special features that make them particularly interesting for people with disabilities.



The initial inventory of resources was considered in terms of the inclusion/exclusion criteria and quality indicators proposed. A number of presentations of examples of existing resources were given, to help participants consider the implications of the discussions in the context of practical examples.

A series of Webinars builds on the seminars delivered at the workshops in order to inform the network of the expertise and experiences available in the network.

Details of all deliberations are given in the project deliverables, available from the project web site [5]. The next workshop, in January 2012, will consider the creation of ontology of ICT-based assistive products (Stage 3).

### ATIS4all

ETNA collaborates with the related ATIS4all thematic network [2], which aims to facilitate access to the most suitable ICT AT or accessibility devices and services according to needs, preferences and contextual characteristics. ATIS4all will start and maintain an open, collaborative portal offering reliable information on AT and inclusive products and services, and cutting-edge technological trends; it will use Web 2.0 participation tools in order to encourage online discussion and exchange of knowledge and expertise, and sharing of information among key actors and end users. At the first ATIS4all workshop, participants exchanged ideas and perspectives, and developed an overview of the Project. The workshop also served to define the next steps in the Project research. The technical co-ordinator of the ATIS4all project attended the ETNA workshops. Both networks were set up in January 2011, and between them involve 42 leading institutions in 16 European countries. The two networks complement each other. Like ETNA, ATIS4all takes advantage of existing repositories and internet resources. ETNA is mainly concerned with the portal's search engine, enabling all the stakeholders to access the data and resources available through a multilingual interface. ATIS4all mainly focuses on building Web 2.0 applications to create an active online community, enhancing dialogue, sharing and participation among users, researchers and developers.

The following are a few examples of the varied range of resources and ICT assistive solutions which should be made available via the ETNA portal. Presentations on many existing resources were given at the second workshop, in order to inform the network of the expertise and experiences available in the network, and in order for the contemplation of the inclusion/exclusion criteria, quality indicators and linking strategies to be carried out in the context of the examples. All presentations, webinars, details of discussions and deliverables are available from the ETNA website [5].

### SpeechBubble

SpeechBubble is a resource of the ACE Centres. The ACE centres provide a person centred, multidisciplinary, independent assessment, advice and training service to people (children and adults) with complex disabilities who require assisted/augmented communication aids in order to communicate and to learn [1]. They try to discover or maximise the potential to communicate, read and write, and investigate whether or not technology can provide any solutions alongside other methods of communication, like signing and gesture. Additionally they aim to influence the development of new products which meet the needs of children and young people who need assistive technology in order to communicate and to learn. They

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also seek to influence policy makers and funding organisations with regard to the importance of inclusive policies and standards for people with communication difficulties to enhance quality of life through access to education.

The ACE Centres' SpeechBubble website provides a unique searchable website through which professionals, parents, carers and communication aid users themselves can compare and contrast the key features of English language-based communication aids available, provide an insight into how they can be operated, and make sense of the bewildering variety of communication software on offer [8]. The sorts of questions the resource can answer are:

- What vocabulary software is available with auditory scanning?
- I know how to use the LLL vocabulary, but what communication aids does it run on?
- I just want regular updates on communication aid developments
- Who offers the best warranty on communication aids?
- I'm an eye-gaze user – what communication software can I use?

As a supplement to SpeechBubble, 'Apps for AAC' provides a comprehensive list and description of Augmentative and Alternative Communication (AAC) apps. Software and types of speech are categorised and the size of the app is described. This list helps users find AAC software on iPods, iPhones, iPads and Android devices, as it is difficult to keep up with this new and rapidly expanding field.

## OATSOFT

OATSoft is dedicated to improving Assistive Technology and computer accessibility through the power of Open Source development techniques [7]. *OATSoft* aims to make the best Open Source Assistive Technology Software (OATS) easy to find. Users and developers meet at *OATSoft* to create better software. Users can find useful free software and discuss and work with developers to get the features they want. Developers work with users and other projects to develop new features and share re-usable components.

Open Source Software is free and the 'source code' that makes the software is freely available. It is developed by international communities operating on-line. Assistive Technology Software allows people with disabilities to overcome some of the disabling effects of society and technology, including computer and web accessibility.

## OAEG

AEGIS is a highly multidisciplinary Consortium (composed of key industry players, SMEs, universities, research institutes, end user organisations, etc.), with expertise in various disciplines relevant to accessible ICT [2]. The AEGIS project has developed a range of open source accessibility solutions which require an organisation to promote their further uptake, promotion and exploitation. The key industrial partners of the consortium, together with users' representatives and the active support of the Scientific Advisory Board have developed an Open Accessibility Everywhere Group (OAEG [6]) which aims to:

- promote the uptake of the AEGIS accessibility open source solutions through a coherent set of incentives and ultimately standardisation,
- maintain and upgrade the AEGIS Open Accessible Framework and the individual open source software resulting from the project, after the project's lifetime.



The AEGIS Integrated Project Consortium will help to define new approaches and solutions for building accessibility support into future information and communication technologies. A key component of the AEGIS Project is that it leverages open source accessibility technologies wherever possible. The AEGIS Project involves research and prototypes that address a broad range of disabilities, including: visual impairment, hearing impairment, physical impairment, and a range of cognitive/developmental disabilities. The project addresses accessibility challenges across three key areas: open source desktop computing, Rich Internet Applications (RIA) and mobile devices, with a multitude of research and development goals within each of these areas.

The OAEG aims to bring together all open source accessibility communities, as well as the techniques and approaches they use. The OAEG aspires to be “the community of the communities” in the open accessibility world.

The OAEG Strategic Objectives are:

- To bring together all communities and initiatives/initiators active in open accessibility fields.
- To allow exchange of information and update progress in accessibility and open source work worldwide.
- To publish the latest news, events, documents and open source s/w or learning objects releases relevant to accessibility, maintaining a knowledge base which will provide the release, alternative versions of that, info about the specifier, developer, user of s/w-learning object, user testing info, etc.
- To allow the exchange of views of renowned developers, experts but also users on the level of accessibility of released products in accordance to international standards and daily practice.
- To allow direct communication between developers and end-users active in the accessibility world.
- To evolve and improve constantly, following the trends and progress in the field, and incorporating the active recommendation and guidance of designers, developers, experts involved in user testing, users and all other types of experts involved in any way in the field.

The OAEG reflects many of the aims of the ETNA Network, and will be a major source of news, developments, expertise, and resources for open source accessibility technologies.

### **ETNA – Portal For ICT At Across Europe: Concluding Remarks**

The aims and objectives of the ETNA thematic network have been described – that is to ensure that access to information on assistive products based on ICT (information and communication technologies) and e-accessibility solutions in Europe is consistently and easily available to all relevant stakeholders. Progress so far and future challenges were described. The ATIS4all thematic network, which collaborates with and complements ETNA, was described. ATIS4all aims to facilitate access to suitable ICT AT resources, by focusing mainly on building Web 2.0 applications to create an active online community, enhancing dialogue, sharing and participation among users, researchers and developers. Some examples of resources and developments which ETNA will facilitate access to were given. ETNA will be a portal to information on accessible resources, products and solutions of a rich

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and varied nature; it will facilitate access to the results of many European projects and resources, and enhance communication and sharing of information between the many and varied stakeholders involved, helping to advance accessibility throughout Europe in a consistent and systematic manner.

## Acknowledgement

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### 3.5. How Can Local Investment In Accessibility Be An Investment In The Future?

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#### Situating

A part of the local population consists of people with a handicap. With a handicap, people are hampered in their functioning. Thus, they attain a vulnerable and always unequal position.

As local government, it is important to prevent handicapped people from becoming isolated. Independence, social involvement and participation are key concepts in this. It is striking that more and more handicapped people are trying to participate in all social, cultural and communal activities in society.

But with 'social participation' it involves all areas of life: living, mobility, working, assistance, free time and social contacts. Living independently and participation are not evident for handicapped people but it is possible by using various schemes, knowledge areas, aids, facilities and support.

Knowing about all these options, making use thereof and obtaining these schemes, means and/or facilities, is not always simple.

In the search for a suitable solution, 'customisations' are often pushed to the front for people with a handicap. Thus this group ends up with separate treatment and approach. This action ensures that society, in my opinion often unwittingly, is often also responsible for the creation and/or the preservation of stigmatising and marginalising thoughts.

In short, society is not accessible enough for people with a handicap. Fully-fledged citizenship, e.g. forming a life-long and across the board part of an accessible society, is not yet common for all.

A minor analysis of various accessibility problems makes it obvious that other population groups experience similar problems.

- Someone wants to go on an outing, but can't find the necessary information at all, or only with difficulty.
- People have difficulty in understanding the content of a brochure.
- Children and adults with a short stature, have difficulty in reaching a bell located at 1m70.
- An older person with a wheelchair falters over the irregularity of the foot path.
- A person with a fractured leg experiences difficulty in using public transport.
- A supplier with a heavy load must carry it in box by box because his vehicle cannot access the five steps to the entrance.



- Adequate wide free access to cupboards and shelves makes it easier for both parents with a pram and wheelchair users to do their business in the shop or supermarket.

It may be obvious that accessibility is a basic quality for everyone's living conditions and the basic condition in order to live an equal life in society. To put it differently, an accessible living environment and service provision are the keys to a fully-fledged social integration and participation of everyone. The man in the street expects first-class, accessible service provision from companies, but also from governments and the non-profit sector.

Concretely, this implies that buildings, the environment and services must be reachable, accessible and usable by everyone and that everyone must be able to use it in an independent and identical way and that care should be taken that the different needs of people be integrated in an obvious way.

To become the best possible policy, it is necessary to do 'crossroad thinking'. Every person is at the crossroads of a number of diverse traits. Just think of a middle aged woman with a handicap, an older person with a chronic disorder and a low income, a semi-skilled youngster of foreign origins with a handicap .... All elements basically form part of the individual identity but also appear as an intersection of various characteristics. All ranking characteristics play a role and at the same time, they are playing in on each other. Hence it remains of great importance to integrate the different needs and demands of people in an obvious way. Thus, they become useful for everyone. At the moment, thoughts are still too often on the 'average user'. This has the logical consequence that handicapped persons usually fall short.

Since both the upper and the local policy should be a reflection of society I think as (local) government it is certainly advisable to give a diversity plan some weight during tenders when awarding an order...In my opinion it clearly demonstrates 'an inclusive policy for different disadvantaged group'.

Personally I regret that reputable organizations, institutions, advisory boards such as SERV cannot find any referral to appointments in the same organization with different locations related to accessibility.

SERV, one of the partners who undersigned the 'engagement statement' for diversity in higher education, in July 2008 released a note with the title 'Workable employment for persons with disabilities or serious health problems' and the commission Diversity of the SERV on 9 July 2008 issued a statement on the 'employment of persons with a handicap in local government'.

Making such references, in my opinion makes it clear that all, in itself laudable initiative form a whole and the reality is that everyone in society should be involved in "accessibility

As a result of the regionalization of certain competencies some standards (for example the width of the door opening in order to be considered as accessible) appear to be different depending on the District where the door is located.

Hence it seems logical to confer with experienced experts from cross-country (regional) borders for an optimal approach in order to get the best approach for 'accessibility problems'.





Thus, the most ideal solution can be used by various member countries of united Europe and the "Planning and Design For All" principles endorsed in 1994 in Stockholm receive a new interpretation.

It also has the advantage that the architect, the contractor and the supplier know what the 'standard' is. Thus, "mass production" is also possible whereby the cost price could possibly still lower.

### Membership Of Advisory Councils

It goes without saying that people with a handicap should form part of advice councils in an equal way. In reality this is however often not the case.

Policy makers often assume that for example the accessibility problems and the suggested solutions from one target group (for example seniors) also applies to all disabled people. Nothing is further from the truth.

This is why I believe that establishing an independent council for and by people with a handicap could lead to a much better solution to the problem. This council should however be as diverse as possible, after all 'the person with a handicap' does not exist.

Representatives of this advisory council can then in turn sit in on other advisory councils such as the senior council, the social council, the Youth council, GECORO. Here they should share and defend the vision of their advisory council. This way the interfaces and proposals for solving the various segments of local society becomes more visible and together, the optimal solution can be found.

In the following it is not the intention to discuss the complete competency package where the local government plays its role as director, stimulator or coordinator. In the first part I wish to highlight the best known points of interest, to then in a second part deal with five extremely different aspects, without attaching any order of importance.

The social accessibility and the accessibility of the 'Social Home'

The Local social policy is the result of the actions that the local actors have undertaken to develop social rights for everyone. In view of further cooperation and discussion between all these local actors, the local governments have been forced to draft a Local Social policy (LSB).

In order to guarantee maximum accessibility of the service for every citizen the municipality is obliged to construct a so-called 'Social Home'. This is where citizens can turn to with any questions regarding the social services in their community, neighbourhood or district.

The Social Home has an information desk and referral function. It does not necessary involve a 'house' but rather a clear point of approach. With many local governments this point of approach is on the premises or in a building managed by the CPAS.

In this context 'the works on accessibility' has an extremely varied interpretation by for example:



- structuring the offer in such a way that it becomes more transparent for the man in the street,
- making the service and assistance better known,
- improving the physical and spatial accessibility,
- through a better internal communication, referral and client follow-up,
- by concentrating on psychological accessibility,
- by removing financial barriers,
- by removing the administrative barriers.

In practice we often see 7 criteria which is handled to determine whether a particular service or offer of assistance is accessible or not. These 7 accessibility criteria are:

1. Usefulness
2. Reliability
3. Understandability
4. Familiarity
5. Accessibility
6. Availability
7. Affordability

**Usefulness** refers to the extent to which the user can use the offer and if it meets the specific requirements (also of specific target groups).

**Reliability** relates to the extent to which the service provider and his/her offer can be perceived as reliable by the user. The reliability in return has an influence on the degree of mental barriers (anxiety because of prejudices).

**Understandability** deals with the degree to which the information regarding the offer is understandable (so much so that the potential user can estimate if the offer is intended for him/her) and the degree to which the service and assistance can be communicated understandably.

**Familiarity** concerns the degree in which the offer is known to the intended target group and is essential for accessibility.

**Accessibility** indicates to what degree the offer is accessible physically, spatially and in time. In a society with ever increasing mobility issues, this is a factor that should not be underestimated.

**Availability** refers to the duration in which the offer is available and the extent of barriers such as waiting lists and administrative barriers.

**Affordability** questions to what extent the price of the offer poses a barrier. Sometimes this criteria is interpreted quite widely and not only the financial expenses are taken into account but also the 'psychological costs' or effort that the user must make to make use of the offer.

The types of actions through which one can respond to impracticality, unreliability, incomprehensibility, inaccessibility, unavailability or unaffordability can be bundled under a number of themes or areas:



Finally, I wish to point out that for local policy makers and employees of the CPAS, it is important to understand that the CPAS have an image problem to deal with. From a recent study, presented at the conference of VVSG with the title 'towards an accessible help and service delivery', it appears that society describes the target group of the CPAS described as people in misery, the strangers, people who want to profit from.... It is also striking that there is still an enormous 'feeling of shame' when taking a step towards the CPAS. This feeling of shame however is more present with older people than the younger population. But it does however decrease as clients experience that their vision on the CPAS is inconsistent. Finally from the investigation it appears that the 'Social Home' escapes these negative comments. That's why the researchers propose to in future only use the term CPAS for official documents and using the listing 'Social Home' in the communication with the broader public.

### The Local Government As Employer

In the following it is not the intention to discuss the complete competency package where the local government plays its role as director, stimulator or coordinator. In the first part I wish to highlight the best known points of interest, to then in a second part deal with five extremely different aspects, without attaching any order of importance.

The reality is however that many local governments have had to tighten the proverbial 'belt' as a result of the economic recession. Now, more than ever, it is necessary to have 'the right person at the right location' to guarantee optimal service to the population. Until not too long ago, when searching for a suitable staff member, diploma requirements were usually taken into consideration. In the last few years we also started working with competency profiles.

However this seldom applies for the employment of people with a handicap. They are often only employed because of 'the 2% standard' or 'out of sympathy'. As a result of this they are often placed in 'undervalued jobs' or they are employed in a function below their qualities.

Apart from the specific role as employer the local government play a particular role as producer and stimulator in the ambit of amongst other the local services economy.

Within the limits of the care area of the work shop the local governments take an active directing role on the local service economy.

This directing role entails amongst other:

- Reviewing, adjustment and coordination of the further structure of local service economy with explicit attention to social requirements for the maximum creation of job opportunities, also for disadvantaged persons;
- Development of the local service economy within the intergovernmental context;
- Presentation of basic information and making the service offer available. To this end, the services guide is the ideal instrument.

In this capacity the local government has the task of finding the optimal organization and reputation of the local service economy' towards the wider population. Furthermore, it is also the intention that, in discussion with the stakeholders, the development of the local employment policy, where the 'job shop' plays a role is considered. An important instrument for this is the local job opportunities forum, which apart from the job shop partners also brings the social partners and possible other actors together on a regular basis on new employment

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initiatives and projects and the local employment policy. Theoretically the policy follow-up of the job shop is a task of the forum.

From a recent HIVA study some important findings surfaces about the policy directions and the political forums:

- there is little participation of partners in the forums in care areas with a low Unemployment level;
- in national care areas there are not always substantive discussions on local (policy) initiatives;
- (smaller) local governments indicate that they often weigh inadequately on the labour market, considering that Flemish and federal government play an important role here. As a result the local policy is often stalled in these municipalities.

It is clear both from scientific research and the recommendations of renowned institutions that employing people with disabilities often leads to a win-win situation. Despite the huge financial incentives from supra local government and / or pararegional institutions, the

incentives policy of the federal government (think of the explanatory memorandum relating to the calculation of the contribution of working people with disabilities from June 2006), and partly the legal obligation of the '2% or 3% standard' of local and top local authorities, the decree stipulations the many local governments assume that handicapped people have very limited capacities and 'cannot take anymore'.

I believe it is appropriate to consider abandoning this stigma and handling the principle of 'the right person at the right place' as a rule. After all managing the diversity of the workforce can be particularly well-managed, especially human resources so that every employee feels valued for the sake of their skills.

As a first step, a local government can participate on for example 'the DuoDay' whereby amongst others the local government is offered a chance to gain more insight into the possibilities of the handicapped person, to gain insight into professional support and services, and to offer the opportunity to gain insight into the requirements, to convince the potential employee of his/her expertise and skills. Thus the expectations of the local government, the prospective employer and the job seeker are better reconciled.

In a following phase it should therefore also be possible to, according to the example of the Flemish Government, reconcile an 'integration protocol' whereby the principal of 'the right person at the right time' also receives stature for this group of employees.

Referring to the various legal stipulations it is a must to, if necessary, provide the necessary changes and/or the necessary guidance.

I am very pleased with the train of thought behind the mentorship program. One should however be very careful to ensure that the mentors are given the correct additional training and also that they become involved in the evaluation of the relevant staff member with a (labour)handicap.



Where the local government plays a directing role in the ambit of the 'social' economy (WEP+, local service economy initiatives, sheltered workshops, social work sites, insertion companies,...) I believe that one should rather use the term 'value' economy.

The term 'social'-economy, I believe, has a negative connotation with the majority of the population. It would involve the 'inferior employment', employment of 'losers'. The choice of the term 'value economy' however clearly indicates that it involves employment which would offer an added value for the individual employee and the entire society. For the individual employee such a name after all again reflects that, just as in the regular economy, the principle 'the right place at the right time' and everyone is assessed based on his/her talents/possibilities. For society it again indicates that the services offered by the various initiatives offer an added value for its individual members, the families, etc. In other words it clearly indicates that the individual members from the disadvantaged groups offer an 'added value' to society

Furthermore I believe that 'crossroad thinking' could bear fruit with the organization of the various initiatives. In this way for example a 50 year old man with a physical handicap could do administrative work for an ironing depot where the actual ironing is done by employees with another type of handicap.

Since many local governments increasingly consider to contract certain orders out to 'private organizations' I think it should be pointed out that they have a good view of what the local and regional 'added value' economy has to offer at whatever expense. After all, thus it can ensure that 'the added value' of the presented services is also made known to the wider public and also others who use these services.

Here I think for example of employment in Sheltered workshops. Contrary to what some believe, sheltered workshops have after all been 'occupational therapy for handicapped persons' for a long time, they are professionally managed companies who can offer a wide range of services.

## Sports

The range of sports activities and organizations for handicapped persons, on a recreative level as well as in a competition context, is extensive.

From this research it appears that only 3% of persons with a handicap under the age of 20 regularly participate in sports activities. Despite the many efforts which are taken locally as well as supra-locally in for example the context of 'the sport for all decree' of 2009, it is obvious that the 'inclusion idea' also here does not go without saying. It appears that locally, despite the additional subsidies, G-sport Rarely gets off the ground unless other members of the club are personally closely involved or there are people with an exemplary function (like Mark Hermans and Marieke Vervoort) who form part of the club.

Furthermore it is striking that private sports clubs and /or organisations are often considered as a 'confidential nest' where one can compete with 'peers' whether or not in competition context.

The non-profit association AnVaSport is an example of this:



*“Disabled people who wish to participate in sports, offering the possibility to practice sports (mainly initiation) in a protected environment in function of integration and with a view on maintaining and improving the general condition. At Anvasport one can participate in a wide range of sports activities. The accent hereby does not lie on competition but on experience and enjoyment (both the activity and the after activity). Anvasporters have perseverance, a sense for social contact, like a challenge and have a substantial sense of humour. Anvasport would like everyone, with his or her specific possibilities, to participate in sports activities. The attention for safety, the opportunity to repair prosthesis on site, immediately taking care of physical ailments, searching for and developing modified tools, these all form part of Anvasport, an association which attracts a large group of handicapped persons.”*

Source: www. Anvasport.com / who and what is Anvasport, October 2010

## Youth

It goes without saying that in Flanders, with varying success, many initiatives have been taken to integrate children with a handicap.

Here I think for example of the inclusive playground activities at a local level and of Akabe: Different is Good!. Scouts and Guides of Flanders will invite everyone to participate, also children and teenagers with a handicap. They are able to do this in a group which offers special attention to children and teenagers with a mental or social handicap.

It goes without saying that these organizations, in the ambit of their role as ‘supporters of accessibility’, may expect some form of stimulus from the local authorities.

Furthermore it is also important that local authorities, for a clear image of the existing range of activities, where people with a handicap are welcome, organized within the own and/or surrounding municipalities also have the necessary contact details.

Integration of disabled people within the local community is spontaneously stimulated by encouraging participation in leisure activities since childhood.

## Public services

I find it regrettable that despite the thorough reformation of most of the legislation and advice connection is connected to a ‘result connection’. It seems to me that, when preparing a file for a board or in cooperation with another local government or files where local and supra-local governments are involved, accessibility advice is indispensable. Think for example of constructing a footpath, developing a playground, developing a station environment, the depot of the Lijn, Flemish road projects where both the municipal and the Flemish government is involved and the school building project “the schools of tomorrow” whereby amongst other “passive construction” is pushed forward as key focus.

In addition, this obligation of a result can also be linked to acquiring an allowance from the higher authorities, a pararegional institution. This connection has a two-fold purpose being the illegal use of funds, intended for the improvement of accessibilities, reduce to a minimum and ensuring that the works are implemented in accordance with the advice and/or agreements. Hereby the decision of the Brussels Capital Regional Government dated 07 May 2009 with regard to the layout of the diversity plans and the allocation of diversity labels can be seen as an example.

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### Accommodation

As part of the housing and residential programming for the municipal territory, it seems worthwhile when drawing up a general framework of a private or public land division and / or housing project carried out by the social construction companies, a minimum number of accessible (social) rental and / or buy residential units, to establish and / or renovate existing homes. Thus, it promotes the inclusion of custom homes and residents in a complete housing project.

As an example of this the approach in the Brussels Capital Region and the Brussels Region Housing can be used in particular.

Here follows a short summary of the various laws and regulations which explicitly refers to the 'approach' for people with a handicap and where the Brussels Regional Housing company plays an important role, amongst others:

- the ordinance dated 17.07.2003 ( completed by the ordinance dated 1 April 2004): article 31, 5°
- decision of the Government of the Brussels Metropolitan District dated 26.09.1996: article 7, 6°
- management agreement of 2010 between the district and the BGHM:
- article 19
- article 88
- the ordinance dated 17 .07.2003 ( completed by the ordinance dated 1 April 2004): title IX Equal treatment. Incorporated by the ordinance of 19 March 2009

### Culture

Personally I regret that reputable organizations, institutions, advisory boards such as SERV cannot find any referral to appointments in the same organization with different locations related to accessibility.

It seems logical that both the local and top local government with a possible cooperation pays particular attention and/or also stimulates the cultural movements for handicapped people as far as possible.

As 'accessibility' is not the key task of such an organization it seems cooperation with the accessible travel information centre, which in itself is a component of 'Toerisme Vlaanderen', is certainly worth considering.

Where the higher authority has a lot to say on 'administrative simplification' and 'unity of files', it is interesting to note that for example the VAPH and the VDAB handle other rules for employing the same person and / or compensating the same tool (for example an ergonomic office chair). Such a process is obviously no incentive for a person with a (labour) handicap to take the step to the labour market. I therefore appeal that you hasten the creation of a 'unified file'.

### General Conclusion

It is clear that the approach of 'people with a handicap' has undergone an enormous evolution. Many efforts and initiatives have been taken to offer these people the opportunity to live a 'fully accessible life'. Since a full integration is not feasible and considering the need,

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society has also ensured that there is a wide range of specific legislation, organizations, so that handicapped people can live an as full and decent life as possible.

The local government can, in various policy domains, play a directing and stimulating policy by using its subsidy regulation. Thus, accessibility is included as a condition for the allocation of municipal allowances, the allocation or refusal of grants could be an instrument to increase / decrease social accessibility of initiatives. Accessibility must furthermore be a prerequisite for the creation of new regulations.

The optimal use of scarce resources, consistency and transparency in the regulation and cross thinking, should cause 'people with a handicap' to form part of society where participation plays an essential role, in the most inclusive way. One can for example, as a result of several of the abovementioned proposals, even for people with a handicap, handle the principle of 'the right man/ woman at the right place'. Thus new professional experts will be sought. And they will get the chance to apply their knowledge and expertise. In this way the stigma around handicapped people can be further removed.

However, in the interest of the individual and / or the group, there must be a possibility for a specific approach. In other words, the local and top local accessibility policy should be directed at the principle of "As far as possible ordinary, as little as possible exceptional".





## 4. Session 4: ARIA and Developer needs and wants

After HTML4, Rich Internet Applications (RIA) arrived and HTML5, creating new challenges regarding accessibility. This session provided both a practical approach by demonstrating tools to create Accessible RIA, while also looking into the current accessibility of nowadays websites and how to improve this.

### 4.1. Providing An IDE For Creating, Simulating And Assessing Accessible Applications

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#### Abstract

This paper presents an Integrated Development Environment (IDE) developed in AEGIS project which provides accessibility to applications by employing the capabilities of the NetBeans platform. Firstly, the IDE incorporates and use AEGIS WAI-ARIA enabled widgets from jQuery, MooTools, and Fluid Infusion libraries in order to create accessible applications. These applications are previewed with an embedded html browser and simulated by using the ACCESSIBLE DIAS (Disability Impairment Approximation Simulator) functionality. For better understanding of the simulation, specific AEGIS and ACCESSIBLE based personas with several impairments are used. Finally, this IDE embeds the ACCESSIBLE WaaT (Web assessment tool) in order to support the overall analysis and verification of the created Web applications in terms of accessibility based on the latest WCAG2 W3C standard.

#### Keywords

Web accessibility, simulation, assessment, IDE.

#### Introduction

This paper presents an Integrated Development Environment (IDE) which allows the creation, simulation and assessment of accessible Web applications. In order to specify in detail the functionality of the IDE it is useful to have adequate knowledge of the state-of-the-art on similar IDEs. The purpose of this survey is to provide the required knowledge on this kind of tools that will influence the design and specifications of the envisioned tool based on best practices and current implementations and reusing software components or systems if necessary, available as open source products. In order to fulfil the aforementioned purpose, the next chapter describes the most representative development platforms for building accessible Web applications.



## State of Art on IDEs

### IBM rational application developer for WebSphere software.

Rational Application Developer for WebSphere Software [1] is an Eclipse-based IDE, made by IBM's Rational Software division, for visually designing, constructing, testing, and deploying Web services, portals, and Java Enterprise Edition (JEE) applications. It also includes wizards, editors, and palettes to assist with the creation and deployment of Web applications. Rational Application Developer includes tools to improve code quality. A Java profiling tool helps to analyse an application's performance, memory usage, and threading problems. A software analysis tool identifies patterns and antipatterns in application code, and compares code to coding standards. The workbench includes tools for deploying an application to a local or remote server. It contains test environments for IBM WebSphere Application Server and IBM WebSphere Portal. It also supports Apache Tomcat. Using these tools, a software developer can test their application locally before publishing it to a production server. Because Rational Application Developer is Eclipse-based, it can support the third-party plug-ins for Eclipse, as well as plug-ins specifically for Rational tools. The latest version of Rational Application Developer is Version 8.0.3, which was released in June 2011. What can be seen as a drawback about this IDE is that it is a commercial one.

### Ajax tools framework project home

The Ajax Tools Framework [2] (ATF) is a tool integrated with Eclipse for Web developers who use Ajax techniques. ATF provides tooling that allows a user to edit, debug, and monitor CSS, HTML, and JavaScript applications and a framework on which adopters can build advanced and technology specific tools. The functionality in ATF breaks down into three main areas: Browser Tooling, JavaScript Debugger and extensions for adopters. The Browser tooling allows a developer to inspect and manipulate their DHTML application in the live browser. The Browser tooling consists of one editor and several views. The Mozilla Browser Editor allows the embedded Mozilla browser to show up in the Eclipse editor area. The JavaScript debugger allows the developer to debug their AJAX/DHTML application. It also allows a developer to set breakpoints, inspect the call stack, variables, etc. of their application. The introduction of the Embedded Mozilla XULRunner Browser support is a common attribute with our IDE; however the downside of this approach is that it relies almost entirely on AJAX.

### CodeLobster PHP edition

Codelobster PHP Edition [3] streamlines and simplifies php development process. It is a free portable IDE for PHP/HTML/CSS/JavaScript development. The main disadvantage of this IDE is that you have to buy low-cost plugins for it to add additional library and framework functionality (such as auto-complete, syntax-highlighting, command help, and other plugin-specific features). In addition CodeLobster is too slow to open big projects and it's hard to find a file in the file list.

### Dojo IDE

The Dojo IDE [4] is an integrated development environment for Dojo Toolkit based applications. Dojo developers can use this free and open source IDE for relaxed frontend and backend web development. The Dojo IDE already supports project management, Javascript Source Code highlighting, code folding, tasks management, bookmarking.



## Developing Accessible Applications in AEGIS

In AEGIS, NetBeans platform has been used as the basis for the development of Web applications. In order to ensure accessibility, AEGIS WAI-ARIA enabled widgets from three different libraries (jQuery, MooTools, FluidInfusion) have been installed (See next Figure). Below, information about the selection of these components and the methodology that developers could follow are shortly presented.

### NetBeans platform

NetBeans is an open, extensible platform that has evolved from a universal tool platform to being a platform for any end-user applications. Its initial conception was as an open IDE platform for integrating a diversity of development tools. More recently, the rich client platform (RCP) was created from the generally useful portions of the NetBeans workbench (e.g., window-based GUI, UI frameworks, plug-ins, help system, update manager). It allows developers to use it as an extensible desktop application and as a platform for building client applications with rich functionality.

The plug-in is the central NetBeans platform mechanism for defining new functionality and extending an existing functionality. It is the smallest unit of function that can be developed and delivered separately. Other than a small kernel known as the platform runtime, all of the NetBeans Platform's and the NetBeans Rich-client Platform's functionality is located in plug-ins. A plug-in exposes functionality to other plug-ins through extension points and/or declares interconnections to other extension points provided by other plug-in. Thus, extension points are well-defined places where plug-ins can contribute and link to functionality.

The plug-in architecture with its plug-ins, extension points, and extensions work in concert with a rich-set of APIs to provide an open system that treats extensibility as a truly first class notion. The rich APIs provide the rich set of frameworks and building blocks for extending the NetBeans IDE and rapid development of rich-client applications.

### WAI-ARIA components

As AEGIS wanted to focus effort on a library which has the largest use and mindshare, jQuery which continues to dominate the statistics was first selected.

MooTools has been selected for two reasons. First Mootools is a very popular and powerful framework, which is used and developed further by a large and active community. A long list of important references proves not only that use of MooTools is spreading, but also the possibilities of the framework. Thus, many people will likely benefit from improving the accessibility Mootools. Second, the accessibility status of MooTools is very low. There is not much activity in the area of accessibility within the MooTools community. Also, no further plans for enhancing the accessibility of the framework are in place. Therefore, it could be an important step for the further development of the framework to bring the topic of accessibility into the community and raise the awareness of its necessity with the AEGIS work.

The Fluid Infusion component set was selected for several reasons:

- It is built upon jQuery, whose importance has already been cleared above, and Fluid work is able to feed accessibility improvements back into jQuery.
- From inception, accessibility, including the use of ARIA, has been a core value of the Fluid Community. Despite this, some accessibility issues especially screen reader

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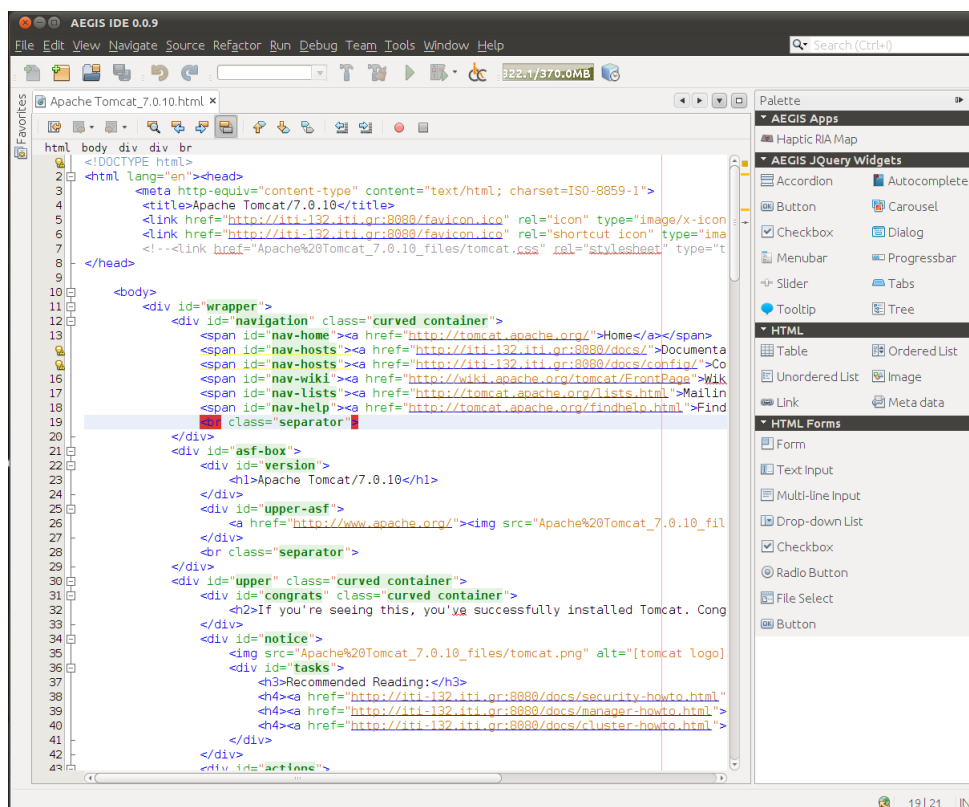


usability issues remain. Examining and correcting these issues will likely reveal important areas for improvement with the ARIA technology (Fluid developers have already passed on comments to W3C), its implementation in browsers, and its implementation by assistive technologies.

- The IDRC, a partner in AEGIS, is the lead organization in the Fluid Community.

### Development methodology

During AEGIS development phase, developers used NetBeans for writing web applications, and installed as plug-ins in NetBeans platform the AEGIS WAI-ARIA enabled widgets from jQuery, MooTools, and Fluid Infusion libraries. While writing HTML code they dragged and dropped several WAI-ARIA enabled web components from NetBeans component palette (See next Figure). Once the application was ready they previewed it by using the DJ Native Swing library. They also simulated their applications using the ACCESSIBLE DIAS (Disability Impairment Approximation Simulator) functionality that could be installed into NetBeans as plug-in (for more information please refer to chapter 4). Finally, they used the ACCESSIBLE WaaT (Web accessibility assessment tool), to further support the overall analysis and verification of the created applications in terms of accessibility based on the latest WCAG2 W3C standard (for more information refer to chapter 5).



NetBeans palette with WAI-ARIA enabled widgets

### Simulating Accessible Applications

An existing plugin for the Netbeans IDE, namely “DIAS” was used for simulation of the accessible applications. Color blindness, Parkinson's disease and various low vision impairments such as loss of central and peripheral vision, blurred vision, extreme light sensitivity and night blindness can be approximately simulated.

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This plugin provides a visual design preview feature that allows developers and designers to realize how their implemented pages are being displayed. The plugin panel consists of two different window boxes that present the previewed and the simulated pages in addition to the impairment selector and the severity controls panels. Any action that happens in the previewed form box is being propagated to the simulated one. Also the developer/designer can be supported by the tool through the presentation of all the detected and possible accessibility errors and warnings of the simulated GUI form. Moreover, appropriate description of the potential problems as well as specific guidelines and recommendations on how to solve the detected problems can be presented. Thus the system user can select and fix any of the identified errors through an appropriate editor which is also responsible for handling the user's action.

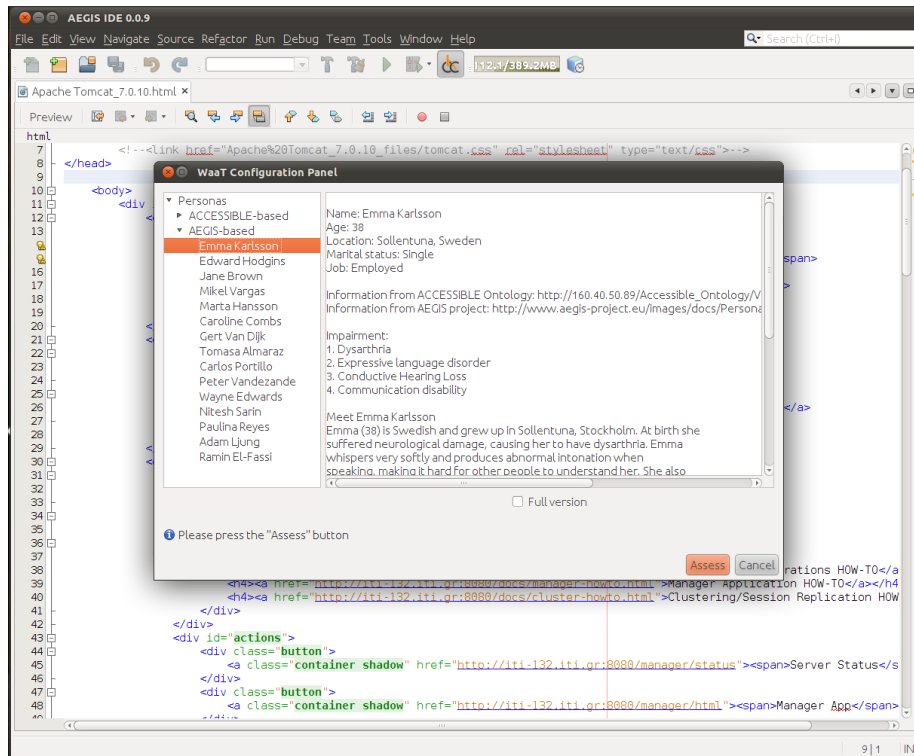
For better understanding of the simulation, specific AEGIS and ACCESSIBLE based personas with several impairments will be used. These Personas are developed to reflect the impairments, as well as combination of impairments, which are met more often. Thus, having already determined the impairments that each Persona suffers from, this tool can perform a simulation that focuses on the specific Persona. DIAS supports the AEGIS-based Personas [5] defined in the premises of the AEGIS FP7 project and the ACCESSIBLE-based Personas [6] defined in the premises of the ACCESSIBLE FP7 project.

### Assessing Accessible Applications

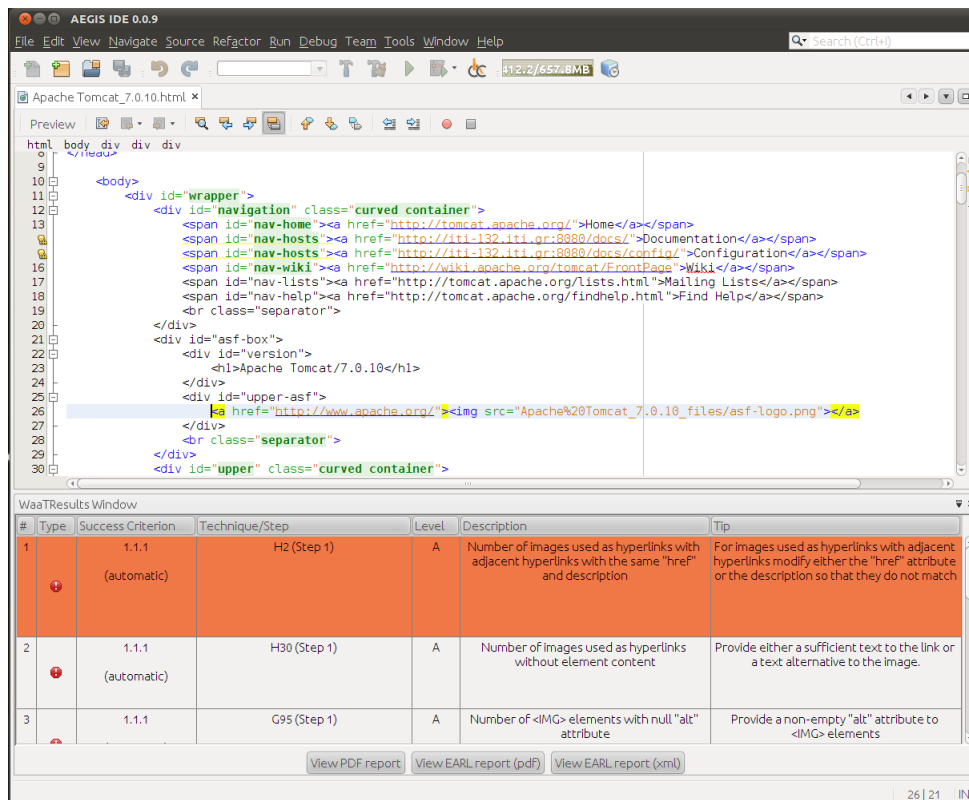
The Web Accessibility Assessment Tool (WaaT) was also integrated in the IDE providing to users (developers, designers, testers) the opportunity to evaluate the accessibility status of the Web application according to the WCAG 2.0 standard. Through the tool, designers and developers can be assisted on accessible software application development, through relevant guidelines on accessibility constraints, errors and warnings that should be taken into account (see next Figure). Specifically, WaaT can detect accessibility violations and it can also provide informative tips that will aid the users in the correction of the detected errors/warnings. The adopted evaluation methodology of the tool allows users to perform a personalized accessibility assessment process, through the selection of different accessibility constraints (e.g. different types of impairments and disabilities, different sets of WCAG 2.0 techniques and tests, personas).

WaaT supports the AEGIS-based Personas defined in the premises of the AEGIS FP7 project and the ACCESSIBLE-based Personas defined in the premises of the ACCESSIBLE FP7 project (see next Figure). The assessment results can be viewed in three different formats: pdf report, EARL [7] report and EARL xml (see next Figure).





Selection of a specific persona



View errors and warnings during assessment



The screenshot shows the AEGIS IDE 0.0.9 interface. The main window displays the results of a WCAG 2.0 Web Assessment Tool. The assessment was performed on Friday, 24 Jun 2011 at 12:04:08 for a page. The accessibility score for the examined page is 46.67, which corresponds to fully accessible according to the conducted tests.

**Assessment overview**

Guideline	Level	Error(s)	Warning(s)
1.1	A	4	1
2.4	A	1	0
2.4	AAA	1	0

The WaaResults Window at the bottom provides a detailed list of errors:

#	Type	Success Criterion	Technique/Step	Level	Description	Tip
1		1.1.1 (automatic)	H2 (Step 1)	A	Number of Images used as hyperlinks with adjacent hyperlinks with the same "href" and description	For images used as hyperlinks with adjacent hyperlinks modify either the "href" attribute or the description so that they do not match
2		1.1.1	H30 (Step 1)	A	Number of Images used as hyperlinks without element content	Provide either a sufficient text to the link or a text alternative to the image

Buttons at the bottom of the WaaResults Window allow viewing the PDF report, EARL report (pdf), and EARL report (xml).

### View assessment results in pdf report

## Conclusions

This IDE accelerates Web development. First of all it hides complexity from novice users. AEGIS IDE uses a series of plugins which shares a common look and feel, reduces the learning curve and helps developers organize complex applications and focus on the task at hand. However, these plugins are particularly beneficial to novice Web developers, who may only need to access a subset of the many capabilities available in the rich environment. Secondly, this IDE speeds development by eliminating many tedious tasks. For more experienced developers, AEGIS IDE automates many tedious tasks that developers routinely perform. It automatically creates a program structure that conforms to WAI-ARIA standards.

We have used the IDE in a testing environment for debugging purposes, but a greater scale evaluation has not been done yet. We plan such an evaluation will be made possible in the near future, when a private alpha of the system will be held providing us with valuable feedback from developers. In general, the tool did meet our expectations providing a usable IDE for developing accessible Web applications. During the development process, we made use of cutting edge WAI-ARIA components.

Apart from the IDE that was developed in this paper we had the chance to experiment and present the plugins we used and the way they can be composed for the architecture of an extended system. This is the reason why this IDE could also serve as a demonstration of those technologies and generally for Web programming techniques, practices and architectures. It is a field of on-going research in which advances are recent and examples are yet few. We hope that our research and presentation could be useful for anyone planning



to use the same plugins helping him integrate this technology for building accessible applications.

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## 4.2. How To Create Real Accessible Aria

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### Abstract

In this paper we present a new methodology and enhancements of the development process for implementation of accessible RIA applications. We have identified and analysed most important accessibility issues of typical RIA applications. Based on this analysis we have proposed solutions on the level of RIA components and the level of RIA applications. Set of 11 heuristics is presented to help RIA developers with quick checking of RIA application accessibility. We propose new approach how to involve visually impaired users into testing process and developed RIA applications.

### Keywords

Accessibility, Rich Internet Application, UCD

### Introduction

Modern RIA user interface component sets are providing highly complex components that are not present in standard family of HTML elements. All modern RIA components are based on HTML elements which are then enhanced by JavaScript [10] functions, CSS styles [9] and images. This means for example that a tree component used in an e-shop application is created for instance by <div> elements or unordered list elements <ul>. It may be also any other HTML element type. An illusion of a tree component is provided by assigned CSS style sheet, which defines the visual design of the tree and also shows the possible ways of interaction with it. For common user the visual feedback is sufficient to understand which component is presented, what its state, information content is and how to interact with it. Visually impaired users are in totally different situation as they cannot utilize the visual feedback and their screen-reader (assistive technology used to explore the web pages) cannot analyse the visual appearance (associated CSS styles). Instead the screen-reader goes inside the HTML code and tries to find there the relevant information. If the screen-reader is misled by the way, how the component is described in the HTML source code the visually impaired user will get confused by senseless speech output produced by the screen reader.

There are three main problem areas which are described in following sections. First one is related to components accessibility, second area is related to accessibility of the whole application created by accessible components and third area is related to the problems with testing of the application accessibility.

### Accessibility Of RIA Components

Many accessibility issues can be solved on the component level. In this section we will describe our methodology how to make the RIA components of a complex RIA framework

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accessible. Our methodology is based on the WAI-ARIA recommendations [1]. We have analysed and redesigned two JSF [11] based RIA frameworks/toolkits - ICEfaces [2] and Trinidad **Error! Reference source not found.**[3] - to show the applicability and advantages of our approach.

### Methodology of component accessibility implementation

For so complex frameworks the implementation of accessibility is a non-trivial problem. To implement the WAI-ARIA recommendations correctly it is necessary to understand the architecture of the given framework in detail - especially to get insight into the object structure with many abstract layers, shared and generic code. It is necessary to analyse also the code that is solving browser differences and bug fixes. This means to test every small change performed in the code. This is a problem because for so complex frameworks the build and deployment time becomes unacceptably long (several minutes per iteration). All these obstacles lead to very slow development. We have defined an agile methodology how to overcome framework complexity when implementing WAI-ARIA [13]

The process of making the existing RIA components accessible can be divided into two phases. In the first phase the developer is finding the accessible behaviour of the component. In the second phase the developer tries to implement this behaviour (found in first phase) back into the framework. By separating these two steps and using prototyping techniques, we were able to split the framework internal architecture from the resulting component architecture. By splitting the problem into two better manageable parts we were able to speed up the development process. Our methodology can be described in a form of a flowchart (see next Figure). If the developer is familiar with the framework the first phase can be omitted.

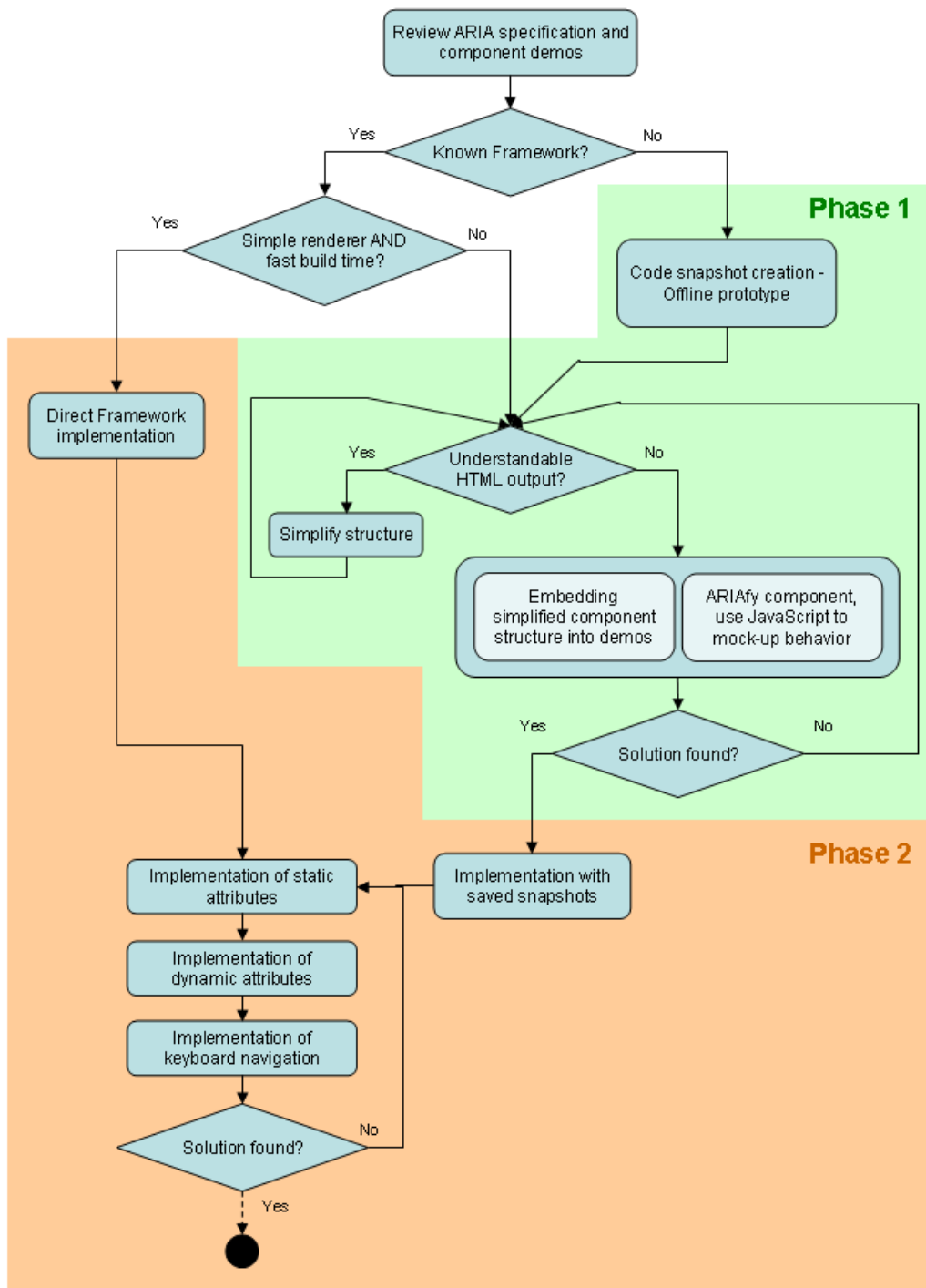
### Phase 1: Prototyping the optimal component behaviour

#### Step 1: Preparing the offline component prototype

To get rid of repetitive necessity to build and deploy the component we are making accessible, we can use the technique we call "offline component prototype" (see next Figure). This technique is based on the idea of making changes to the component without any connection the server. This can be done with help of modern browsers with special plugins which can capture the HTML code, JavaScript and CSS as it was generated on the server.

We used this offline component prototype to implement an InputNumberSpinbox, an Apache Trinidad component, instead of dealing with hierarchy of renderers inside the framework. We have captured the code of the InputNumberSpinbox by Mozilla Firefox browser. All the client-side and most of the server-side functionalities were preserved. This source code is ready to be enriched with the WAI-ARIA attributes.





**ARIA implementation methodology in a form flowchart**

Step 2: Simplification of the component architecture.

Placement of the WAI-ARIA attributes into the components of complex RIA frameworks is not always straightforward process. Therefore before we start to implement the WAI-ARIA recommendations we try to simplify the component architecture by means of removing outer layout, hidden elements, long names and so on (see Simplify Structure in above Figure). Some functionality will be broken after this simplification, but with simplified code we can easier understand how the component is structured and how this structure affects



implementation of WAI-ARIA. From our experience, once the structure is obvious, it becomes easier to track the source of many problems - such as layout tables.

### Step 3: Adding WAI-ARIA attributes into offline component prototypes.

At this step we will try to insert WAI-ARIA attributes into the offline component prototypes. We can take advantage of already existing WAI-ARIA implementation in components with similar functionality.

WAI-ARIA attributes could be split into two groups (static and dynamic) according to changes performed on them by JavaScript. Static attributes are attributes that do not change over time and are not modified via JavaScript on the client side. On the other hand dynamic attributes are modified by JavaScript functions on the client side based on events that occur during the web application life time.

After finishing the placement of static WAI-ARIA mark-up into the offline component prototypes the next stage would be the correct keyboard navigation and finally the dynamic attributes. The JavaScript code created to handle changes of dynamic attributes should be based on the JavaScript code produced for the component by the framework. In some cases and only for very simplified offline component prototypes, we wrote JavaScript that was completely independent, but it had to be rewritten in the second phase to become integral part of the framework.

Based on our experience we propose a procedure of adding WAI-ARIA attributes into offline component prototypes of complex RIA frameworks:

- Pick the component type (role) from the WAI-ARIA taxonomy
- Check the specification and existing accessibility implementations
- According to the role find out the list of supported states and properties in the WAI-ARIA documentation
- Check the component structure in the mark-up (parent/child)
- Repeat steps 1-4 for the all children of the component
- Establish keyboard navigation of the component and define the navigation to the component within the document
- Based on implemented functionality, apply and manage needed WAI-ARIA states in response to user input events
- Manage showing and hiding of sections in the component
- Check basic accessibility, such as alternative text for images
- Define how the component will interact with other components when it will be placed in future RIA application
- Test with web browser, assistive technology, and people with disabilities

At the end of this first phase we would typically have several prototypes of an accessible component. To choose the best one we can compare with other implementation of similar components (good examples are provided on web pages of Illinois Centre for Information Technology Accessibility [4] ). The comparison is done by means of comparing the screen reader outputs. We recommend testing with several browsers and screen readers as there can be significant differences which can lead to principal accessibility issues.



### *Phase 2: Implementation of the final component of given framework*

When we are confident with the accessibility solution of our component prototype and have a clear idea what changes need to be implemented, we can start to implement the WAI-ARIA directly into the framework. Our goal is to make such changes to the framework, that it will produce the same code (HTML and JavaScript) as we have created in our offline component prototype.

#### Step 1: Implementing static attributes.

Static attributes are attributes that do not change over time and are not modified via JavaScript. We start with implementing the *role* attribute. We have to identify the correct renderer, which name can be derived from the component name. There were situations in which the renderer was shared by several components and the name was therefore different. Debugging the whole library turned out to be problematic as well. It slowed the build time and with so many classes and asynchronous calls, we could not always follow the path in the code.

To be able to associate different parts of the renderer with the output HTML we have identified several unique strings inside the HTML code and performed a whole-library search. We used JavaScript handler names or CSS class names to get to the right location within the framework from which we could navigate by finding method usages. As the resulting component code can heavily depend on the container, several completely different locations had to be updated to cover all possible variants.

A UML class diagram was drawn to document that particular piece of architecture - a collection of classes that made up a renderer. The importance of documenting architectural patterns got more important as we implemented more components.

#### Step 2: Implementing dynamic attributes.

The significant number of attributes is continuously modified on the client side by means of JavaScript. For example collapsible panel component has attribute that notifies whether the panel is currently collapsed or expanded. First we need to get list of supported *states* and *properties*. They can be found in the WAI-ARIA specification section 5.3. To find out what we do have to implement for our component, we can consult the section 5.4. Then we need to match them with the properties offered by the framework. The result is a mapping table that summarizes how each component property should be synchronized with changing component state and what values it should acquire to follow WAI-ARIA as described in following Table.

Before moving to the next step (Step 3), we perform a final verification of the modified component to check not only its WAI-ARIA compliance but also test that it works within the scope of the RIA framework, screen readers and web browsers. Now we can identify places for implementation of ARIA inside the renderer. Due to the long build times of the framework we have batched several potential point-cuts before building the framework. Identifying how each framework attribute is propagated in code was a challenge at first but as we have found, many properties were shared among different components.



Framework property	WAI-ARIA States and Properties
label	Changes the text of the label that is associated with the Spinbutton Label attributes sets the HTML label with appropriate for attribute and therefore no ARIA is required. The following transcript verifies the label being set to "Year". Year edit has auto complete
maximum	Set the maximum acceptable value of the field <b>Needs to be implemented using aria-valuemax attribute</b>
minimum	Sets the minimum acceptable value of the field <b>Needs to be implemented using aria-valuemin attribute</b>
required	Defines whether the component is required for form submission <b>Needs to be defined using aria-required attribute</b>
requiredMessageDetail	Specifies error message for required field that is still empty <b>Needs to be linked with input field using aria-describedby property</b>

#### Mapping of framework properties (Spinbutton component) to WAI-ARIA

##### Step 3: Implementing keyboard navigation.

Keyboard navigation principles are described in WAI-ARIA specification - section 3. For more compact overview of best patterns in keyboard navigation, we use AOL DHTML Style Guide **Error! Reference source not found.**[6] as it also takes into consideration various keyboard shortcuts that are reserved by the operating systems, browsers and assistive technologies.

In order to map each function to a predefined key stroke, we had to find the JavaScript handler that performs the function and call it as a reaction to the key stroke. In the framework we can then add a handler on the component's out-most container to call our function for every keyboard operation. Inside the function itself we manage focus and call appropriate calls. The implementation can look as follows (Seebelow Code):

```
writer.writeAttribute("onkeypress", "_handleTabpanelNavigation(event, this)", null);
writer.writeAttribute("onkeydown", "_handleTabpanelNavigation(event, this)", null);
```

#### Attaching keyboard navigation to Tabpanel component

The other solution we tend to use is to parse the component and get references to any actionable elements. Then we can call the click () method on them to perform the desired operation as a result of pressing the key.

#### Problems with accessibility implementation

Apart from issues that were described in the previous parts of this paper, we have found the following problems when developing accessible components [12].



### *Complex layout defined by tables*

Both frameworks use a lot of nested tables for creation of page layout, component layout etc. For example for the tabpanel, there are used three levels of tables to create round corners, position icons of tabs and graphical design of the component. We can set the attribute role to "presentation" value to change the semantics of the table and its cells to be understood as a text elements. Unfortunately the screen readers will still have problems to read it correctly. They tend to mention cells of the table in the description they are creating. If the cell is empty (used as decoration), screen readers sometimes ignore it sometimes not. Then we can hear the word "blank" several times which can be confusing for users. We recommend using the HTML elements in a way they are intended to. In this case it means not to use tables for creation of layouts but only for presenting tabular data.

### *Focus manipulation*

Many dynamic changes occur in RIA applications. The content of the page can be changed anytime without having to reload the page. In some cases the component is updated in such a way, that the whole component is removed from DOM (Document Object Model), recreated on the server and then reinserted back into the DOM. This brings a serious accessibility issues. Imagine that we have a web page with tree component and the focus is placed on the third node of the tree. What happens when we try to expand this node? The whole tree is removed from the DOM and a new tree (with expanded third node) is re-inserted. The problem is that removing the tree from the DOM leads to lose of the focus which gets reset.

The focus is not on the third node where it originally was, which results to the situation where the screen reader begins reading from the top of the page or starts describing the re-inserted component instead of notifying the user about the changes to the node component (third node was expanded). This behaviour causes certainly a lot of confusion.

### *Use link elements for links and button elements for actions/functions*

Blind users are used to explore all links that are present on the web page as it provides good overview of potential target web pages and they can decide where to go next. Unfortunately current RIA web applications have often many other functions which are typically represented by link elements too. On the web we can comment, subscribe, report, vote, etc. These functions can relate to the whole web page but often relate to each blog post, comment or picture. The result is that each web page, contains large number of these functions. When the user is interested in navigation on such web site, dealing with large number of links is very difficult. Since we do not currently make any distinction among those two categories (links and functions), the complexity of navigation is rising with the number of functions the web site offers.

For example, the ICEfaces toolkit uses link elements with href attribute that is empty or contains "#" symbol and appropriate function is performed by JavaScript code. It is because a link element can receive focus. But the problem is that screen readers still read the destination (href attribute) for link elements even when we change the semantic by the role attribute. Then the user can hear very strange utterances such as "javascript:" or URI of some images. The right solution how to make an element focusable is using div element with attribute tabindex that is set to 0 (or positive integer value) instead of misusing a link element.



## Accessibility Of RIA Applications

Development of accessible standalone components includes implementation of component roles, their states and properties (some of them can be dynamically changed) and keyboard navigation as it is described in previous chapter. The advantage of this approach is that the changes in the components can be implemented only once for each component in some web framework (e.g. ICEfaces, Trinidad). The developer without any deep knowledge about the accessibility can then use these components to create an accessible application - more precisely said an application composed of accessible RIA components.

The problem is that if we develop RIA application from accessible components, we are not guaranteed that we will create an accessible ARIA application. It is because there are a lot of another problems which we have to start to solve. Imagine an application with a login form. The scenario is simple. We want to log in the application. This task is very easy for user with no disabilities. We look at the page, get oriented on it, find the login form, fill-in user name and password and click on the submit button. But what about users with disabilities? Now we should start to ask questions like these:

- How users get oriented on the page?
- How users get into the login form? How long does it take to them?
- If users click on login button, what happens?
- If the content of the page is dynamically changed (e.g. real-time validation and error messages), how will be users informed about it?

These questions uncover many problems which can be divided into the following 3 main groups:

### a) Navigation on the page

We must ensure that the user will be able to navigate on the whole site and traverse it. Everything what is reachable for users without disabilities should be also reachable for users with disabilities. For efficient orientation and movement in RIA application the WAI-ARIA provides us with "landmarks". They serve for indication of sections which appear commonly on most websites (e.g. navigation area, search area, main part, etc.). If we mark these parts of our RIA application with appropriate landmarks, user can be informed by assistive technology about their presence (what increases the understandability of the web application) and can move directly into the desired part of the web application.

### b) Relationships between components

There are several important relationships between components which should be indicated. One of them defines which component controls another component. If this information is contained in the source code, the assistive technology can navigate the user directly to the related part and vice versa. For this relation WAI-ARIA provides aria-controls attribute, that specifies which components are affected by this component. Unfortunately current screen readers does not present any information defined by this attribute.

### c) Dynamic changes of presented information





There are parts of pages which are dynamically changed. For example a user could be informed when a new chat message arrives. For this WAI-ARIA specification provides aria-live attribute. When the part is marked with this attribute, the assistive technology watches this area and presents to the user any changes that happened.

WAI-ARIA provides guidance with several design principles and techniques. But as it was demonstrated above, some problems can be solved on the application level only and no framework can do it for us automatically.

### Heuristics for developing accessible RIA applications

To help developers with creation of accessible RIA applications we have created a set of general heuristics that would adopt above mentioned principles. These heuristics are inspired by Nielsen's set of usability heuristics **Error! Reference source not found.** [7].

Studies have shown that accessibility heuristics can complement the accessibility guidelines **Error! Reference source not found.**[8]. In order to be effective they need to act as mnemonics and not as a source of knowledge. The evaluator must therefore have skills in accessibility and usability. The set of 11 heuristics based on our experience with WAI-ARIA is as follows:

#### 1. Design with screen reader modes in mind

Screen readers and another assistive technologies use several browsing modes. Make sure all parts of the web page are accessible at least with "virtual cursor" and "forms mode". In forms mode all information in the form area must be linked to one of the form elements as a label or description.

#### 2. Provide text alternative for all non-textual elements

Icons and other similar visual elements that carry information to the user should have a textual alternative available. The only exception is when a non-textual element is used for decoration or layout purposes.

#### 3. Use headings to mark important areas

Headings are the only elements with various levels of importance. They are often used to scan the content and should be used when possible to denote sections.

#### 4. Handle hidden section appropriately

When showing larger section move focus to the section. When showing a tooltip all content should be connected as description.

#### 5. Communicate important information and feedback as soon as possible

Use on-the-fly validation where possible. Use live regions to communicate asynchronous messages.

#### 6. Create proper linkage of controls, labels and messages

Connect menus with corresponding dynamically loaded sections using aria-controls.

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## 7. Distinguish all components

All components that have their Roles identified in WAI-ARIA should be marked using appropriate Role.

## 8. Define complete keyboard operation and where possible, standardize

Use design patterns defined in WAI-ARIA or DHTML Style Guide to determine the proper keyboard navigation before implementing your own.

## 9. Define document structure with ARIA landmarks

Identify as many common structure parts as possible and apply WAI-ARIA landmark roles to them.

## 10. Provide a logical tab order

Menus should be close in the means of tab order to the sections they are affecting. Tab order is important as it is used to quickly scan the page for interactive components. If the tab order is faulty, the mental model of the web page will likely be incorrect.

## 11. Use buttons for functions and links for linking

Make clear distinction between buttons and links. For all functions that are available on the page use buttons. For navigation purposes and for linking to other pages or anchoring, use links.

## Testing Of Application Accessibility

Real accessibility of RIA application cannot be ensured without testing process which involves disabled users. This is mainly because it is very hard for the developers to realistically simulate their disabilities and behaviour. Besides the consistent usage of the WAI-ARIA recommendations and our heuristics it the involvement of disabled users in the testing process must be done from the very beginning of the development process. Unfortunately this is not an easy task.

### Accessibility testing with blind users

While testing accessibility of web applications, we have observed that blind testers were having problems with understanding their content. Most often this happens during early stages of development, when the tested RIA framework or the application is not accessible enough to provide sufficient amount of information necessary to understand the page structure correctly. When the content of a page has been briefly described to testers, orientation and understanding of the web application increased significantly. For example a web application containing panel with two columns, where the first column contains a tree control with items and the second column contains panel having content depending on selected item of the tree component, a tester of such page finds out that there is something like a tree and something like a panel, but does have serious problems with understanding their relation. If we will provide the tester with information like "There is a panel with two columns with a tree control and panel with dynamic bind to control." the understanding of the web will increase and the testing processes will get faster and more effective, because the tester knows what should be expected.

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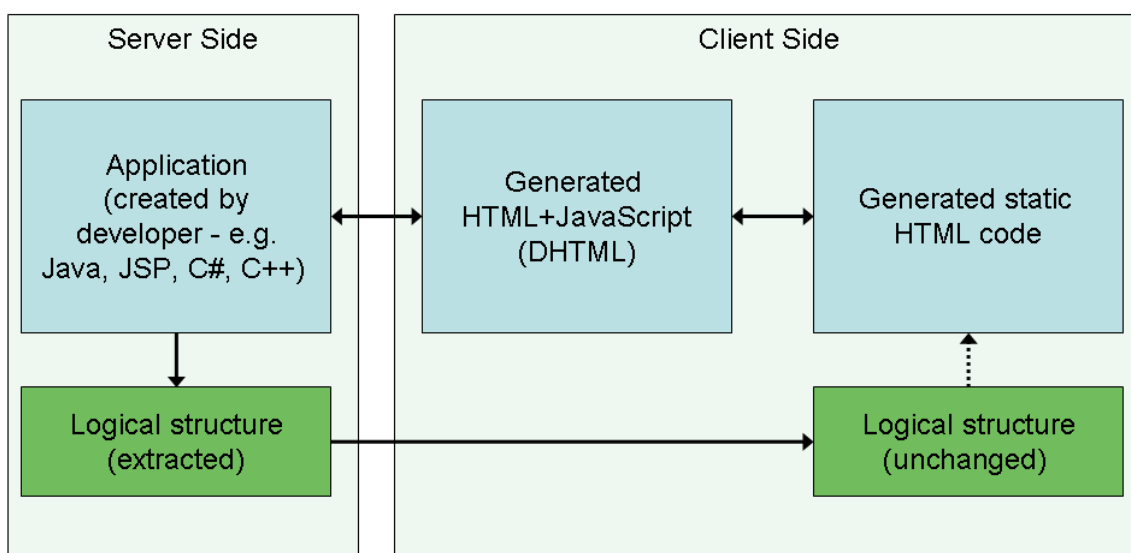


We believe that the problem is caused by semantic gap which exists between the logical structure of the application source code and the structure of generated HTML code in the browser. We call this code generated by the web toolkit and the browser a “final code”. The logical structure of the code created by a developer represents the logical structure and behaviour of application.

Tester’s mental model of the application structure and behaviour is built from the final code, where the original logical structure is destroyed. For example, the tree control in ICEfaces toolkit is represented by HTML nested div elements structure with behaviour described by some JavaScript code stored in an external file. This semantic gap can be bridged by generation of additional information and attaching it to the final code. In our project we call such information, the “page description”. We are trying to extract the page description automatically from the original source code of pages and put it into the final code. This process is shown in following Figure.

First task is to find out a way how to design a page description, which is easy to understand for visually impaired users. In ideal way, the page description should be close to a description of the logical structure given in natural language. Description should be based on original source code. Because the original logical structure of the page is formed by a tree structure of components the page description has a tree structure too and therefore can be effectively recorded by common HTML list element types ul and li. These elements are supported by screen readers very well.

Another question is how to describe dynamic bindings. For example when we have a web application with a quest-book, there will be probably a button which submits our message and sends it to the server. In the page description we want to inform the blind testers about this binding by adding a note to the button. The note may look like this: “Updates field with name: QuestBookTextField”. It is possible to extract this dynamic information with use of multi-pass analysis of the original page source code.



**Automatic enriching the HTML code with semantic information for better testing**



To generate understandable page description we need to find right keywords and phrases, which allow us to describe page designed in different frameworks. Fortunately, it appears that sets of components in many frameworks are very similar. For our purposes we will call them the “common components set”. The common components set is a set of user interface components used by web designers. This set contains the most often used components. While defining this set of common components we have to analyse components used in frameworks and compared them with WAI-ARIA *role* values. WAI-ARIA *role* values are describing abstract components for accessibility purposes. It appears that this list can be significantly reduced, because a lot of items from original list are not used by the frameworks. On the other hand, there are also components used by frameworks that are not in WAI-ARIA *role* list, for example collapsible panel. Having the common components set and it's detailed description we are able to define a mapping from toolkit components into the components from the common components set.

### Plugin for testing support

To support an automatic generation of the page description, we have designed a solution in a form of a plug-in to NetBeans IDE, which is able to extract important information from the original source code of application and while using the mapping mentioned above build a tree made of common components. The tree is then transformed into a final page code. In this form it can be utilized by the disabled testers.

### Conclusion

We have described methodology that can help RIA application developers with creation of accessible ARIA application. Our approach is based on our practical experience we have gained during implementation of ARIA into components from two JSF based frameworks and development of sample ARIA applications. We have introduced set of new heuristics that will help other developers with production of accessible RIA applications. With help of plug-in we have also developed we can involve visually impaired user into the testing from the very beginning of the development process. All procedures were carefully described and can serve as very detailed guidelines for either developing accessible web toolkits or RIA applications.

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### 4.3. Attaining Accessible Web Presence – Our Experiences

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#### Abstract

In 21st century ability of a nation to innovate and convert its knowledge into wealth determines its future, and therefore providing quality education for all has become essential. While digitization of education coupled by invention and proliferation of assistive technology have created wealth of learning opportunities for students with disabilities however, insufficient accessibility of educational material and services seriously hinder the realization of all inclusive education [5].Charity begins at home and so does inclusivity. So we decided to assess and remedy accessibility issues at University of Pune. This paper talks about our experiences of this project.

#### Keywords

Accessibility Compliance, Assistive Technologies, Persons With Disabilities, Inclusive Education, Administrative Challenges, Accessibility Testing

#### Introduction

With the advent of internet and communication technology ways to impart and absorb knowledge have changed significantly. Digitization of education and advancements in access technologies have made It possible to deliver information, any time anywhere and to diverse devises. At the same time invention and proliferation of assistive technologies like screen readers have made it possible for visually impaired (VI) to acquire knowledge form diverse sources. While the revolution is empowering and liberating for VI, insufficient accessibility of digital material poses paramount challenges. Efficient education system is essential to create skilled workforce including VI workforce in a country like India.

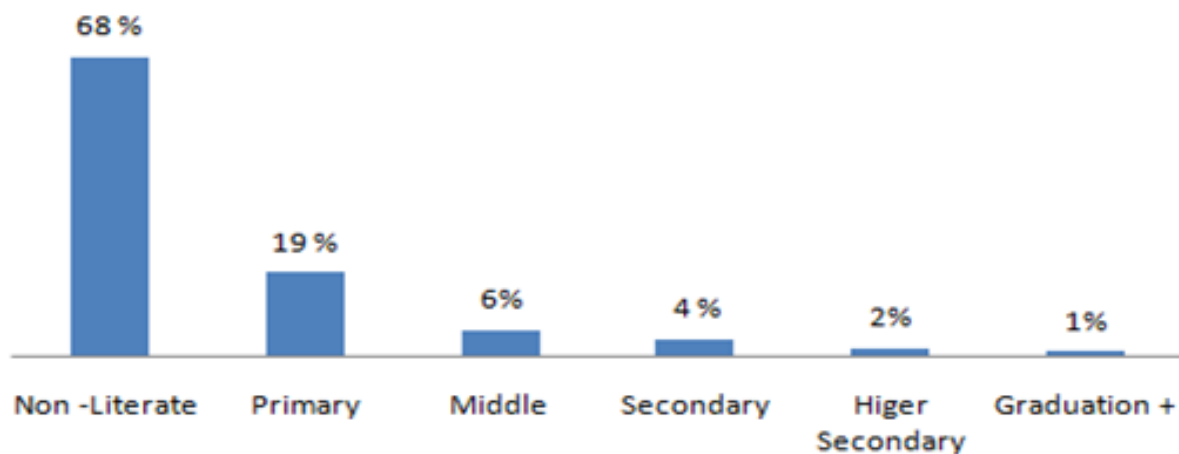
We at University of Pune believe in leadership by example. Hence we started with accessibility assessment and remediation of multitude of online facilities provided at University of Pune.



Most of the facilities were not accessible for users with disabilities. So Advanced technology Blind Student's Learning Centre (ATBSLC) at university of Pune, along with centre for Information and Network Security (CINS) at university of Pune together commenced a project to make university web presence compliant with WCAG 2.0 standards. The paper describes 1st phase of the project. It comprises details of accessibility implementation of the said facilities for five schools and departments of the university. The paper also highlights various project management challenges in terms of scarce awareness about accessibility needs, budget constraints and paucity of in-house accessibility expertise.

As education goes digital and assistive technologies mature the number of visually impaired individuals enrolling in university and affiliated colleges must see a sizable increase, but numbers depict that still the large section of visually impaired students is unable to pursue quality education as shown in the Figure below.

### Graphical Representation of Dropout rate of VI population in Indian Education system [1]



#### Education Wise Population Distribution of Visually Impaired in India – Census 2001

As shown by the above Figure the situation related to education of visually impaired is quite discouraging. The dropout rate of visually impaired students is huge. 68% of VI population in India is Non-Literate. 19% of the population is enrolled in primary education, 6% in Middle level education, 4% in secondary, 2% in higher secondary and only 1% of enrolment is in the graduate level education. Factors like unfavourable economic condition, lack of sensitization about people with disabilities, state policies, and cost of technology infrastructure are responsible for the high dropout rate of visually impaired from schooling.

#### How did we begin?

The University of Pune houses 46 academic departments. It has about 307 recognized research institutes and 612 affiliated colleges offering graduate and under-graduate courses. Over 700,000 students are enrolled every year in this university. But number of enrolment of students with visual disabilities is less than 0.02% of the total enrolments. We conducted a survey to investigate the reasons for such a low enrolment. The causes which surfaced during the survey are summarized below:

- Lack of awareness and sensitization amongst the university staff

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- Inaccessible web interface to university facilities and services
- Inaccessibility of educational material
- Lack of awareness amongst the VI about learning opportunities
- Lack of acceptance of VI in the society
- Unfavourable economic condition of students

We presented this analysis to the higher management of university of Pune and the conclusion of the discussion revealed that Issues 1, 2, 3 are more in control of the university and hence can be tackled immediately. Addressing the issues 4 and 5 are not in our immediate scope and can be a long term project, while issue 6 is beyond the control of university.

For addressing the issue 1 the University of Pune has established 'Advanced technology blind student learning centre for students with visual disability to provide educational accessibility for students with disabilities. The centre is equipped with state-of-the-art facilities of advance hardware's like Brail printer, and software's like screen reader and book reader, necessary for visually challenged students which create an environment for inclusive learning.

For sensitization of university staff the centre has been conducting following activities for last three years

- Conduct seminars and workshops on inclusive learning for staff and students
- Invite accessibility experts to share their experiences with students and staff
- Arranging for student counselling training sessions for staff

For addressing the issue 2 and 3 we chalked out an accessibility implementation plan and adopted a five step process to retrofit accessibility issues [3].

- Jot down the accessibility policy
- Have a quick accessibility review of the existing web interface and educational material
- Define accessibility requirements
- Bridge the accessibility gaps
- Periodically Monitor the accessibility of the web interface and educational material and take corrective action

### **Jot down the accessibility policy**

Smooth and successful adoption of accessibility at an organization level rests on a solid foundation of a framework comprising policy and guiding principles. Therefore we kick started the project by laying a foundation stone of "policy for accessibility at University of Pune".

Several universities across the globe have embraced accessibility of their respective websites, Therefore we studied accessibility policies of universities like Stanford university online accessibility program, university of Illinois accessibility program and web accessibility in mind program of Uta state university etc.





The University constituted an “expert committee for differently-abled” (ECD), which owned the responsibility of formulating, implementing and revising policy and guidelines for differently-abled students and employees.

The group comprised representatives from accessibility experts, faculty members, senior management of the University and most importantly students with disabilities.

The following guiding principles have been established by the University of Pune expert “committee for differently-abled” (ECD) to unlock the potential of all university of Pune students, faculty, staff with disabilities.

- A. University of Pune is committed for eliminating the consequences of discrimination against people with disabilities, so they may fully and independently participate in the comprehensive scope of campus programs, services, and activities;
- B. Programs, policies, and procedures intended to enhance or protect access by people with disabilities shall be consistent with;
- C. All University of Pune faculty and staff share the responsibility for being sensitive to and providing reasonable accommodations to people with disabilities; and
- D. University shall maintain effective procedures to resolve access dilemmas on campus, including the assignment of campus staff to resolve access problems.

### **Define accessibility requirements**

To consider the journey to be a success, one must predetermine the destination. The destination in case of achieving accessibility is the appropriate conformance level.

To determine the most logical and reasonable level of conformance we pondered over several acts and guidelines. We considered PWD act of government of India, UNCRPD, Section 508 and WCAG2, Considering the fact that the students associated with the centre are visually impaired we gave priority to those WCAG 2.0 success criterion those are pertaining to use of accessible graphics and multimedia, accessible forms and tables and dynamic content that is suitable for screen reader access.

As depicted in the Figure, Level A and AA success criterion suffice accessibility needs of visually disabled and hence we determined to comply to WCAG2.0 AA conformance.

### **Bridging accessibility gaps**

Immediately after the preliminary review, we undertook the exercise of bridging the gaps which were uncovered during the review. We classified the pages under three categories On the basis of level of the page complexity as complex, medium complex and simple.

- Pages containing dynamic content, interactive elements and lengthy forms were classified as complex.
- Pages containing simple forms and instructions were classified as medium complex.
- Pages those contained only information and minimal interaction were considered to be simple.

Approximately 10 to 15 per cent pages were classified as complex and on an average they had 20 accessibility errors. In addition to common accessibility mistakes like absence of text equivalents these pages depicted serious issues of inaccessible JavaScript.



Around 40 to 50 per cent pages were classified as medium complex and on an average they had 15 accessibility errors. Most of the errors were due to improper use of headings and missing or inappropriate page titles.

Around 25 to 35 per cent pages got classified as simple and less than 5 accessibility errors.

The development engineers fixed the issues in order of the page complexity. As a part of the retrofit activity, each page content was appropriately structured using structural elements like headings and lists.

Dead or broken links were fixed or removed as appropriate. Content and formatting were separated by developing appropriate templates and style sheets.

Accessibility of each change was verified by the end users with disability.

### **Periodically Monitor the accessibility of the web interface and educational material and take corrective action**

Adoption of accessibility is not a onetime exercise but is a life time commitment hence accessibility review of the website at regular intervals is essential. Usually the frequency of web-content updates is once in every month. We ensure fair accessibility of the ongoing updates by:

- Incorporating accessibility of new content right in design phase itself
- Monitoring the website for compliance to accessibility standards
- We have a dedicated team that carries out the accessibility review of the website on regular basis

### **Addressing the Issue No.3 of Inaccessibility of educational material**

- Creation of audio books by recording with the help of volunteer readers affiliated with us.
- Creation of brail books using the brail printer of our department
- Incorporating accessibility in online study material in form of PDF and HTML documents.

## **Challenges**

As we march on the path to accessibility we are bound to face certain technical difficulties and management challenges. Some of the challenges that we faced are summarized below.

- Website complexity: the website of university of Pune is very complex. Several parts of the website are managed and maintained by different groups on different servers which were made it difficult for us to strategizing accessibility implementation.
- Lack of in-house expertise
- Copy right issues – recording the book involves certain copyright issues and publisher may not always allow us to create audio versions of the textbooks
- Paucity of resources in terms of manpower and allocated funds

### **Long term plan to address the Issue number 4 and 5**

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During the process we observed that there exist challenges at macro level. To mitigate those we are actively trying to expand the scope of our counselling, sensitization activities beyond university campus.

## Conclusion

With the education going digital and most of the universities going online, learning opportunities have increased multifold. Access to education has become possible anywhere and on any device. However as we move ahead in this revolution, in accessibility of study material defeat the purpose of inclusive education. Therefore we undertook a project to make our university website and study material accessible for all students including the students with disabilities. We formulated and implemented five step processes of accessibility assessment and remediation. Though we have come a long way still a lot more needs to be done to me really implement inclusive education.

## Acknowledgement

We would like to thank all the Heads of the Institutions of University of Pune for supporting this project

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## 4.4. Gaining Access To Information At A Municipality Website A Question Of Age?

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### Abstract

The number of senior citizens is increasing quickly. The use of new media is also on the rise in our information society. Websites are an important tool for (local) governments to provide information to their citizens. If we want information supply through ICT to remain available to senior citizens in order to ensure their access to the digital information sources, we need to gain insight into their navigation behaviour. This paper therefore presents the results of an explorative eye-tracking study at a Dutch municipality which focuses on the question whether senior citizens do indeed navigate websites differently from younger citizens.

### Keywords

Navigation Behaviour Of Different Age Groups, Eye-Tracking, Heatmaps, Accessible Websites For All, Designing For Dynamic Diversity

### Introduction

The number of senior citizens and the use of new media in our information society are on the rise. In the year 2000, the Council and the Commission presented the eEurope Action Plan, entitled ‘An Information Society For All’, which set out the following three main objectives: 1) the realization of a cheaper, faster, secure Internet, 2) investment in people and skills, and 3) stimulation of the use of the Internet. The second objective specifically stated that: ‘the Lisbon European Council recognised that special attention should be given to disabled people and fight against “info-exclusion”. (...) As government services and important public information become increasingly available on-line, ensuring access to (local) government websites for all citizens becomes as important as ensuring access to public buildings.’ [6]

It is interesting to note that, while the e-Europe Action Plan made explicit mention of disabled people, it wholly failed to address the group of senior citizens. In the light of the growing number of older users in our information society, this is a group whose concerns also merit attention. ICT must remain available to senior citizens, to ensure their access to the digital information sources provided by (local) governments, offering products and services they need. Some researchers argue that there is a widening generational ‘digital gap’ between those people who are able to use ICT and those who are not. It was Prensky who coined the notions of ‘digital natives’ and ‘digital immigrants’ [23]. From an educational point of view, he considers students to be ‘digital natives’ who ‘are all native speakers of the digital language of computers, video games and the Internet. So what does that make the rest of us? Those of us who were not born into the digital world but have, at some point later in our lives, become fascinated by and adopted many or most aspects of the new technology are, and



always will be compared to them, Digital Immigrants.’ Prensky (2001: 1-2) Do they really exist, these ‘digital natives’, who are identified as the generations who grew up with new media? And is there really an older generation of ‘digital immigrants’ playing catch-up by trying to learn how to use new media? Other researchers, e.g. Lenhart & Horrigan (2003), take a different perspective [16]. They introduced the notion of a ‘digital spectrum’, in which people use ICT to varying degrees, depending not only on age but also on factors such as sex, educational background and frequency of internet use.

If we want the supply of information through new media, such as websites to remain accessible to senior citizens in order to ensure their access to the digital information sources provided by (local) governments and the much-needed products and services offered there, we need to gain insight into their navigation behaviour. This paper therefore presents the results of an explorative eye-tracking study which focuses on the question whether older users do indeed navigate websites differently from younger users. Or are the differences within this group (due to factors such as sex, educational background and frequency of internet use) bigger than differences between younger and older website users?

### Characteristics Of Navigating Older Users: A Quick Scan

Are there studies which furnish insight into the way senior citizens navigate websites and the factors which help or hinder their ability to gain access to such digital information? The proceedings of the 4th International Conference on Universal access in human computer interaction at Beijing in July 2007, edited by Stephanidis, offer some insight into the way senior citizens looking for information navigate websites [24]. Part IV of ‘Understanding Diversity: Age’ indeed presents several studies focusing on senior citizens using new media and how this can make their lives more comfortable. One of the contributions entitled ‘Older adults and the Web: Lessons learned from Eye-Tracking’, by Tullis put forward empirical research results about differences between younger and older U.S. users in the way they scan web pages: ‘An eye-tracking study of a prototype website was conducted with 10 younger adults (ages 20-39) and 10 older adults (ages 50-69) to determine if there are differences in how they scan web pages. They performed the same task on the website. On the average, the older adults spent 42% more time looking at the content of the pages than did the younger adults. They also spent 51% more time looking at the navigation areas. The pattern of fixations on almost all pages showed that the older adults looked at more parts of the page than did the younger adults. (...) One thing we did not see was any difference in the likelihood of older and younger users to view page content “below the fold” (i.e., that they had to scroll the view).’ Tullis (2007: 1030, 1038) [26]

This study shows interesting patterns which may be validated by comparable empirical research. An example of such research is that of Houtepen who in 2007 conducted an explorative eye-tracking study in the Netherlands with 13 younger users (18-25 years) and 7 older users (older than 50) [13]. They were requested to perform a task (in this case, finding health care information). The results showed that:

- the older users needed more time to fulfil the task (almost 6 minutes compared to the 2.5 minutes the younger users spent to fulfil their task);
- senior citizens read more and make less use of the website’s search box facility.



Like Tullis' study, Houtepen's research shows that older users need more time and follow a different reading pattern. A measurement study, using three websites and a Web-wide task, with 20 senior citizens and a control group of 20 users between the ages of 21 and 55 conducted by Pernice & Nielsen (2002) confirms the differences in time on task: 12:33 minutes for the senior citizens versus 7:14 minutes for the younger control group. They also offer an explanation for this difference: 'Websites tend to be produced by young designers, who often assume that all users have perfect vision and motor control, and know everything about the Web. These assumptions are rarely upheld, even when the users are not seniors. However, as indicated by our usability metrics, seniors are hurt more by usability problems than younger users. Among the obvious physical attributes often affected by human aging process are eyesight, precision of movement, and memory.' Pernice & Nielsen (2002: 4) [22]

The studies conducted by Tullis (2007), Houtepen (2007) and Pernice & Nielsen (2002), as well as literature reviews in this field ([1], [4]) offer insight into differences related to time on task and navigation patterns between younger and older users. However, a few critical comments would seem in order:

- The number of participants in the studies was very low, making empirical research with more users necessary.
- These studies focused only on age, omitting to take into account the role of factors such as sex, educational background and frequency of internet use. It is therefore unclear whether differences within an age group are bigger than the differences between older and younger people.

### Eye-Tracking Study: Research Questions And Methodology

What is needed is research based on empirical studies with larger groups of older and younger people. Public websites are an interesting research object. They are an important tool for (local) governments to provide information to their citizens. I therefore conducted an explorative eye-tracking study at the website of Maarssen, a Dutch municipality. Senior and younger citizens performed a search task on this website [31]. They had to find information related to parking facilities for people with disabilities in their municipality which could be found at a specific web page of this institution. Their navigation behaviour (use of the search box and reading patterns (eye-movements)) was then analyzed, not only by using eye-tracking data (heatmaps) [32], but also by paying specific attention to effectiveness (search task completed successfully or not within 5 minutes), efficiency (the time they needed to fulfil their search task) and user satisfaction (rating usability); see also [8] and [14].

Older people often are considered to be a more diverse group than younger people. Bouma (2000: 68) for example explains that 'Education and job specialization have been rising all through the 20th century, and the new generations of older citizens have learned to be both assertive and active. It is certain that they will be a heterogeneous group, since cumulative life experiences vary so much more than among young adults.' [2] In my explorative eye-tracking study I therefore also paid attention to the effect of sex, educational background (higher or lower level of education) and the frequency of use (daily or not daily) on the navigation behaviour of senior citizens.

If we conduct eye-tracking studies with larger groups and pay attention, not only to age, but also to the above mentioned factors, we will gain a better understanding of the differences



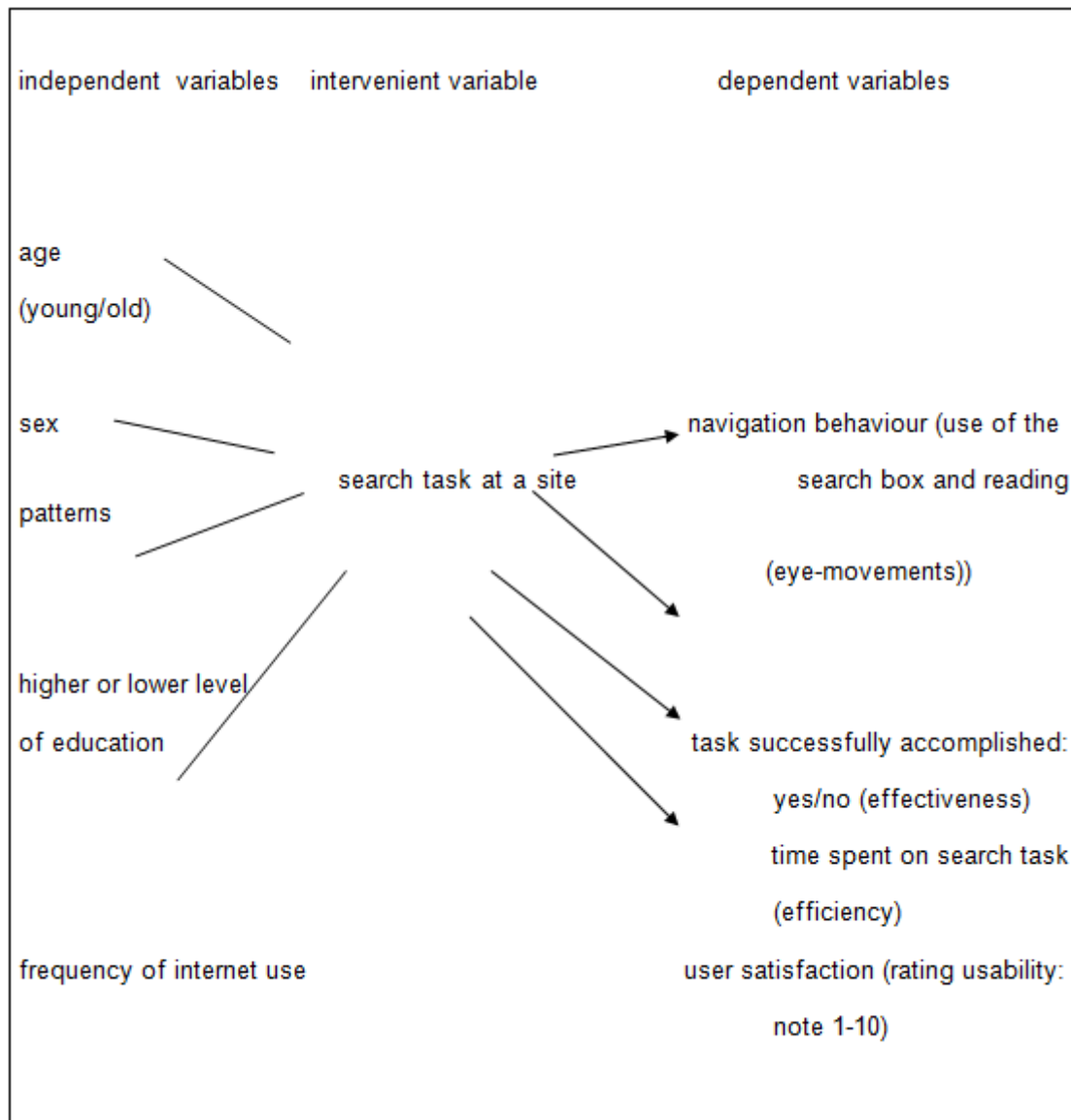
and similarities related to navigation behaviour. The question is, obviously, how to set up and conduct such a study. In this paper, I make use of the data from the eye-tracking study I conducted among 29 younger and 29 older users (respectively about 21 years old and 65 years and older) in the Netherlands in April 2009.

<b>User group</b>	<b>N</b>
All users	58
All older users	29
All younger users	29
All female users	28
All male users	30
All younger female users	14
All younger male users	15
All older female users	14
All older male users	15
All older users with higher education	19
All older users without higher education	10
All older users using internet daily	18
All older user not using internet daily	11

**Different user groups**

Compared to earlier empirical research conducted in this field, a relatively large number of participants were recruited to my eye-tracking study. The number of 2 x 29 participants far exceeds the minimum of 8 participants per user type in usability tests specified by the NIST CIF (see [9] and [28]) [33].





### Research design

## Results

### Use of the search box

The heatmaps presented in the next section show us that the majority of users made no use of the search box during the search task. Next Table confirms this result:

- The differences between the older persons used and the younger age group related to the use of the search box were rather small: respectively 37.9% versus 41.4%.

Other striking results presented in next Table:

- The percentage of the younger female users making use of the search box was lower than that of the younger male users: 28,6% versus 53.3%.
- Only 26.7% of the older male users made use of the search box versus 50% of the older female users.

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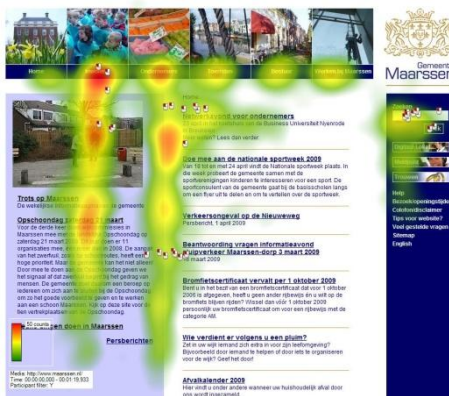


User Group	Search box used during search task		Search box not used during search task	
	N	%	N	%
All users	23	39.7	35	60.3
All older users	11	37.9	18	62.1
All younger users	12	41.4	17	58.6
All female users	11	39.3	17	60.7
All male users	12	40	18	60
All younger female users	4	28.6	10	71,4
All younger male users	8	53.3	7	46.7
All older female users	7	50	7	50
All older male users	4	26.7	11	73.3
All older users with higher education	7	36.8	12	63.2
All older users without higher education	4	40	6	60
All older users using internet daily	7	38.9	11	61.1
All older users not using internet daily	4	36.4	7	63.6

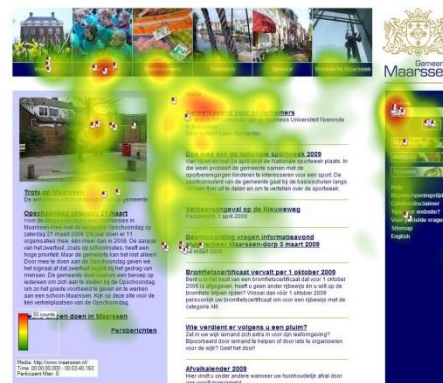
Use of the search box

Navigation areas

The navigation patterns of senior citizens using the municipality's website differ from those of younger people to a certain extent [34]. Older users read more text than younger users. Heatmap (1) shows that their reading pattern at the homepage is much broader than the reading pattern of the younger users in map (heatmap 2):



Heatmap (1): all older users



Heatmap (2): all younger users



The eye-tracking studies conducted by Tullis (2007) and Houtepen (2007) showed a similar result.

### Effectiveness, efficiency and user satisfaction

*Effectiveness (search task (not) successfully accomplished within 5 minutes)*

User Group	Search task successfully accomplished		Search task not successfully accomplished	
	N	%	N	%
All users	52	89.7	6	10.3
All older users	23	79.3	6	20.7
All younger users	29	100	0	0
All female users	24	85.7	4	14.3
All male users	28	93.3	2	6.7
All younger female users	14	100	0	0
All younger male users	15	100	0	0
All older female users	10	71.4	4	28.6
All older male users	13	86.7	2	13.3
All older users with higher education	17	89.5	2	10.5
All older users without higher education	6	60	4	40
All older users using internet daily	14	77.8	4	22.2
All older users not using internet daily	9	81.8	2	18.2

#### Effectiveness

Above Table shows clearly that most users (89.7%) accomplished the search task within the 5 minute time limit, although some differences were apparent between user groups:

- 79.3 % of all older users accomplished the search task successfully versus 100% of all younger users.
- 86.7% of all male older users succeeded in accomplishing the search task successfully versus 71.4% of all older female users.
- Older users with a higher level of education were more successful than less educated older users: 89.5% versus 60%.

*Efficiency (total time spent on search task)*



In order to analyse how efficient the users were in accomplishing their search task, only those users were taken into account who succeeded in accomplishing this successfully within 5 minutes.

User Group	Average search time (in seconds)	Median (in seconds)	N
All users	91	76	52
All older users	104	83	23
All younger users	81	69	29
All female users	89	77	24
All male users	93	76	28
All younger female users	69	65	14
All younger male users	92	70	15
All older female users	116	89	10
All older male users	94	76	13
All older users with higher education	94	83	17
All older users with no higher education	131	101	6
All older users using internet daily	98	88	14
All older user not using internet daily	113	84	9

#### Efficiency

The most striking results:

- On the average, users needed 91 seconds to accomplish their search task.
- Younger users were faster than the older users, averaging 81 seconds versus 104 seconds.
- Older male users were faster than female users, averaging 94 versus 116 seconds.
- Older users with higher education were much faster than older users without higher education, respectively averaging 94 seconds and 131 seconds).
- Older users who did not make daily use of the internet were slower than older users who make daily use of the internet, respectively averaging 113 seconds and 98 seconds.
- Medians for all user groups were lower than the average for those groups, implying that some individuals scored much higher in these user groups.

*User satisfaction (usability rated by notes 1- 10)*

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User Group	Average note	Median note	N
All users	7.4	7.0	58
All older users	7.6	8.0	29
All younger users	7.2	7.0	29
All female users	7.4	7.0	28
All male users	7.4	7.0	30
All younger female users	7.1	7.0	14
All younger male users	7.2	7.0	15
All older female users	7.6	8.0	14
All older male users	7.5	8.0	15
All older users with higher education	7.7	8.0	19
All older users without higher education	7.3	8.5	10
All older users using internet daily	7.4	7.7	18
All older user not using internet daily	7.8	7.8	11

#### User satisfaction

The most striking results:

- The municipality's website scored a 7.4 average for user friendliness.
- All user groups scored higher than 7.0 average.
- Differences between user groups were rather small.
- Medians for all older user groups were higher than the average for those groups, implying that some individuals scored lower in these older user groups.

### Conclusions

In this final section the conclusions related to the most striking results will be presented. The results of this explorative eye-tracking study at a Dutch municipality's website demonstrate in the first place that, to some extent, age has an impact on the way older and younger users accomplish a search task at a website.

- The heatmaps showed that navigation patterns of senior citizens differ from those of younger people to a certain extent. Older users read more text than younger users. The eye-tracking studies conducted by Tullis (2007) and Houtepen (2007) showed a similar result.



- 79.3 % of all older users accomplished the search task successfully versus 100% of all younger users.
- Younger users were found to be faster than older users, averaging 81 versus 104 seconds.

This confirms the result of the studies conducted by Tullis (2007) and Houtepen (2007).

Yet this eye-tracking study also showed that age is not the only variable explaining differences in navigation behaviour. Sex, educational background and frequency of internet use all also play a role:

- Only 26.7% of the older male users made use of the search box versus 50% of the older female users.
- 86.7% of all older male users succeeded in accomplishing the search task successfully versus 71.4% of all older female users.
- Older male users were faster than female users, averaging 94 versus 116 seconds.
- Older users with a higher level of education were more successful than less educated older users: 89.5% versus 60%.
- Older users with higher education were much faster than older users without higher education, respectively averaging 94 seconds and 131 seconds).
- Older users who did not make daily use of the internet were slower than older users who make daily use of the internet, respectively averaging 113 seconds and 98 seconds.

Finally, we can conclude that, although differences in navigation behaviour in this eye-tracking study are to some extent age-related, differences are also seen within the group of senior citizens ('intra-age variability' [7]) due to sex, educational background and frequency of internet use. The black-and-white distinction between Prensky's 'digital natives' and 'digital immigrants' was absent. [23] Instead, what emerged was far more a 'digital spectrum' rather than a 'digital divide' [16].

### Implications For Website Designers

If future empirical research confirms the findings of this explorative eye-tracking study, the implication for website designers (who often belong to a younger generation) could be to take into account diversity between and within generations by 'designing for dynamic diversity' [10], 'the premise of which is that older people are much more diverse in terms of life experience and levels of capability and disability than their younger counterparts.' Chisnell & Redish (2004: 48) [4]

In particular, older users who have little internet experience and have a broader reading pattern on websites ([13], [26]), and the very old who are confronted with age-related limitations owing to declining visual, hearing, cognitive and motor functions ([2], [5], [19]), so called 'age-restricted users' ([4], [11], [12]), have to receive more attention. Bouma (2000: 71-72), for example, comments that age-related functional limitations occur with a certain regularity from the age of 75 onwards, and are common from the age of 85 and over. So, as people grow older, there is no escaping the fact that age can start to play a certain role regarding the accessibility of the digital information, and that it then may be regarded as an explanatory variable. [2] 'Age-restricted users' are at considerable risk from age-related



functional limitations, making it difficult and more time-consuming for them to search information on websites. Economists refer in this connection to ‘obsolescence’ (also e.g. [17], [25]). Wright (2000: 86) notes that in such a case, ‘multi-modal redundancy’, for example, using both visual and auditory signs, could help. [29] Zajicek and Morissey (2003), referring to ‘multimodality’, advocate the use of text and sound. [30] Moreover, White et al. (2001) discuss special software that facilitates the access of groups with age-related functional limitations to our information society. [27]

Researchers and designers working on new ‘interface architecture’ would be wise to make a note of such insights where older people are concerned. [3] The fear that this might irritate younger and more experienced users is unfounded. A study carried out by Johnson & Kent (2007) showed that, rather than having an adverse effect on a site’s user friendliness, it tended to enhance it for all users. [14]

One last recommendation: If you wish to enhance the accessibility of your organisation’s website then follow the principle of ‘designing for dynamic diversity’ by asking various users to participate in usability testing and to proceed in different rounds: ‘In most cases I tend to think the ideal numbers of users for each round of testing is three, or at most four. The first three users are very likely to encounter nearly all of the most significant problems [35], and it’s much more important to do more rounds of testing than to wring everything you can out of each round. Testing of only three users helps ensure you will do another round soon (...). Also, since you will have fixed the problems you uncovered in the first round, in the next round it’s likely that all three users will uncover a new set of problems, since they won’t be getting stuck on the first set of problems.’ Krug (2006: 138) [15]

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- Also available via the conference website [www.aegis-conference.eu](http://www.aegis-conference.eu)



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- [33] However, this number is still not large. It is therefore accurate to characterize this study as an explorative one, in which I demonstrate trends. For this reason, no standard deviations and p-values are included.
- [34] I also created heatmaps of user groups according to sex, educational background and frequency of internet use, but there were no differences in reading patterns between these heatmaps.
- [35] See Jakob Nielsen's March 2000 Alertbox column «Why You Only Need to Test with 5 Users » at <http://www.useit.com> for a good discussion of this topic,.





## 4.5. A Case Study In The Design Of Educational Widgets To Support The Concept Of An Adaptable Personal Learning Environment

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### Abstract

The concept of adaptability and accessibility is particularly pertinent in terms of creating a learning environment that meets the individual needs of disabled learners that cannot be met by standard approaches and could affect their ability to access learning at all. This paper explores the potential of adaptable tools (widgets, apps or gadgets), as a component of an adaptable personal learning environment, by presenting a case study in the design, implementation and evaluation of educational widgets: Widgets for Inclusive Distributed Environments (WIDE). This paper describes the WIDE approach to the development of open source widgets to support disabled learners.

### Keywords

Widgets, Accessibility, Adaptability, Learning Environments, Personalisation

### Introduction

The paradigm shift in the means of interaction with the web is being enabled by the convergence of three trends: the growing number of Internet-capable mobile devices, increasing flexible web content and continued development of the networks that support connectivity [2]. Students are now familiar with online systems such as the BBC website or iGoogle which offer a high degree of personalisation in the functionality that can be selected, the appearance of content and the ways in which users can present themselves to others. The emergence of Web 2.0 and the consequential growth of personalised applications, has also fuelled debate on the notion of Personal Learning Environments (PLEs). The challenge and potential to connect and mash up different Web based applications and the considerable growth in the widgets/mobile applications market, are driving the impetus to go beyond the traditional virtual learning environment and to adopt the concept of a Personal Learning Environment. The Web 2.0 paradigm has also introduced a more collaborative and user-centred approach to web development with the emergence of social networking and information sharing. Learners have become proactive and the web has become a service provider with the popularisation of Service-Oriented Architectures (SOA) Web widgets consume these services as small standalone web applications. This led to new ideas in the e-Learning community to promote adaptability and personalisation of virtual learning environments especially for adaptation to specific needs and preferences.

Widgets can represent discrete tools, applications, assistive technology or other learning supports to perform specific functions. In the context of the research reported here, a widget is considered as a discrete, self-contained application that works across a range of browsers



or platforms [6]. A combination of different widgets can serve as front-end applications for distributed learning aids and services in a mash up based personal learning environment [8]. In terms of widgets to support disabled learners, examples include widgets that support learners with motor difficulties in completing web forms, widgets for creating high contrast view/themes or activating voice recognition for students with vision impairments, or symbols-based calendars for students with learning disabilities or cognitive disabilities that are non-text users.

Widgets for Inclusive Distributed Environments (WIDE), is a project funded as part of the UK JISC Distributed Learning Environments initiative, explored the potential of widgets as a component of a mash up personalised learning. The paper describes the WIDE approach to the development of widgets for accessible learning and explores the potential of the personalised development of learning applications to provide the choice of tools, applications or services to support the learning experience of disabled students.

### Adaptable Personal Learning Environment (APLE)

In recent years, researchers have begun to question the rigidity of the 'traditional' learning management system (LMS) that has become part of the higher education landscape since the turn of the century, and explore the concept alternative 'mash-up' personal learning environment [1]. A personal learning environment (PLE) that allows the learner to select, configure and personalise applications and tools according to their own needs and preferences, is particularly pertinent in the potential for the support and participation of disabled students, as such students may have very particular and individual needs that cannot be met by standard approaches. Students are coming to expect a high degree of personalisation in the functionality, content and the ways in which users can present themselves to others and, as a result, communication among students and staff using social software and held 'outside' of the institution continues to grow with institutions beginning to deploy cloud solutions for part of their student learning environment provision. This means that software applications need no longer be monolithic and can naturally be separated into distributed components [7]. The concept of a Mash-up PLE is to provide an open set of learning tools for the users to gather as they see fit in order to build his own environment rather than offering a monolithic platform which can be personalisable or customisable by users [10].

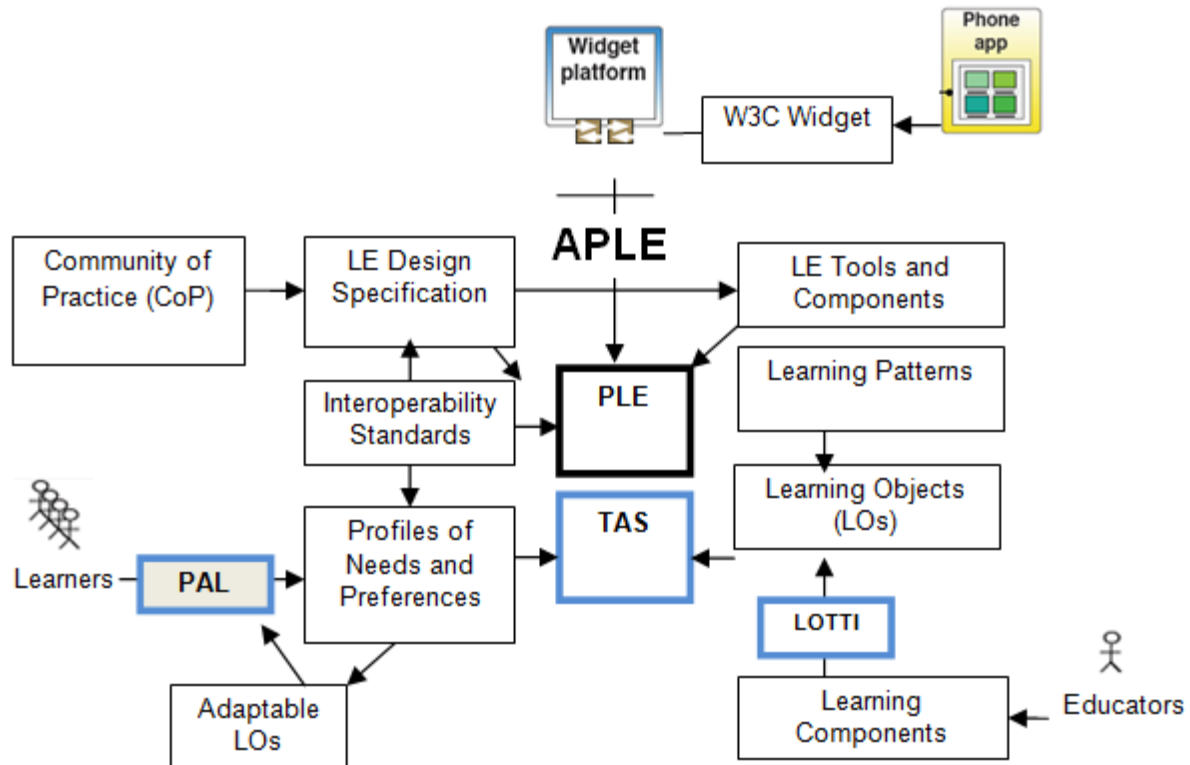
An Adaptable Personal Learning Environment (APLE) extends the notion of PLE and responds to the challenge of providing truly learner-centred, accessible, personalised and flexible learning, particularly, but not exclusively aimed at disabled students. This adaptability is based on the recognition that people with sensory, cognitive or motor impairments may have needs that make access not just inconvenient but impossible if not met. For this reason we have developed a range of solutions [4] that deal with the capacity of the environment to adapt to the needs and preferences of learners with disabilities). An APLE should include:

- A framework that supports alternative interfaces, applications, learning objects and interaction options;
- a means for learners (or their supporters) to establish a profile of their needs and preferences for access and interaction;
- a means of creating or retrieving adaptable learning objects by teachers with limited development skills;

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- a method for supporting the adaptation of learning objects and components according to the learners profile;
- a community of practice to share, propose, define or develop aspects of the APLE; and
- support for standards to facilitate interoperability .



### An Adaptable Personal Learning Environment

In our vision of an APLE, a collection of services is gathered in one place and from there broadcast to a range of platforms. Widgets (small self-contained tools or applications that consume web services) can function as component parts of an APLE or as embeddable tools within the environment for individual learners. In terms of this project, we have identified the need for an additional platform that, in a Community of Practice development approach, might exist parallel to the Widget Platform. Widgets –especially those created to meet the specific needs of disabled students who may require particular adaptations – are dynamic and not necessarily static in content or structure.

To date several essential components of the APLE have been developed – a profile tool (PAL) to enable learners to specify their needs and preferences; a learning object authoring tool (LOTTI) that supports the design and development of accessible learning objects and their alternative components (or a pointer to them), and a transformation, augmentation and substitution service (TAS) to effect the matching of accessible components and learners profiles. In previous papers we have reported on those completed aspects of our work that individually form components of an APLE, including adaptable interfaces [5] adaptable learning objects and a Transformation, Augmentation and Substitution Service (TAS) [3].



These components provide the basis for an open source framework to support a fully Adaptable Personal Learning Environment.

### Widgets For Inclusive Distributed Environments (Wide) Project

The WIDE project comprised accessibility experts, academics, researchers, teachers, tutors and other practitioners from the Higher, Further and Specialist College education sectors. The project aimed to develop resources that extend the functionality and flexibility of VLEs to meet the needs of students who may require their learning resources to be adapted to meet their specific needs. Researchers and technologists worked together with practitioners in teaching or support roles to identify a student need, and to explore the potential issues and impacts of solutions to that need. The ideas were then translated into a design document, which represented a learning design for a widget to best support an individual student. The development team then produced the widgets in cooperation with the designers to produce a bank of high quality widgets that can be plugged in to a range of VLEs, developed by and for those responsible for supporting disabled students.

### Agile Development Method

An agile development methodology is based on iterative and incremental development, where requirements and solutions evolve through collaboration. Working as an informal team designs are formulated, design specifications outlined and prototypes developed for feedback from the designers. Amendments are made to the prototypes before alpha testing by the designers. Further amendments can then be made and the widget released for evaluation and field testing. The nature of widgets lends themselves to agile methods: the basic widget is straightforward to develop, so prototypes can be quickly produced for feedback and amendment before final development.

Through a series of workshops and follow up activities, participants identified appropriate learning designs (digital and non-digital) derived from practice to be re-purposed as widgets.

The image shows two templates side-by-side. The left template is titled 'Widget Learning Design Template' and is a form with various sections: Date, Topic, Designer, Keywords, Summary, Persona, Scenario, Learning Design, Content, Links, Related Ideas, Warranty, and License. The right template is titled 'Widget Storyboard Sheet' and is a grid of six boxes for sketching content, with a title field and a note about indicating navigation flow.

**WIDE widget learning design and storyboard template.**

During the workshops, participants were introduced to examples of learning supports, briefed and prepared for the activities. Using a set of specially adapted templates participants were able to organise their expert knowledge to produce a learning design that encapsulates the necessary information on the interface and functionality of the widget:

Persona: a precise description of a typical user

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- Scenario: the learning context in which the widget would be used
- Learning Design: describes the widget functionality
- Content: any additional resources or assets that would be required
- Links: any external service or API the widget might need to be linked to
- Related Ideas: possible adaptations to create an alternative widget

On completion, the learning designs were photographed, archived digitally, and made available on the WIDE wiki (<http://arc.tees.ac.uk/wide>). As each widget was developed, the designer was contacted for feedback on the widget (design, interface, functionality etc). This ensures that the designer is aware that ‘their’ widget is being developed and that they are involved in the whole process.

### Widget Development

A total of 31 widget designs were produced during the WIDE workshops, which meant that each team produced more than one design. These designs include a wide range of widgets such as: a ‘visual shopping list’ widget that provides symbol-based task list, a digital abacus widget that provides a learning aid to assist students with motor difficulties in their math calculations, and a ‘sentence jumbler’ widget that shuffles the words in a sentence requiring the user to put them in the right order. The widget designs were classified into three categories: tools that are self-contained widgets that might require access to a Web service but do not store or edit data, applications which are complex widgets that use Web services to store and retrieve persistent data and learning objects which are independent self standing units of learning content.

The designs identified by the participants included a wide range of different types of widgets – all designed to meet particular needs - categorised as time management widgets, task management widgets, assistive technology widgets, learning aids, independence tools, social network widgets, content-free apps and learning objects. Following the design process, each of the widgets were classified in terms of a number of factors grouped into technical elements (such as whether they needed access to a database, web-services, operating system or GPS) display features (widget window, desktop, full-screen, movable, resizable, dockable etc) and application compatibility (such as to mobile device, browser or VLE). These features determined the development platform of the widget. As a result, three types of widgets were developed:

- Wookie[11] widgets: standard W3C widget running from a Wookie web server.
- Opera widgets: standard W3C widget but benefitting from installation on a desktop or devices hosting the Opera web browser.
- Mobile, desktop or windows app: designed primarily to install and run on a specific mobile phone or device, laptop or as a windows app and therefore usually not W3C-widget compliant.

In practice, the majority of designs were implemented as Wookie widgets, while only a small number required facilities that weren’t available to the widgets standard APIs so needed to be Opera only or Windows apps.



## Wide Widgets Evaluation

A full evaluation of the WIDE widgets in use is necessarily a longitudinal process and is on-going. This paper focuses on the evaluation of the WIDE widgets at implementation and deployment stage. A discussion of the external evaluation of the widgets and the WIDE design approach and process by accessibility and technical experts and the evaluation of the analysis can be found in other publications by the authors [9];[6]

### Evaluation at Implementation Stage

A preliminary evaluation of the widgets has been carried out and initial results confirm that the designers are enthusiastic about their widgets, generally the learning designs have been translated successfully into widgets and they have met the expectations of the designers. A total of 13 participants took part in the evaluation and evaluated the widgets they have designed.

A selection of the feedback and suggestions for further development (some of which has already been implemented) is given below:

#### Touch Screen Timer widget:

'It's excellent! Well thought out. I like the digital display going red during the last 5 seconds'

#### Visual Shopping List widget:

'I like the idea of audio feed back on choice selection and selected items put into basket.'

#### Digital Abacus widget:

'This is very impressive. Thank you for bringing my idea to creation. The widget works fine and is very close to how I imagined it to work. Could you make the background of the application transparent so the user can see the other 'open' window behind the abacus?' (This was implemented).

#### Sentence Jumbler widget:

'First of all let me say that the Sentence jumbler is a really nice idea and I like how quickly it works - no waiting for too long. I think that if I was going to use this with a learner it would be useful to be able to generate more than one sentence at a time for the learner and click jumble and leave them to it for a few minutes' (Dyslexia Tutor)

The widgets have been widely disseminated and we have already had a request for an adaptation to the Visual Shopping List widget:

'When I saw the Visual Shopping List in the JorumOpen listings I knew it was something I should show to the teachers. They like the widget very much and have asked me to try and find out if it can be adapted. Their particular idea is that the teacher would be able to type in weights and specify exact brands, where necessary, to allow the system to be used within cooking classes where students visit the catering store to collect their ingredients.'

### Evaluation at deployment stage

A preliminary evaluation of the widgets developed was carried out, where selected widgets were evaluated by disabled students in practice. These students have not been involved in

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the workshops and they were given a list of widgets from which they could choose one to download and evaluate. The data collection method that was employed was a questionnaire that included both rating scale and open ended questions. The students were required to comment on the widgets' functionality, suggest how they would use them, and identify possible adaptations to their design, functionality or purpose. Overall, the feedback for the widgets was positive and the students identified a number of possible adaptations to the widgets. All of the students found the process of downloading the widget straightforward and easy and only one of the students had difficulties in understanding the purpose of widget.

A selection from the comments from the open ended questions is given below:

**Spell it widget:**

'This is great for anyone with learning difficulties when it comes to spelling. As a dyslexic myself, this is a great tool. All you have to do is guess how to begin spelling the word and the widget does the rest for you!'

**Visual shopping list widget:**

'The widget is quite simple to operate but I would have liked some kind of table with the items on to be generated after the done button is clicked'.

**One-Click timer widget:**

'I expected a simple and easy to use widget with a basic but usable interface, but I was actually unable to get it working at the beginning. I would have liked the option of adding multiple alarms'.

The other student also commented on the interface of the widget.

'I would use this timer when working on small tasks –especially in a time critical environment. But I tried clicking and dragging the timer bar but instead it dragged the whole application and I would have liked a solid background to it so it won't conflict with my desktop'.

## Conclusions

The findings of the WIDE case study demonstrate a need for personalised applications to enhance the learning experience of students with disabilities; they also recognise that although basic widgets are simple for those with some technical expertise to develop, the development of new widgets is likely to be beyond the means of most teachers or tutors. For this reason current work involves a set of authoring tools (incorporating libraries of templates, services and APIs and a repository) that would enable academics without technical skills to develop, modify, adapt and share widgets is required. The development of the Widget Authoring Toolkit (WIDGaT) requires an extension of the CoP to include developers, content providers, researchers and learning design experts as well as teachers, tutors and students. This represents a significant challenge but would provide a means for a much more extensive CoP to develop widgets tailored precisely to the needs of disabled students, and would make a considerable contribution to emerging models for supporting greater levels of personalisation and customisation of learning for all individuals.



Clearly an APLE that aims to meet the needs of a wide range of learners, often with very specific requirements cannot be achieved by any one group of researchers or developers. A Community of Practice comprising of researchers, developers, learners, educational technologists, tutors, students, standards experts and assistive technologists is essential to ensure that the maximum potential for all learners is met. By taking a collaborative approach such as this the opportunity to produce an adaptable model that will grow and change according to the needs of the user is maximised and the model can become a reality.

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## 5. Session 5A: OSS and standardisation

Standardising the work on accessibility is core to ensure the uptake of its advanced best practices, thus ensuring that the implementation is undertaken on a wider scale. This session addressed this by looking both at the ontologies involved, as well as the standards related to WCAG.

### 5.1. A Meta Ontology Language To Be Standardised: OntoLogY Integration And Interoperability (OntoOp)

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#### Abstract

Assistive technology, especially for persons with disabilities, increasingly relies on electronic communication among users, between users and their devices, and among these devices. Making such ICT accessible and inclusive often requires remedial programming, which tends to be costly or even impossible. We, therefore, aim at more interoperable devices, services accessing these devices, and content delivered by these services, at the levels of 1. data and metadata, 2. datamodels and data modelling methods and 3. metamodels as well as a meta ontology language.

Even though ontologies are widely being used to enable content interoperability, there is currently no unified framework for ontology interoperability itself. This paper outlines the design considerations underlying OntoOp (Ontology Integration and Interoperability), a new standardisation activity in ISO/TC 37/SC 3 to become an international standard, which aims at filling this gap.

#### Keywords

International Standards, Content Interoperability, Content Repositories, Structured Content, Standardised Data Models, Standardised Content, Accessibility, Ontologies, Ontology Languages

#### Introduction

The Recommendation on software and content development principles 2010 formulated at the 12th International Conference on Computers Helping People with Special Needs (ICCHP 2010) addresses the important aspect of interoperable content from an eAccessibility and eInclusion perspective. Content interoperability enhances the possibilities to search, retrieve, and recombine content from different points of view. Content interoperability enhances the personalisability of ICT devices, which is especially important for persons with disabilities (PwD). Content interoperability can only be achieved on the basis of – preferably internation-



al – standards. However, although a number of pertinent standards exist, some of these need revision, and additional standards are needed for new requirements.

Content interoperability means the capability of content entities to be combined with or embedded in other (types of) content items on the one hand, and to carry enough context information for being extensively re-used (i.e. re-usability extended towards re-purposability). Different items of structured content are increasingly combined with or embedded in each other. The fact that structured content must increasingly be multilingual and also multimodal only adds to the complexity. Therefore, a systemic and generic approach to data modeling and content management has become the order of the day.

So far the standardisation efforts concerning structured content focused on:

- Data categories and metadata used in the conceptual design of individual entries of structured content,
- Data models and data modeling methods,
- Metamodels to make competing data models interoperable.

Some kinds of structured content, such as coding systems (e.g. for names of countries, currencies, languages or safety symbols) are so important that the content items themselves are internationally standardised. If ontologies, in the meaning of knowledge representation, are included, the above-mentioned metamodels need to be extended towards meta ontologies and ontology languages, in order to provide the possibility to make ontologies interoperable.

An ontology is a “formal, explicit specification of a shared conceptualisation” [1], which represents a shared vocabulary and taxonomy that models a domain — that is, the definition of concepts and other information objects, as well as their properties and relations. An ontology language – different from mere knowledge representation – provides a metamodel for such formal, explicit specifications of a shared conceptualisation.

Particularly in the field of eAccessibility&eInclusion, the use and re-use of all kinds of content across different technical platforms is a must. On the other hand, today, strongly heterogeneous content is still more the rule than the exception. While in the past the development focus was on tools (i.e. devices, computer hardware and software), it is increasingly recognised today that “communication” ultimately is the most important issue, namely:

- communication with and among persons with disabilities (PwD) directly or through ICT devices,
- communication between PwD and the devices they use, and
- communication among these devices.

Needless to say that the above-mentioned approach has a big impact on software development, as can be gathered from the documents MoU/MG/05 N0221 [21], [2] and MoU/MG/05 N0222 [3]. Modularity and comprehensive interoperability, capability for multilinguality and multimodality based on open standards are increasingly required. Therefore, metadata, data models, messages, protocols, conversion of all sorts, multilinguality (incl. cultural diversity), multimodality, design for all (DfA) etc. have become the objective of standardisation efforts in industry, first of all in eBusiness, by specialised organisations or in public institutions. [4]



Since a number of years, the number of standards for services and structured content is growing exponentially. PwD are among those who will benefit most from this development. However, in reality, as experienced in the OASIS project mentioned in Section 2, and elsewhere, probably most of the existing repositories of structured data are not consistent even within a given repository, and contradictory between different repositories. Most of them are not based on proper metadata and data modelling methods, and therefore not integratable, not reliable, and full of deficiencies. This is unacceptable especially in applications that support PwD, particularly in our aging societies, where more and more people suffer from multiple impairments. Implementing best practices in existing content repositories, such as in eBusiness [22], and improving data quality and reliability by higher standards for quality assessment and certification, are necessary steps – but not sufficient. The current reality shows that assistive services are, and will most likely always be, relying on a multitude of heterogeneous content repositories with their underlying models and metamodels. The proposed International Standard “OntoOp” (cf. Section 3) acknowledges this diversity and aims at bridging such different models and metamodels.

### Implementation Case: The Oasis Eu Project

OASIS (Open architecture for Accessible Services Integration and Standardisation) is an ongoing European large-scale Integrated Project within the 7th Framework Programme. It started in January 2008 for a period of four years. OASIS aims at an innovative reference architecture, based upon ontologies and semantic services, which will allow plug and play and cost-effective interconnection of existing and new services in all domains required for the independent and autonomous living of the elderly and enhancing their Quality of Life (for this and the following see [5]). Despite including Ambient Assisted Living (AAL) components, the focus on services means that the OASIS approach is generic and thus applicable to eApplications beyond the functional and technical requirements of AAL.

OASIS will provide a complementary solution to the direction now being pursued in the Semantic Web approach to ontology design: whereas in the Semantic Web re-usability is pursued across open ontologies, OASIS wants to achieve re-usability within strict modularity, by means of a Common Ontological Framework (COF). COF follows the above-mentioned MoU/MG recommendation, which states as basic requirements for the development of fundamental methodology standards concerning content interoperability the fitness for:

- multilinguality (also covering cultural diversity),
- multimodality and multimedia,
- eAccessibility (also covering eInclusion), and
- multi-channel presentations,

which have to be considered at the earliest stage of software design and then throughout all software development cycles. [2] As side effects in software design are a source of major system instability, development and maintenance costs, avoiding them for ontology design will be a major innovative contribution of considerable benefit.

### OntoOp (ISO/TC 37/SC 3 WI 17347)

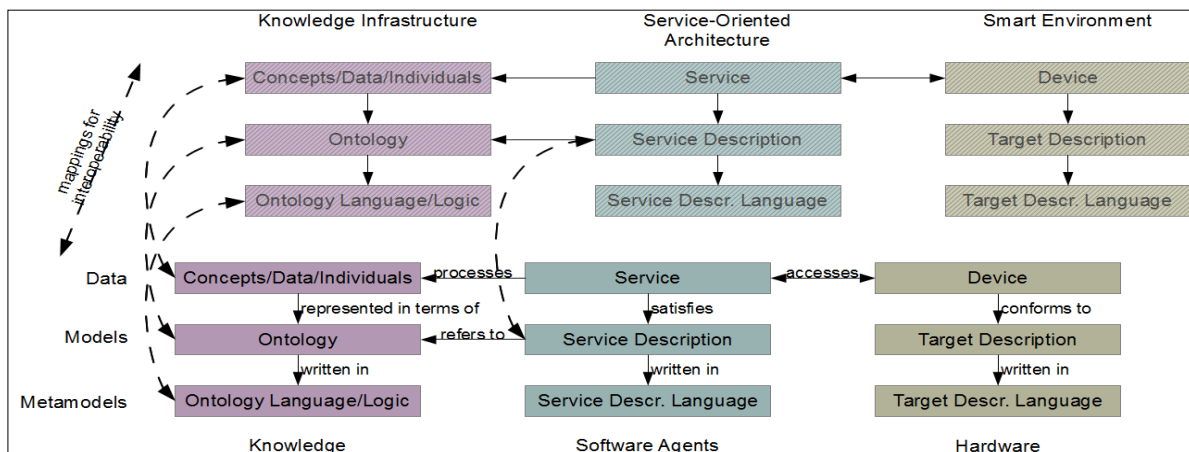
Although in current ontology standardisation initiatives much has already been taken from established software engineering practice, surprisingly little of what is known about modularity and structuring has so far been applied. Part of this gap can be traced back to

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differing starting points: adopting a description logic basis, as typical within Semantic Web oriented information modelling, has restricted the development of more powerful and generic approaches to supporting modularity. This is largely due to the fact that existing metamodel specifications and ontology definition standards assume that the ontologies produced are essentially compatible down to the exchange of terms and filling in respective knowledge gaps. But this ‘assumption’ of ontological compatibility frequently fails to hold. It also does not match current practice nor expectations when standardisation is considered across technical communities.

In order to fill the current gaps in modular ontology design and to augment ongoing standardisation efforts with an essential layer of standardised modularity and structuring guidelines, a new working item (WI 17347) on “Ontology Integration and Interoperability (OntoOp)” has been initiated in ISO/TC 37/SC 3 “Systems to manage terminology, knowledge and content”. The initiative brings together new results in the international state of the art in ontology-based interoperability. This includes results from several large-scale initiatives. Thus the proposed International Standard OntoOp aims at bridging the above-mentioned gaps in standards and guidelines.



### Interoperability of Knowledge, Service, and Hardware

The general picture of interoperability that we propose is shown in Fig. 1. Read from left to right, the story of the picture is as follows: ontology-based knowledge infrastructure provides the conceptual background for service-oriented architectures, and software services in turn interact with hardware targets (devices) in smart environments (such as ambient assisted living homes). Read from top to bottom, the story is that individual concepts belong to ontologies, which in turn are formulated in some ontology language, such as OWL or Common Logic. Likewise, services adhere to service descriptions, which are in turn formulated in a service description language, such as WSDL or DIANE. Finally, hardware devices (called targets) conform to target descriptions, and e.g. the Universal Remote Console consortium has formulated an XML format for such target descriptions [6].

The important insight is that interoperability – the third dimension in this diagram – needs to address all these levels. Concerning the vertical line, let us stay at the left column (knowledge infrastructure) for a moment. Interoperability of data means that data is converted from one format into another one as required (e.g. JPEG to PNG). At the ontology level, there is the need to relate different ontologies using different terminologies and

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concepts. Finally, ontologies may have been formulated in different ontology languages, and these languages need to be related in order to gain interoperability. Indeed, interoperability between two knowledge representations may involve mappings at all three levels simultaneously: data, ontologies, and ontology languages. The mappings arising at these levels are represented by the dashed lines. For ontology-based web services and for devices, the situation is similar, but mappings have not yet been studied to the same extent as for ontologies.

Concerning the horizontal line, interoperability of services and service composition can often be enhanced by grounding the service descriptions in some ontology (or different but interoperated) ontologies. Interoperability of targets is often ensured by encapsulating as software services and then using service composition techniques.

The OntoOp standardisation effort has been started with this big picture of interoperability in mind, but soon forces have been concentrated to the ontology part of the picture – this bears enough complexity in its own. As indicated by the structural similarities, we hope that the lessons learnt there will be useful for the service and device level as well.

### Motivation of OntoOp

We now provide details for the ontology part of the above diagram but refer to [7] for a more in-depth elaboration. As a matter of fact, we face a multitude of ontology languages. While the OWL standard [8] has led to an important unification of notation and semantics, still many diverse formalisms are used for writing ontologies. Some of these, such as UML class diagrams [9], can be considered fragments and notational variants of OWL, while others, such as Common Logic [10], clearly go beyond the expressiveness of OWL. Moreover, not only the underlying logics are different, but also the modularity and structuring constructs, and the reasoning methods.

Many ontologies, in AAL and other domains, are written in description logics such as SROIQ(D) (underlying OWL 2 DL) and its fragments. These logics are characterised by a rather fine-tuned expressivity, exhibiting (still) decidable satisfiability problems, whilst being amenable to highly optimised implementations. However, in many practical cases the expressivity has to be extended beyond the scope of standard DLs – to first-order or even second-order logic. As an example for the former, consider simple devices such as light switches, which only need a simple domain model for their own operation, whereas the model required for integrating many such devices in a complex AAL environment can be provided by grounding the simple individual ontologies in a foundational ontology, such as DOLCE [11], with its abstract, generic notions of space, time, parthood, etc.

As OWL mainly targets applications in the Semantic Web and related areas, it cannot be expected to be fit for any purpose: there will always be new, typically interdisciplinary application areas for ontologies where the employed (or required) formal languages do not directly fit into the OWL landscape. Heterogeneity (of ontology languages) is thus clearly an important issue. This does not only include cases where the expressivity of OWL is simply exceeded (such as when moving to full first-order logic), but, ultimately, also cases where combinations with or connections to formalism with different semantics have to be covered, such as temporal or spatial logics; cf. e.g. [12].



Ontology interoperability is closely related to ontology matching and alignment [13]. Here, we will not consider the process of finding suitable matchings and alignments, but rather aim at a language for expressing them. Ontology interoperability is also related to ontology modularity and structuring; see [7] for further details.

### Requirements for a Future Standard

We here propose a solution to the above issues based on the concept of heterogeneity: facing the fact that several logics and formalisms are used for designing ontologies, we suggest heterogeneous structuring constructs that allow to combine ontologies in various ways, in a systematic and formally and semantically well-founded fashion.

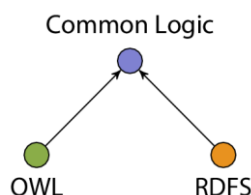
The proposed standard will specify a distributed ontology language (DOL), which will serve as a language for distributed knowledge representation in ontologies and interoperability among ontologies, and in the long run also among services and devices.

It is important to stress that we do not aim at “yet another ontology language”. Rather, DOL will be a meta-language for integrating existing ontology languages, such that one can continue to use existing tools. DOL shall allow for including all practically relevant languages – OWL together with its sublanguages (called profiles), the UML class diagrams, Common Logic (and its dialects), and others [7] – but also possible future languages. This is achieved via conformance criteria inspired by Common Logic [10]. We are currently specifying criteria for how each of the following can conform with DOL: a logic underlying an ontology language, a concrete serialization of an ontology language, a document (which may contain fragments in different ontology languages), and an application that processes such documents.

DOL will allow the user to integrate and compare ontologies written in different languages. Mappings between ontologies, as they occur in ontology matching and alignment [13], will be first-class citizens. Moreover, the standard will also accommodate for:

- translations between ontology languages, as objects expressible in the language;
- heterogeneous ontologies combining parts written in different languages; and
- ontologies distributed over different internet locations.

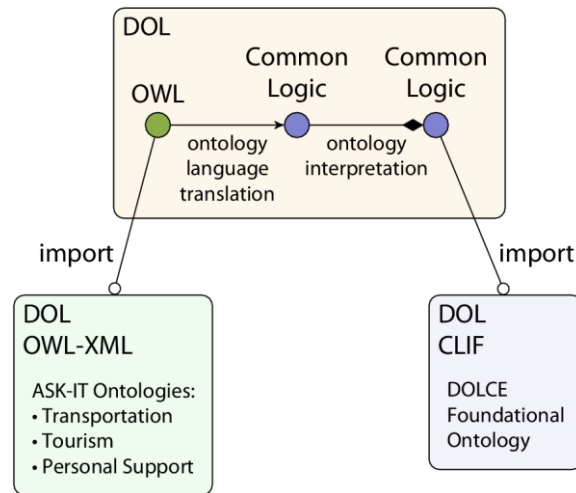
DOL will be defined with a formal syntax and criteria for further serialisations to conform. In particular, we shall target machine processing by specifying conforming XML and RDF serialisations called Distributed Ontology Interchange format (DIF). Existing ontologies in existing XML- or text-based serialisations shall be made valid DOL ontologies with a minimum amount of syntactic adaptation.



### Interoperability of Knowledge, Service, and Hardware



For giving DOL a well-defined formal semantics, we will define and standardise a core graph of appropriate ontology language translations (see below), which is open for extension by translations to further conforming languages. Every pair of ontology languages should have ontology translations into a common target language (cf. previous Figure).



### Interoperability of Knowledge, Service, and Hardware

#### A Very Brief Sketch of the Hyperontology Framework

The definition of the semantics of the distributed ontology language DOL leads to technical challenges, since all the individual ontology languages come with their own syntax and semantics, which need to be integrated properly. Addressing this problem of logical translation between ontology languages, [14] has presented the theoretical foundations for the distributed ontology language DOL on the ‘translation layer’. The general idea here is that such translations will allow users to use their own preferred ontology formalism, whilst being interoperable with other formalisms.

At the heart of our approach, therefore, is a graph of ontology languages and translations, enabling users to:

- relate ontologies that are written in different formalisms;
- re-use ontology modules even if they have been formulated in different formalisms;
- re-use ontology tools like theorem provers and module extractors along translations.

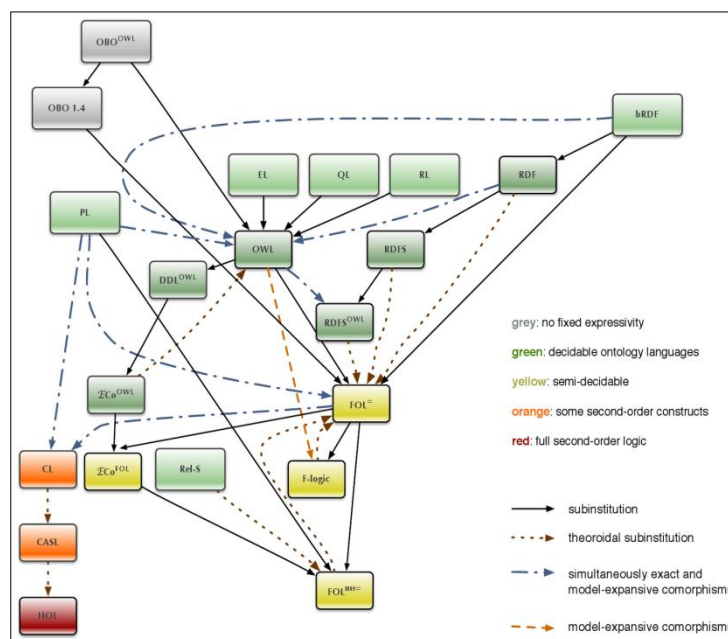
More generally, our approach is based on the theory of institutions (i.e. abstract model theory) and formal structuring techniques from algebraic specification theory. Its main features are the following, paraphrasing [15]: [23]

- The ontology designer can use, e.g., OWL to specify most parts of an ontology, and can use first-order (or even higher-order) logic where needed. Moreover, the overall ontology can be assembled from (and can be split up into) semantically meaningful parts (‘modules’) that are systematically related by structuring mechanisms. These parts can then be re-used and/or extended in different settings.



- Institution theory provides the framework for formalising ‘logic translations’ between different ontology languages, translating the syntax and semantics of different formalisms. These translations allow in particular the ‘borrowing’ of reasoning and editing tools from one logic to another, when appropriately related.

Tool support for developing heterogeneous ontologies is available via the Heterogeneous Tool Set Hets [24], which provides parsing, static analysis and proof management for heterogeneous logical theories. Hets visualises the module structure of complex logical theories, using so-called development graphs, as well as the concept hierarchies of individual theories (i.e. ontologies) in that graph. Moreover, Hets is able to prove intended consequences of theories, prove refinements between theories, or demonstrate their consistency. This is done by integrating several first-order provers and model-finders (Spass, Darwin), the higher-order prover Isabelle, as well as DL reasoners like Pellet and Fact++.



### Translations between ontology languages

A detailed discussion of the various translational relationships between (almost) all known ontology languages can be found in [14]; Fig. 4 illustrates the translational relationships. Leaving out technicalities (but see [14]), a ‘regular’ translation between two ontology languages means that the syntax and semantics of one logic can be translated into another. This means that, typically, the former is a fragment of the latter. A standard example would be OWL which, via the standard translation, can be considered a fragment of first-order logic. The languages shown in Fig. 4 range from sub-Boolean (OWL fragments) to sub-second-order (Common Logic, but extending full first-order by some second-order constructs).

Notice that there are often several translation between two distinct languages, namely one given by an immediate arrow (the ‘natural’ translation), and one given by composing several other translations. The reason for giving translations that could alternatively also be obtained via composition of already existing translations is that the ‘natural translations’ typically have better properties in terms of comprehensibility and succinctness. The choice of a translation therefore impacts in particular computational properties and tool re-usability.

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## Embedded Documentation

Accessibility is not just enhanced by offering novel services that assist end users by performing actions on their behalf, but also by explaining the functionality of existing services. To that end, we require ontologies to not just enable knowledge representation in an explicit, machine-comprehensible way, but also to provide human-comprehensible annotations of its concepts. Such embedded documentation obviously supports knowledge engineers and service developers in using an ontology, but services can also expose the documentation to their end users at runtime.

State-of-the-art ontology languages hardly address documentation. Common Logic [10], for example, merely allows for attaching unstructured comments to its phrases (modules, sentences, imports, or text). OWL [8], thanks to its roots in the RDF metadata model, allows for supplying additional types of comments (annotation properties) and supports complex multi-lingual annotations, but there are fewer subjects within OWL ontologies to which such annotations can be attached. More complex kinds of annotations, e.g. of subsets of an ontology [25], are not currently supported by any language – let alone the software engineering practice of “literate programming”, where natural language documentation and formal expressions are freely interwoven and reference each other in a fine-grained way, enabling the generation of both a reference manual and compilable/executable code (here: a formal ontology) from the same source.

Building on initial results obtained with a proof-of-concept ontology language with rich documentation capabilities [16], DOL intends to enable ontology engineers to document arbitrary fragments of existing ontologies without having to translate them. To that end, DOL will extend the annotation facilities of existing ontology languages with a vocabulary for non-intrusive standoff markup, pointing to the exact subjects of annotation from external documentation files or from special internal comments. The DOL annotation sublanguage will be built on established Semantic Web standards, including RDF for representing annotations in general, RDFa [17] for fine-grained embedding of annotations into XML serialisations of ontologies, and XPointer URIs [18] as a non-destructive means of referencing text or XML pieces, where the original ontology language does not provide built-in identification mechanisms.

Finally, we will compile a list of vocabularies recommended for annotating ontologies, comprising generic metadata vocabularies such as Dublin Core [19] as well as ontology-specific vocabularies such as the Ontology Metadata Vocabulary (OMV [20]).

## Summary And Outlook

Content integration – whether in the form of virtual or real data integration – and content interoperability must be based among others on

- consistent methodology standards for data models and data modelling,
- coordinated standardisation of several kinds of structured content,
- standardised identification systems for individual pieces of information,
- standardised transfer protocols and interchange formats, in order to be efficient and reliable,
- standardised metamodels and a standardised meta ontology language.



Persons with disabilities are among those who will benefit most from these standards. They will not only be able to use information across technical platforms, but also gain access to information and knowledge in general, which would also improve their access to education.

There are several technical committees sharing standardisation work on the above-mentioned aspects. OASIS attempts to combine the results of a number of past projects with best practices concerning structured content development and maintenance as well as with respect to content integration. We have sketched a new “distributed ontology language”, DOL, enabling integration of a number of existing and future ontology languages, as well as ontology mappings and language mappings, leading to sustainable interoperability among ontologies. A formal, machine-comprehensible semantics is provided by the Common Ontological Framework and its sophisticated heterogeneous structuring mechanisms, whereas an annotation and documentation framework improves comprehensibility for human users. Future work will have a closer look at the interoperability of ontologies, services and devices as well.

If there are standards, standards-based certification is possible. Especially with respect to eAccessibility&eInclusion there is a definite need for certification, validation or verification of data, which possibly can largely be done through web services. These standards and certification schemes would:

- first of all benefit PwD,
- benefit also small content and service providers,
- be affordable and
- fit the kind of service, the technical state-of-the-art at the service providers' side and the expectations of the clients.

Coordination and harmonisation efforts supported by the EU Commission have a positive effect on the development of technical, organisational and content interoperability standards as well as standards-based content repositories, which will benefit first of all persons with disabilities.

## Acknowledgements

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- [21] MoU/MG: Management Group of the ITU-ISO-IEC-UN/ECE Memorandum of Understanding on standardisation in elec-tronic business
- [22] For eBusiness content repositories, we refer to the standards developed by ISO/TC 184/SC 4.
- [23] For technical detail and extensive discussion we have to refer to [15].
- [24] <http://www.dfki.de/sks/hets>
- [25] unless such subsets have been modelled explicitly as ontology modules



## 5.2. Influence Of WCAG Rules On Academic Websites Rankings: A Correlation Study Between Accessibility And Quantitative Webometrics

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### Abstract

This paper focuses on finding out if the strict use of WCAG rules helps universities to improve positions in the Ranking Web of World Universities. For this purpose, top 25 European universities are selected and analyzed. On one hand, an accessibility analysis is performed through TAW test, retrieving automatic errors and warnings for the URL of each homepage's university. On the other hand, a cybermetric analysis is carried out, obtaining size, external inlinks, domain authority, and domain MozRank values. Results confirm the lack of correlation among accessibility and cybermetric figures, at least in the population under study.

### Keywords

WCAG, Accessibility, Cybermetrics, Webometrics, University Rankings, Europe. TAW.

### Introduction

Nowadays, Content Management Systems (CMS) are mainly used to maintaining and upgrading large websites, due to their functionality: content creation, management, publishing, and presentation [1].

The CMS must be considered as an application used to create, edit, manage, and publish digital content in a variety of formats. The content manager generates dynamic pages, interacting with the server in order to generate a web page at the request of a user, with the content extracted from a database server, and a default style format. This style is determined using templates performed by Cascading Style Sheets (CSS). This separation of instructions, content, and style is useful for web administration, but provides some concerns about accessibility issues, Should a CMS rely on a specific CSS in order to comply with accessibility standards, such as W3C WCAG standards?

Many academic websites, such as Universities and Higher Education Institutions (HEIs) rely on a CMS in order to create, publish, disseminate, and preserve their contents and services. Web content is such important nowadays that even some university rankings, (the most influential is the Ranking Web of World Universities [2] [3]) takes into account these quantitative data to rank universities, through some diverse webometric indicators, such as visibility (number of external inlinks of the site), or size (number of files within a web domain), among others [4] [5]. If it is assumed that universities utilize a CMS, and these applications are prone to present accessibility problems due to their excessive influence of the applied template (although these mistakes could be fixed by redesigning), the following question could be raised: are accessibility mistakes influencing in the position of universities in the



Ranking Web of World Universities? In order to answer this question, the main goals of this paper are shown below:

- To analyze a possible correlation between applied cybermetric indicators and accessibility problems in academic websites.
- To identify a possible relation of accessibility problems with the use of a specific CMS in academic websites.

## Methodology

Ranking Web of World Universities [7] (January 2011 edition) is used to select the first 25 European universities (see next table). The URLs of each university conforms to the population under study. For each URL is performed an accessibility and cybermetric analysis. Both analyses were performed on the first week of July 2011.

## Accessibility analysis

The T.A.W [8] automatic web accessibility test (WCAG 2.0 standard; AA level) is applied to the 25 URLs, obtaining an extensive report about WCAG compliance of each web page, where mistakes are divided into errors and warnings. From each report, the following quantitative data is extracted:

- Number of perceptible errors/warnings (PER): the information and the components of the user interface must be presented to users so that they can perceive.
- Number of operable errors/warnings (OPE): the components of the user interface and navigation must be operable.
- Number of compressible errors/warnings (COM): the information and managing the user interface should be understandable.
- Number of robustness errors/warnings (ROB): content must be robust enough to be interpreted reliably by a wide variety of user agents, including assistive technologies.
- Total errors/warnings: The sum of the above categories.

The process to identify the CMS used in each URL was performed by two methods: automatically, and by a personal letter sent to web administrators. The automatic method has been realized with the help of software Wappalyzer [9] v1.13.2, that running both on Mozilla and Chrome browsers shows in the address bar some of the various elements which the page was built with. Among the elements that distinguish shows the web server used, different Java's frameworks employed. Various types of embedded code used to get accurate usage statistics, and if it's possible the CMS, is also between these elements.

## Webometric analysis

Each URL is measured by four webometric indicators:

- Domain Authority (DomA)
- Domain MozRank (DmR)
- Size (S)
- Visibility (V)



DomA and Dmr are retrieved directly from Open site explorer [6], while S and V are extracted from Yahoo Site Explorer- Spain mirror [10]. For V, only external links targeted to the homepage (not the entire site) are considered, in order to make this value comparable with those obtained by T.A.W test.

Finally, the data obtained from the two analyses was exported into a spreadsheet in order to be statistically treated. Spearman's correlation was calculated between each indicator, due to the non-normality distribution in web indicators.

<b>EURO RANK</b>	<b>WORLD RANK</b>	<b>UNIVERSITY</b>	<b>URL</b>	<b>COUNTRY</b>
1	19	University of Cambridge	cam.ac.uk	UK
2	31	University College London	ucl.ac.uk	UK
3	32	University of Southampton	soton.ac.uk	UK
4	41	University of Oxford	ox.ac.uk	UK
5	43	Swiss Federal Institute of Technology	ethz.ch	Switzerland
6	54	University of Oslo	uio.no	Norway
7	62	University of Helsinki	helsinki.fi	Finland
8	67	University of Edinburgh	ed.ac.uk	UK
9	74	University of Glasgow	gla.ac.uk	UK
10	82	Universität Wien	univie.ac.at	Austria
11	85	Utrecht University	uu.nl	Netherlands
12	87	Università di Bologna	unibo.it	Italy
13	93	Durham University	dur.ac.uk	UK
14	98	Freie Universität Berlin	fu-berlin.de	Germany
15	100	Uppsala University	uu.se	Sweden
16	101	University of Warwick	warwick.ac.uk	UK
17	103	University of Leeds	leeds.ac.uk	UK
18	105	Ludwig Maximilians Universität ...	uni-muenchen.de	Germany
19	106	Humboldt Universität zu Berlin	hu-berlin.de	Germany
20	109	Università di Pisa	unipi.it	Italy

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EURO RANK	WORLD RANK	UNIVERSITY	URL	COUNTRY
21	110	Universidad Complutense de Madrid	ucm.es	Spain
22	112	Universität Münster	uni-muenster.de	Germany
23	113	University of Copenhagen	ku.dk	Denmark
24	116	Norwegian University of Science ...	ntnu.no	Norway
25	124	University of Amsterdam	uva.nl	Netherlands

25 top European universities (source: webometrics.info)

## Results

### Accessibility analysis

The following Table shows the errors and warnings detected by T.A.W test, for each type of fault (perceptible, operative, compressible, and robustness). Universidad Complutense of Madrid is the only university within the top 25 European institutions without any accessibility problems (automatically detected, obviously). Up to nine universities present more than twenty errors, which are considered excessive if we consider that is websites representing to higher-education institutions. Other aspects that should be mentioned are the rate of perceptible errors in some centres. For example, Oxford University shows seven problems, all of them perceptible, or Ludwig Maximilians Universität München, with 26 problems, 23 of them perceptible.

As expected, the number of warnings is higher than errors. Any university shows ought warnings, and only four (Durham University, Cambridge University, University of Wien, and Universidad Complutense of Madrid) show zero warnings in a single category. Moreover, the correlation between errors and warnings is very low ( $R=0,33$ ).

URL	PER	OPE	COM	ROB	T
ucm.es	0;54	0;24	0;0	0;67	0;106
cam.ac.uk	0;28	1;27	0;6	0;1	1;61
dur.ac.uk	1;11	0;10	0;6	1;0	2;27
gla.ac.uk	2;7	0;21	1;6	0;1	3;35
uio.no	3;38	0;37	0;18	0;37	3;130
leeds.ac.uk	3;71	0;44	1;13	1;6	5;134
soton.ac.uk	2;22	0;15	1;6	2;35	5;78
fu-berlin.de	5;68	1;68	0;6	0;12	6;154
ox.ac.uk	7;59	0;55	0;12	0;13	7;139
ucl.ac.uk	6;25	2;25	1;6	1;8	10;64
ed.ac.uk	7;45	0;32	2;6	2;89	11;91
uu.se	7;12	2;9	1;6	2;6	12;61
uni-muenster.de	9;12	0;3	3;6	3;25	15;46





URL	PER	OPE	COM	ROB	T
hu-berlin.de	2;23	1;47	0;6	13;20	16;96
ntnu.no	10;26	0;36	0;12	7;100	17;174
univie.ac.at	13;41	4;17	1;6	1;0	19;64
warwick.ac.uk	18;73	3;35	1;12	1;28	23;148
unibo.it	14;79	7;57	2;6	2;6	25;148
uni-muenchen.de	23;49	0;28	2;6	1;17	26;100
uu.nl	22;77	4;29	1;6	0;43	27;155
ku.dk	7;56	17;42	6;6	2;2	32;106
uva.nl	24;41	3;32	2;6	5;265	34;344
unipi.it	23;46	13;35	7;6	7;2	50;89
helsinki.fi	40;36	4;12	5;12	20;15	69;75
ethz.ch	61;54	6;30	10;37	10;20	87;141

#### WCAG Compliance: errors;warnings

The following Table illustrates the CMS applications used in the homepage of universities considered under study, and which we have information. This information is unknown in nineteen universities (personal e-mail was only answered by only two webmasters, which give us with some information about its systems), and there is no information in the public source code of the homepage.

UNIVERSITY	CMS
ucl.ac.uk	Silva CMS
hu-berlin.de	Plone
unipi.it	Joomla
uio.no	Vortex (self-developed)
univie.ac.at	TYPO3
uu.nl	Microsoft SharePoint

#### CMS used by universities

#### Webometric analysis

Finally, the next Table shows webometric performance obtained for each indicator:

URL	DomA	DmR	S	V
cam.ac.uk	85	7,23	2.740.000	174
dur.ac.uk	79	6,48	489.000	56
ed.ac.uk	82	6,98	787.000	82
ethz.ch	77	7,01	1.340.000	136
fu-berlin.de	80	6,85	815.000	171
gla.ac.uk	80	6,8	944.000	87
helsinki.fi	76	6,76	1.600.000	78
hu-berlin.de	77	6,72	1.140.000	69
ku.dk	74	6,64	647.000	173
leeds.ac.uk	82	6,86	377.000	95
ntnu.no	74	6,54	1.210.000	168
ox.ac.uk	85	7,23	1.360.000	218
soton.ac.uk	82	6,8	603.000	78
ucl.ac.uk	81	6,97	886.000	292
ucm.es	84	6,45	1.160.000	91

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URL	DomA	DmR	S	V
uio.no	73	6,81	1.580.000	130
unibo.it	75	6,56	906.000	77
uni-muenchen.de	80	6,68	562.000	45
uni-muenster.de	79	6,62	608.000	62
unipi.it	74	6,35	526.000	29
univie.ac.at	83	6,8	1.690.000	187
uu.nl	75	6,72	1.040.000	71
uu.se	73	6,65	981.000	67
uva.nl	76	6,72	902.000	97
warwick.ac.uk	83	6,64	1.020.000	141
ucl.ac.uk	81	6,97	886.000	<b>292</b>

#### Webometric performance

Webometric indicators show as Cambridge University performs really high in almost all indicators (DomA, DmR, and size), while University College London is the University whose homepage with more external inlinks (292), followed by Oxford (218), Wien University (187), and Cambridge (174).

#### Correlation analysis

With data compiled in 3.1 and 3.2, table 5 is performed, showing Spearman correlation between webometric and accessibility indicators, in this case total errors/warnings, and perceptible errors/warnings.

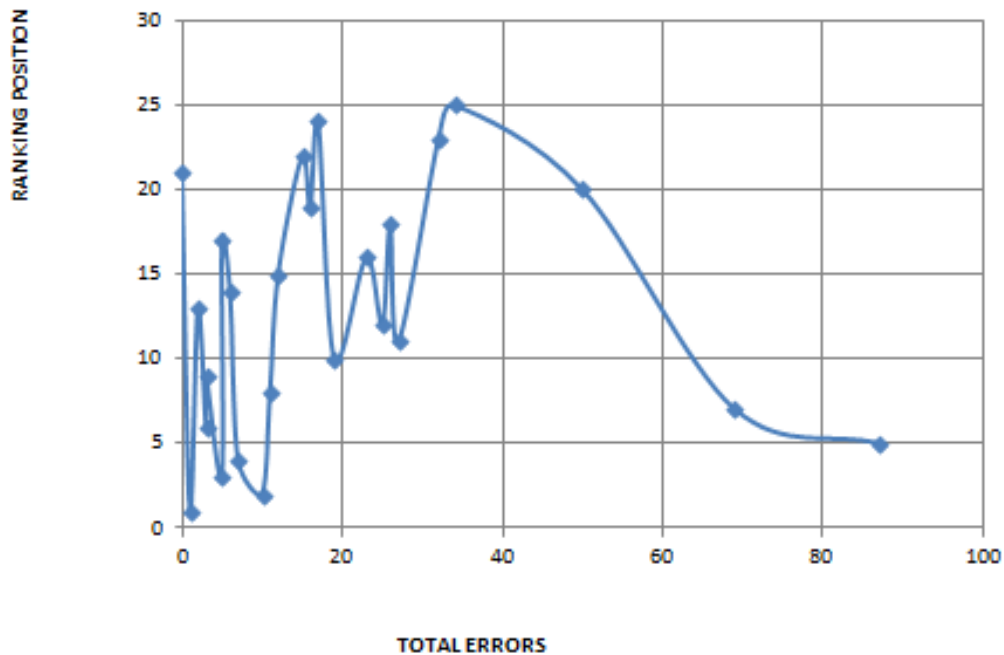
INDICATOR	TOTAL	TOTAL	PERCEPTIBLE	PERCEPTIBLE
	ERRORS	WARNINGS	ERRORS	WARNINGS
DomA	0,49	-0,19	0,44	-0,10
DmR	0,23	-0,13	0,21	-0,02
Size	-0,02	0,23	-0,02	-0,01
External inlinks	0,16	-0,25	0,15	-0,22
EWR	0,30	0,36	0,25	0,11

#### Correlation between accessibility and web performance

The higher value identified corresponds with the correlation between DomA and Total errors (R=0,49), what reflects the lack of correlation between webometrics and accessibility problems. External inlinks, which is considered the indicator that could be more influenced by a poor accessible website, does not present any correlation with errors and warnings (R=0,16 and R= -0,25, respectively). Finally, the relation between size and errors/warnings seems to be practically random.

In addition, the correlation between the position of each university in the European web ranking and the accessibility problems detected is shown. Results confirm the low level of correlation. Next Figure shows the performance of each university in both indicators (ranking position and total errors detected).





**Ranking position and total accessibility errors per each university.**

## Conclusions

Results confirm the lack of correlation among webometric indicators, and accessibility errors/warnings (measured by TAW automatic test) for 25 top European universities.

Complete correlation with specific CMS has been impossible to assess due to lack of information about the applications used by all universities. This raises questions about why the secrecy about which CMS is been used by each university, in case any was used. One possible cause why our automatic system does not find the CMS used by the institution might be that the home page was maintained manually edited with software like Macromedia Dreamweaver or Microsoft FrontPage.

We make a special appeal to point out the lack of interest that webmasters put in making cascading style sheets (CSS) grammatically correct, without errors to be transferred to all pages of the universities (as they are used as templates for the rest of pages). We believe that a large percentage of all types of errors appeared in the accessibility analysis are due to bugs in the CSS of each university. Although this should be confirmed by further analysis of them.

Some webometric indicators, as external inlinks, seem to be independent of accessibility problems automatically detected in the homepages, what could mean that universities are linked by users who do not detect these problems? Other reasons could be that universities are linked due to other academic or meritocratic reasons, and accessibility is not influencing the decision of linking. Other indicators, such as size and Domain MozRank, is completely random with accessibility.

These results confirm the shortage correlation found with the position of universities in the Ranking Web of World Universities, because the combined indicator used (Webometric

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Rank, WR), is composed by, among others, size and external inlinks. Measuring other webometric indicators based on usage (e.g. total visits, unique visits, downloads) may arise from other results. In any case, due to the importance of accessibility parameters, and their poor correlation with WR, this ranking should evaluate the possibility of include some of these indicators in their final formula.

Perceptible errors perform lower correlation rates with webometrics as total errors. This situation repeats with warnings. This could indicate that the correlation is increased adding more problems, and not one specific (in this case, perceptible). In any case, this study should be completed with another population and webometric indicators in order to assess the results obtained.

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## 6. Session 5B: Accessible content

Inclusion starts often with having an equal access to information. This session looked at the basic element: accessible content. This was demonstrated via various available plugins that allow content creators to create fully accessible documents, and export them to accessible formats (Daisy, Braille, PDF), while also guidelines that are freely available were presented. Additionally, the accessibility of video and TV broadcasts was addressed.

### 6.1. An Accessibility Checker For Openoffice.Org And Libreoffice Writer

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#### Abstract

OpenOffice.org Writer and its more recent alternative (or fork) LibreOffice Writer both implement the OpenDocument Format (ODF) and support various output formats including the Portable Document Format (PDF) and XHTML. Through the extensions odt2daisy and odt2braille, both developed in the context of the AEGIS project, Writer can also export ODF documents to DAISY (audio books) and Braille. In order to output a usable DAISY book or Braille book, authors first need to create an accessible source document. The objective of the accessibility checker that is being developed in the context of the European AEGIS project is to support authors in creating accessible ODF documents and to prepare these documents for conversion to DAISY and/or Braille. The paper discusses the various user interface options that were explored and why a task panel was chosen as user interface, describes how authors can use the task panel to repair errors and warnings, gives examples of automatic and semi-automatic repairs supported by the checker, describes which errors and warnings are implemented, and how the checker may eventually be released as open source component.

#### Keywords

Accessibility, accessibility evaluation, office documents, OpenOffice.org, LibreOffice, Evaluation and Report Language (EARL)

#### Introduction

Digital accessibility covers many areas. The e-Accessibility Policy Toolkit for Persons with Disabilities developed by the International Telecommunication Union (ITU) and the Global Initiative for Inclusive ICTs (G3ict) to support the implementation of the UN Convention on the Rights of Persons with Disabilities covers the following technology areas: wireless phones, radios, television, remote consoles, landline phones, Web sites, personal computers, software, electronic kiosks, broadband services and access to published works [6]. Access to office formats for word processing, spread sheets and presentations is a superset of and a precondition for “access to published works”. There are considerably fewer

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guidelines and tools related to the accessibility of office formats than for web content. However, office formats are often used as a source for web content, for example by exporting word processing files as HTML or PDF. Office formats also need to be accessible in order to be a suitable source for formats aimed at persons with disabilities, notably audio books (typically DAISY books [7]) and Braille. Authors would greatly benefit from guidance for accessible authoring that is integrated into an office suite. The accessibility checker for OpenOffice.org and LibreOffice Writer developed in the framework of the AEGIS project [3] provides this kind of guidance. The remainder of this paper describes the background for this tool, how it is implemented and what functionality it offers.

## Accessibility of Office Formats

### Existing Accessibility Evaluation Tools

Since the publication of the Web Content Accessibility Guidelines (WCAG) 1.0 in 1999 [4], many tools for the evaluation of web content have been developed. The website of the World Wide Web Consortium (W3C) contains a database of Web accessibility evaluation tools that lists a few dozen tools [17]. These tools range from simple colour contrast checkers to “web accessibility managers” for website administrators. Compared to this database, the list of accessibility evaluation tools for office formats is very short. A few tools for the evaluation of PDF documents are available (Adobe Acrobat Pro, NetCentric’s CommonLook Section 508 for Adobe Acrobat, the freeware PDF Accessibility Checker (PAC) by the Swiss organisation Zugang für Alle/Access for All and the web-based PDF accessibility checker by the eGovMon project in Norway), but these tools cover a final-form output format that cannot be easily edited. Tools that evaluate word processing files are very scarce:

- aDesigner is a tool that was originally developed by IBM Tokyo [11] and later donated to the Eclipse Foundation [5]. This tool is a disability simulator for web content that also helps users check the accessibility of OpenDocument Format (ODF) and Flash content.
- The accessibility checker introduced in Microsoft Word 2010, PowerPoint 2010 and Excel 2010, which provides errors, warning and tips [12], is the first evaluation tool that is built into an office suite.

aDesigner is therefore the only tool that evaluates the accessibility of ODF content. Other checkers that were developed in the past have been abandoned. The Open Document Format Accessibility Evaluation tool developed by a team of students at the University of Illinois at Urbana-Champaign under the supervision of Dr. Jon Gunderson came online in 2006 [8] but has not been available for several years. The SourceForge project hosting site contains at least 9 ODF accessibility checkers that were started in 2006 as part of the “IBM Accessibility Phase 2 Contest” in Japan. These projects have names such as “ODT Accessibility Checker”, “ODT Checker”, “Simple ODT Validator” and “ODF Accessibility Validator” and have all been abandoned.

At the end of 2009, OpenOffice.org’s User Experience Team brainstormed on an idea for “Document Check” functionality, which would cover areas such as accessibility, compatibility of file formats, security aspects (for example, macros and running external programs) and content-related aspects such as missing references, readability, filesize and the document’s printable area [13, 14]. The Document Foundation’s Design Team (many members of which



came from the OpenOffice.org project) is also interested in elaborating this idea for integration into LibreOffice [15]. The accessibility checker developed by the AEGIS project may become part of the desired functionality.

### LibreOffice/OpenOffice.org as a Source for Accessible Formats

OpenOffice.org is probably the most widely used open source office suite. Both OpenOffice.org and its recent fork LibreOffice can be used to create accessible content. Guidance is available in various locations, including the ODF Accessibility Guidelines by the Accessibility subcommittee of the OASIS Open Document Format for Office Applications (OpenDocument) TC [16], the Authoring Techniques for Accessible Office Documents by the Accessible Digital Office Document (ADOD) Project [2] and “OpenOffice.org and Accessibility” by Web Accessibility in Mind (WebAIM) [18].

Thanks to the availability of the open source extensions odt2daisy [10] and odt2braille [9], both developed in the framework of the AEGIS project, OpenOffice.org and LibreOffice Writer can export OpenDocument Text (ODT) to DAISY books and Braille, respectively. However, in order to create valid and usable DAISY books or Braille documents, the ODT source documents need to fulfil a number of criteria, for example,

- images and other objects need a text alternative, which can be rendered as synthetic speech or Braille,
- headings need to be styled with Heading styles instead of big bold text or other visual characteristics that suggest headings,
- the default language of the document and any language changes inside the document need to be identified in order to select the correct speech synthesis engine or Braille translation table during the conversion process,
- images need to be in JPEG or PNG (Portable Network Graphics) format when exporting to DAISY.

Some accessibility criteria are easy to fulfil, while others are easily overlooked, for example, because they have no visual effect (e.g. adding text alternatives to objects, accidentally creating empty headings). Some criteria are only relevant when exporting to another format, for example, the restriction on image formats in DAISY. Integrating support for accessible authoring into OpenOffice.org/LibreOffice Writer would make it easier for authors to meet accessibility criteria.

## The ODT Accessibility Checker

### User Interface

The goal of the accessibility checker is to make users aware of accessibility issues in their content. Ideally, this should be as straightforward as checking the spelling, a feature that is built into several office suites, but accessibility is more complex than spelling. There are several ways in which authors could be alerted to accessibility issues. Several methods were explored in the initial stages of the project.

The first option consisted in adding a new layout mode, similar to the Print Layout and Web Layout that can be found in Writer’s View menu. This new “Accessibility View” would make authors aware of how assistive technologies (AT) “perceive” the document. For example,



where an image has no text alternative, there would be nothing (or just an empty frame). Where headings are faked by means of big bold text instead of the appropriate Heading styles, the content of these headings would be rendered as normal text. Where tables are faked by paragraphs of tab-separated columns, the text of the “columns” could simply run together. However, the Accessibility View would be incomplete without guidance on how to repair the issues. There was also a technical barrier: the accessibility checker is developed as an extension, and extensions cannot create new layout modes. It is possible to work around this by creating a read-only copy of the source document and modify this copy through the OpenOffice.org API. However, it is not possible to keep this copy synchronised with the source document because the OpenOffice.org API does not provide listeners through which an extension can keep track of modifications in the content.

The second option consisted in adding errors and warnings to the source document by means of highlighting and/or some type of comments or notes. When using highlighting, removing the highlighting should be as simple as clicking a button. Unfortunately, adding such highlighting can only be done by modifying the document; the accessibility checker would then need to remove any remaining highlighting when the user closes the document without repairing all the issues (and in this process distinguish between its own highlighting and highlighting added by the user). The same is true for underlining: the type of underlining that is used by Writer’s built-in spelling checker cannot be created by an extension, and the type of underlining that can be created by an extension would become part of the document (unlike the wavy underlining for spelling errors). Using OpenOffice.org’s built-in comment system to provide information on accessibility issues was judged too technical and insufficiently user-friendly.

The project finally settled on the use of a task panel to display a list of errors and warnings and all the other required information. The task panel is a component that has long been available in Impress (the presentation component of the office suite), where it is used for defining slide layouts, custom animations, slide transitions and other slide features. The task panel has been available in Writer only since OpenOffice.org and LibreOffice 3.3.

The task panel used by the accessibility checker consists of three parts (see Illustration 1, below). The top part displays a list of errors and warnings for issues detected in the document. When the author selects an error or warning, the relevant section of the document is highlighted (in a way similar to the highlighting used by the Except or Reject changes dialog). The middle part displays three types of information for the error or warning currently highlighted in the top part: the name of the issue, a description (which usually explains why something is an accessibility issue) and suggestions for repair. The bottom part contains five buttons: a ‘Recheck’ button to trigger the accessibility evaluation, a ‘Clear’ button to clear the list of errors and warnings, a ‘Repair’ button to repair issues that can be fixed automatically or semi-automatically, an ‘Ignore’ button that can be used to delete a false positive, and a ‘More help’ button. The Repair button only becomes active when an issue can be repaired automatically or semi-automatically.

Examples of automatic repair include the following:

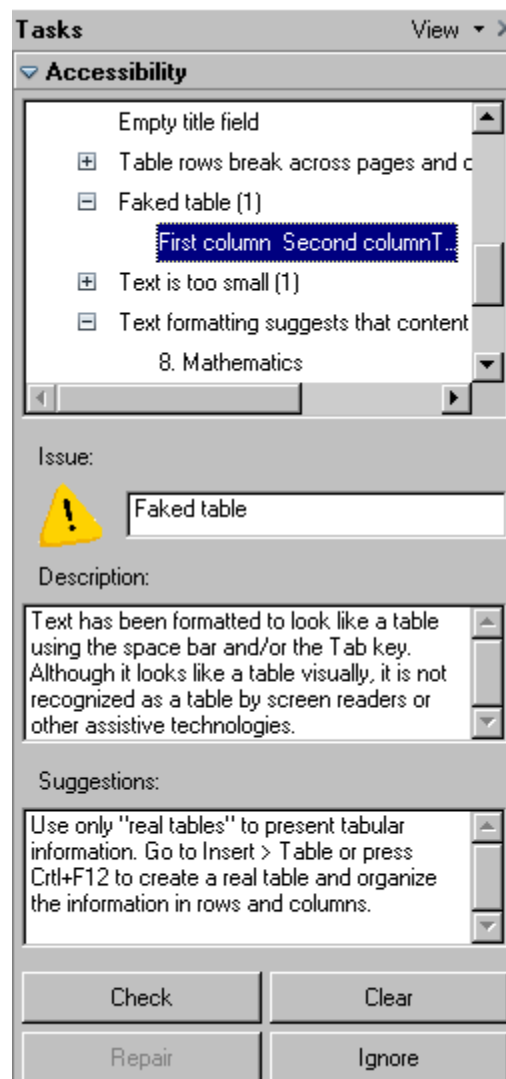
- When the checker finds an empty heading (i.e. an empty paragraph with a Heading style), activating Repair replaces the Heading style with the Default style.

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- When a table allow rows to break across pages and columns, activating Repair unchecks the option “Allow row to break across pages and columns” that authors would otherwise need to find in the Table Format dialog.



### User interface with errors, descriptions and suggestions

Examples of semi-automatic repair include the following:

- When the document has no default language, activating Repair opens the language settings dialog, where authors can set the default language for documents.
- When an image or other object has no text alternative, activating Repair opens the Description dialog, where authors can enter the objects title (which would match HTML's alt attribute) and description.
- When the document's title field is empty, activating Repair opens the document properties dialog, where authors can enter this metadata item. The document title is used by odt2daisy when converting the document to an audio book.

Many repairs cannot be performed automatically or semi-automatically, for example,



- When text is too small, the author needs to modify the applicable style or the direct formatting of the small text.
- When the document contains images in formats not supported by DAISY, the author needs to convert the images to JPEG or PNG outside Writer and re-insert the new image.
- When a table contains merged cells, the author must decide whether to split to cells again or to simplify the table in a different way.

In each of these instances, the repair suggestions explain what the author can do to fix the issue.

### Implemented Issues and Warnings

Web developers and web accessibility advocates can refer to the W3C's Web Content Accessibility Guidelines (WCAG) as the generally accepted reference for web accessibility. Authors of office formats are not so fortunate. They can refer to Accessibility Guidelines Version 1.0 prepared by the ODF Accessibility subcommittee or the Authoring Techniques for Accessible Office Documents by the ADOD project (see above), but these documents don't have a structure based on testable and easily referenceable success criteria that is attractive to evaluation tool developers. The table below provides a mapping between WCAG 2.0 success criteria, the Authoring Techniques for Accessible Office Documents from the ADOD project (version 3.2, dated February 2011) and the ODF checks that are currently supported. The evaluation tool can perform checks that are applicable only to Braille or to DAISY; these checks can be enabled or disabled in the options dialog. Some checks do not map to any WCAG 2.0 criterion, for example the check for image formats that are not supported by DAISY. Note that the accessibility checker currently only evaluates OpenDocument Text (the word processing format); at the time of writing there is no support for presentations or spreadsheets.

WCAG 2.0	ODF Check(s)	Comments
1.1.1 Non-text Content	Error: formula has no text alternative.  Warnings: image has no text alternative; object has no text alternative; special characters or symbols are rendered by means of a special font instead of Unicode.	ADOD Technique 3  Some images may be decorative and therefore not require a text alternative.
1.3.1 Info and Relationships	Warnings: table contains merged cells; table cell contains another table; table has no repeatable heading row(s); table rows break across pages or columns; table is very long; long table has caption below table instead of above; caption is not linked to any image or table; text formatting (e.g. big bold text) suggests that a paragraph should have a Heading style.	ADOD Technique 6 (using named styles instead of direct formatting)  ADOD Technique 7.1, 7.2, 7.3, 7.4



WCAG 2.0	ODF Check(s)	Comments
1.3.2 Meaningful Sequence	Not tested	Requires research on the effect of floating objects and frames on reading order.
1.3.3 Sensory Characteristics	Not tested	ADOD Technique 9.4
1.4.1 Use of Color	Not tested	ADOD Technique 8 (in charts) ADOD Technique 9.3
1.4.2 Audio Control	Not tested	
1.4.3 Contrast (Minimum) (AA)	Error: contrast between foreground text and background is too low.	ADOD Technique 9.2
1.4.4 Resize text (AA)	No test required	Writer has built-in zoom functionality.
1.4.5 Images of Text (AA)	Not tested	ADOD Technique 9.5
1.4.6 Contrast (Enhanced) (AAA)	(See success criterion 1.4.3.)	
1.4.7 Low or No Background Audio (AAA)	Not applicable	Writer documents can embed audio but not as background sound.
1.4.8 Visual Presentation (AAA)	Warnings: text is justified; font size is smaller than 9 points; long span of text in all caps, underlined or italic.	ADOD Technique 9.1 WCAG does not require a minimum font size or prohibit text that is in all caps, underlined or italic.
1.4.9 Images of Text (No Exception) (AAA)	(See success criterion 1.4.5.)	
2.1.1 Keyboard	Warning: An image anchor is not set to "As Character".	ADOD Technique 4
2.1.2 No Keyboard Trap	Not tested/no test required	Unless macros can trap the keyboard, this needs to be handled by Writer.



WCAG 2.0	ODF Check(s)	Comments
2.1.3 Keyboard (No Exception) (AAA)	(See success criterion 2.1.1.)	
2.2.1 Timing Adjustable	Not applicable	Not applicable, unless macros can create time limits.
2.2.2 Pause, Stop, Hide	Not tested, except blinking text.	
2.2.3 No Timing (AAA)	Not applicable	
2.2.4 Interruptions (AAA)	Not applicable	
2.2.5 Re-authenticating (AAA)	Not applicable	
2.3.1 Three Flashes or Below Threshold	Not tested	
2.3.2 Three Flashes (AAA)	Not tested	
2.4.1 Bypass Blocks	Not applicable	
2.4.2 Page Titled	<p>Errors: document has more than one Title style; document has an empty Title style.</p> <p>Warnings: document has no Title style; paragraph below Title is formatted in a way that suggest it should have a Subtitle style.</p>	Some documents may not require a title, e.g. letters.
2.4.3 Focus Order	Not tested/not applicable	Writer is an editing environment, and pressing TAB has a different effect than navigation in a browser.
2.4.4 Link Purpose (In Context)	Warning: hyperlink text is identical to hyperlink URL.	ADOD Technique 10.2
2.4.5 Multiple Ways (AA)	Warning: Braille edition has no table of contents.	ADOD Technique 7.5, 7.6



WCAG 2.0	ODF Check(s)	Comments
2.4.6 Headings and Labels (AA)	Errors: empty Heading style; incorrectly ordered headings; heading inside a frame (DAISY check).  Warnings: document contains no Heading styles; document has more than 6 levels of headings (DAISY).	ADOD Technique 5  Some documents may not require headings, e.g. letters.
2.4.7 Focus Visible (AA)	Not tested	
2.4.8 Location (AAA)	Not applicable	
2.4.9 Link Purpose (Link Only) (AAA)	(See success criterion 2.4.4.)	
2.4.10 Section Headings (AAA)	(See success criterion 2.4.6.)	
3.1.1 Language of Page	Error: document has no default language	ADOD Technique 2
3.1.2 Language of Parts (AA)	Errors: span of text has no language; a hyperlink has no language.  Warning: paragraph has no identification.	ADOD Technique 2  In Writer, hyperlinks have no language unless the author specifies one (or modifies the character style "Internet Link").
3.1.3 Unusual Words (AAA)	Not tested	
3.1.4 Abbreviations (AAA)	Not tested	Writer does not have a built-in style or mechanism for abbreviated forms.
3.1.5 Reading Level (AAA)	Not tested	ADOD Technique 10.1  Algorithms to evaluate reading level are language dependent.
3.1.6 Pronunciation (AAA)	Not tested	Relevant to DAISY export. Unclear how this can be addressed in Writer.
4.1.1 Parsing	No test required	Writer takes care of well-formed XML internally.



WCAG 2.0	ODF Check(s)	Comments
4.1.2 Name, Role, Value	Not tested	ADOD Technique 6 (using named styles facilitates mapping to roles)

#### Mapping between WCAG 2.0, ADOD and ODF accessibility checks

Some WCAG 2.0 success criteria are not listed in the above table:

- The success criteria for time-based media (audio, video) under Guideline 1.2. These criteria are rarely relevant to word processing documents but can be relevant to presentations with embedded media.
- The success criteria for predictable behaviour of web pages under Guideline 3.2.
- The success criteria for input assistance (forms and context-sensitive help) under Guideline 3.3.

The following warnings do not correspond to any success criterion in WCAG 2.0:

- The document contains images in a format not supported by DAISY.
- An empty title field in the document properties (useful for DAISY or PDF export).
- The document contains a form (form accessibility in ODF requires more research).
- Material will be omitted in the Braille edition because it is not placed in any volume, supplement or preliminary section.
- Material is omitted in the Braille edition because odt2braille is unable to process it.
- In Braille, material is transposed from its original location. This warns the author that lists, text boxes and images inside a table rendered outside the table in the Braille version.
- A volume doesn't start at a logical place. Volumes should begin with a heading.
- The document contains 8 dot Braille but the file format (for Braille export) does not support it.
- The document contains 8 dot Braille but the embosser does not support it.

ADOD Techniques 11 (check accessibility), 12 (use accessibility features when saving or exporting to other formats) and 13 (consider using accessibility support applications/plugins) do not correspond to any success criterion in WCAG 2.0.

- The mapping table shows that many WCAG 2.0 success criteria are not evaluated by the accessibility checker. There are several reasons for this.
- The easiest success criteria were implemented first, in order to quickly develop a working prototype for internal evaluation by the AEGIS project.
- For some success criteria, it is unclear how they can be evaluated systematically triggering false positives, for example, the success criteria 1.3.3 (sensory characteristics), 1.4.5 (images of text), 2.4.4 (link purpose) and 2.3.1 (flashing content).
- Some success criteria require language-specific resources, notably the success criteria 3.1.3 (unusual words), 3.1.5 (reading level), 3.1.6 (pronunciation) and 3.1.2 (language of parts). For success criterion 3.1.2 it is possible to rely in Writer's built-in

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language guessing functions, so the question is now at which level of granularity the language changes should be detected.

### Evaluation and Report Language (EARL)

OpenOffice.org and LibreOffice support the use of RDF (Resource Description Framework) for storing metadata inside ODF files. The accessibility checker stores information on errors and warnings as RDF inside the document. The format used for this purpose is the Evaluation and Report Language (EARL)[1], an RDF format for describing test results that is being developed by the World Wide Web Consortium (W3C). In addition to the list of errors and warnings, the metadata also describe which errors and warnings have been repaired or ignored, when the most recent accessibility evaluation was performed, and by which evaluation tool. The ODF accessibility checker is designed as a framework into which several evaluation components can be “plugged” in. One such component would be odt2braille, which would check the document for issues that are specific to Braille conversion. The test results from odt2braille would then also be stored in the EARL report.

### Conclusions and Future Work

The ODF accessibility checker evaluates many criteria for accessible documents. In addition to repair suggestions, it also supports a few automatic and semi-automatic repair functions. When the accessibility checker becomes available in OpenOffice.org and LibreOffice, it could become part of the Tools menu, below language-related items such as “Spelling and Grammar”.

The accessibility checker will probably be released under an open source license, possibly the Lesser General Public License (LGPL) 3, which is also the license for odt2daisy and odt2braille. It could become an extension for Writer or part of the Writer source code.

The accessibility checker currently only evaluates Writer documents. Evaluating presentations and spread sheets is part of the future plans.

### Acknowledgements

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## 6.2. Video Relay Service Practices And Policies Around The World

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### Abstract

Although video relay services (VRS) have done much to enable telecommunication between deaf and hearing people, technical and policy limitations prevent them from reaching their full potential. We compare the practices and policies of VRS across nine countries via typical use cases. Drawing on their respective strengths and weaknesses, we develop technical and policy recommendations for improving VRS across the world.

### Keywords

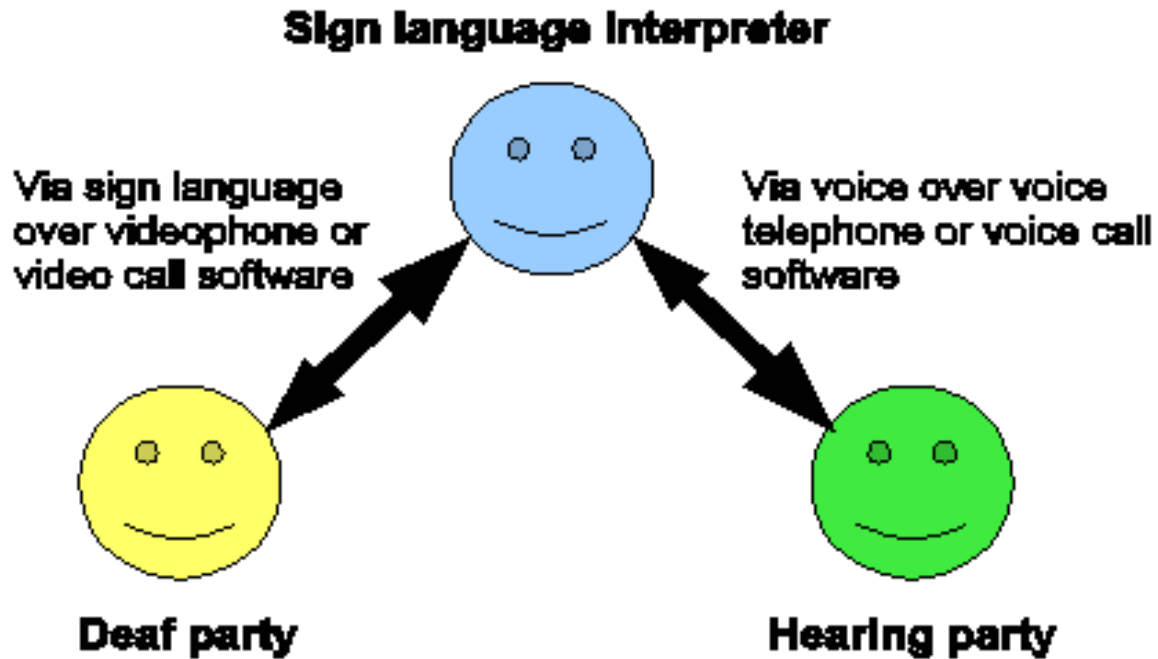
video relay services, videophones, functional equivalence, deaf telecommunications, sign language

### Introduction

Videophones and video chat services have taken deaf communities by storm. This is hardly surprising, given that for many deaf people, a sign language conversation is the most natural and efficient way to communicate with one another. Internet-based video services have allowed such communication to take place over a distance. Video relay services (VRS) let deaf and hearing people communicate on even terms: calls are relayed in real time through a sign language interpreter via a video call, who connects to the hearing party via a voice call (see next Figure). The speed and naturalness of VRS allows deaf people (such as the AEGIS persona Tomasa Almaraz, who is described as being unable to use the phone) to participate in mainstream society to a much greater degree than ever before.

Despite these advances, we are nowhere near the point yet where deaf and hearing people have equal access to telecommunications. The litmus test is the principle of functional equivalence: can deaf people use telecommunication services in the same unrestricted manner and at the same costs as hearing people? The answer, in many cases and places, is no: Whereas hearing people can use any phone anywhere in the world to call any other party any time, at nominal cost, the same does not hold true for deaf videophone users. Incompatible video communication protocols, expensive-to-use relay services, uneven sign language interpreting skills, limited operating hours, demand outpacing supply, a lack of coherent funding models, and uneven access to emergency services all pose frustrating limitations, and leave much of the potential of videophones and VRS unrealized.





#### Concept behind video relay services

The first step toward resolving these issues is to assess the state of various VRS around the world, and to evaluate their respective strong and weak areas. To this end, in this paper we present a comparative description of the technologies and policies of VRS in nine countries across the world via typical use cases, and, based on their respective strengths, develop recommendations for best practices and policies for the use of videophones and video relay services by deaf and hearing people alike.

#### Video Relay Services in Context

The purpose of VRS is to provide access to telecommunications. This scenario is distinct from the one where a deaf person places a video call to an interpreter, in order to communicate with a hearing person in the same physical location as the deaf caller. This latter scenario is called video remote interpreting (VRI), and it is not uncommon for VRS providers to support both scenarios. Some countries strictly separate VRS and VRI (such as the USA and Germany, where funding is tied to telecommunications access), whereas in some other countries the boundary is more fluid (such as Norway and Finland) [2].

VRS are not the only type of relay service. The concept is the same with all such services – a deaf, hard of hearing, or speech impaired person uses his preferred mode of communication, which the relay operator translates into a voice call to the hearing party. These services include text telephone and Internet-based text relays, speech-to-speech relays (revoicing a speech-impaired person for improved intelligibility), and captioned telephones where the deaf caller uses his voice, and responses show up as captions.

Text-based relay services are limited by people's typing speeds, which impedes the flow of the conversation. They also make automated telephone response systems inaccessible, as they time out before the relay operator can finish typing the available options and obtain the



caller's selection. Captioned telephones and VRS, in contrast, offer conversation speeds similar to spoken language calls (in the USA, the average VRS call length is four minutes [6]). The importance of VRS for equal access in telecommunications is underscored by their dominance in the USA, where 100 million minutes per year are spent on such calls [7], more than all other types of interstate relay services combined.

## Video Relay Services in Practice Today: Use Cases

We gathered data from nine countries across the world: USA, Germany, Sweden, Finland, Norway, Denmark, UK, Australia, and New Zealand, through people who are involved with the VRS in the respective countries. A more detailed comparison matrix with the practices and policies of these countries can be found on the companion web page at <http://tinyurl.com/VRSComparison>. Here, due to space limitations, we merely highlight several important technical and policy aspects of those VRS via typical use cases.

### Typical Use Cases

#### A deaf person makes a call to a hearing person:

In the USA, the deaf person can call day and night, while in some other countries he must pay attention to the opening hours of the VRS (Sweden, Germany), or even days of operation (all other countries). In Germany, the UK, and New Zealand the caller is subject to per-minute charges. In Finland, Kela (Social Insurance Institution) grants 180 free interpreter hours per year to the deaf and hard of hearing, but customers can apply for more.

The VRS takes the call on a first come first served basis. In the USA and Sweden, policies require the VRS to have enough call handling capacity, such that on average it takes less than two minutes to connect the call to a sign language interpreter. In the other countries surveyed, demand can outstrip interpreter availability, and the caller has to be prepared for potentially long waits, irrespective of the urgency of the call.

The deaf person can use SIP-capable videophones and software (Germany, Sweden, UK, Denmark, Norway, New Zealand), H.323-capable videophones and software (USA, UK, New Zealand, Denmark, Norway), UMTS on a cell phone (Sweden, Germany, Norway), Skype (Norway, Australia), FaceTime (USA, UK), or a web page (USA, Sweden, UK).

Some VRS allow text messaging as an additional channel of communication between the interpreter and the deaf person, which enhances usability for items that require exact spelling, such as names, confirmation numbers, and so on (USA – but provider-dependent, Germany, Sweden, Australia). Text messaging also lets deaf-blind people sign, while receiving responses as text. In some countries the deaf caller has the option of connecting his voice directly to the remote party (voice carry over), and receiving responses through the interpreter (USA, UK, Denmark, Norway).

In some countries, business calls are subject to different rules. In Germany, the deaf person can call only during regular business hours, and is subject to per-minute charges four times higher than for personal calls, which he may be able to recover through the office for employment integration. In the UK, the employment office may pay for the subscription fee and per-minute charges after assessment and approval. In Denmark, the person has to call a service different from the VRS used for personal calls.



**A hearing person needs to call a deaf person:**

In the USA and the UK, the deaf person can hand out a personal telephone number and be assured that the hearing caller will be automatically connected to the proper endpoint via the VRS. Elsewhere, he has to hand out the VRS's voice telephone number, and further instructions on how to have the VRS interpreter establish the connection, via telling him the callee's name, or SIP address. This is a problem, for example, if a company's web form requires a phone number for call back – the deaf person has to put instructions in the comments field of the form (if available) and hope that the company pays attention.

**A deaf person experiences an emergency:**

In the USA, the deaf person dials the standard emergency number 9-1-1 through his videophone or software 24 hours a day. This call receives priority in the queue of available interpreters, and the person's location is passed on automatically to the VRS, which in turn passes on the caller information to the appropriate regional answering point. In Sweden, a trial is underway to provide emergency relay services 24 hours a day, as well as 3-way calls with the emergency centre, as part of the EU-funded REACH 112 project.

In Germany, the deaf person has to inform the interpreter of the emergency and his location, who then calls a central answering point in Frankfurt, which in turn forwards the call to the appropriate local answering point. In Norway and Denmark, the deaf person likewise has to inform the interpreter of the emergency, who then contacts the appropriate answering point. In other countries or outside of regular operating hours of the VRS where applicable, the deaf person has to look for other ways to deal with the emergency.

**A deaf person makes a point-to-point video call to another deaf or hearing person:**

In this scenario no VRS operator is involved. It is still of interest, because ideally the deaf person can use a single program or device for all his communication needs, as opposed to switching among several. Otherwise, the deaf person is put in a situation similar to the early days of cell phones, when different networks could not talk to one another.

In the USA and the UK, if the other person is a registered deaf VRS user, the caller dials his telephone number. In New Zealand – or the USA and UK if one party is hearing –, people can call one another only if the callee informs the caller of his IP address, and if his firewall/NAT router is configured to forward the appropriate TCP and UDP ports for the H.323 protocol to the videophone or software. In other countries, the caller uses the callee's SIP address (Sweden, Denmark, and Norway) or his VRS-registered username (Denmark, Norway). International point-to-point calls work only in limited cases (H.323 via IP address, or SIP address if the implementations and terminal networks are compatible); USA and UK telephone numbers are not supported for such calls. In countries where cell phone carriers support UMTS video calls, people also have the option of calling one another by their cell phone number and paying per-minute charges.

**Recommendations****Technical Considerations****Interoperability:**

There is a proliferation of proprietary and open standards used for the video connection involved in VRS and point-to-point calls (as seen above, at a minimum H.323, SIP, H.324M,

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FaceTime, Skype, and Adobe Flash video via RTMP), none of which currently are able to connect to one another. Even SIP-capable devices are not guaranteed to be interoperable, due to differences in video codecs and transports, and firewall traversal provisions. In addition, there is a proliferation of methods for passing text messages between the deaf user and the interpreter (proprietary, RFC 3428 SIP Message, IM, Skype, or not supported at all). This state of affairs is very far from the simplicity of calls initiated by a hearing person, who can pick up any phone, dial a number, and expect the call to work.

It is urgent that terminal and VRS providers worldwide settle on a common interoperable standard for making video calls, and that this standard is also interoperable with mainstream equipment and software. SIP seems to be the obvious choice, although additional standardization efforts will be required to ensure that video, audio (for voice carry over), and text are interoperable, and that it will work across firewalls and NAT. At the same time, sign language conversations place demands on video and camera quality that need to be considered within the scope of universal design for calling equipment, software, and networks [3] [4].

#### *Integration into phone network:*

As shown above, with the exception of the USA and the UK, relay calls are complicated to set up for hearing people, and work differently from all other types of voice calls. This impedes calls to the deaf by hearing people. The importance of simplicity and integration is highlighted by the experiences of the State of Maryland in the USA where the number of relay calls initiated by hearing people jumped by 23% in a single month, after a simple common number for relay calls was instituted **Error! Reference source not found.** It is very much in line with the principles of universal design that there should be no difference in how deaf and hearing people can be reached over the phone. To this end, the USA and UK models should be followed, where VRS calls are transparently routed to the callee via regular telephone numbers.

#### *Emergencies:*

In emergencies people are stressed, and it is vital that they can use familiar equipment and methods to contact an emergency responder (see recent survey results on emergency access [1]). No matter whether an emergency call proceeds through a regular VRS call (e.g., 9-1-1 in the USA) or via dedicated emergency VRS (e.g. Sweden with the REACH 112 trial), it must be initiated via the same common user interface that is used to dial regular VRS calls. The equipment and the VRS provider must establish the appropriate connection transparently. This also requires transmitting that there is an emergency during the setup phase of the connection with the VRS (e.g., on the protocol level), so that it is feasible to prioritize calls or pull in interpreters who are trained to handle emergencies.

With hearing callers, the emergency responders can listen to the background cues during the call, and retrieve location information without caller invention. The principles of functional equivalence and equal access to emergency services suggest similar capabilities for deaf-initiated emergency calls. This implies that there must be a mechanism for passing on location information during a VRS call (in the USA, this is met by the registration requirement for all VRS users, which requires them to enter their address). Moreover, this implies that 3-way calls among the deaf caller, the responder, and an interpreter need to be supported, as



in the REACH 112 trials, so that the responder can see the caller and his environment directly even when VRS interpreters are used.

## Policy Considerations

### Legal framework, philosophies, and funding:

There is a plethora of legal frameworks for providing and funding relay services. Some countries have telecommunication laws that mandate relay services explicitly (USA, Germany, New Zealand), while in others it is implied by disability, social welfare, and labour market participation laws (Sweden, Finland, Norway). Funding mechanisms include contributions by telecommunication carriers based on market share (USA, Germany), relay subscriber charges (Germany, UK), and social welfare contributions by corporations or indirectly via taxes (e.g., Germany, UK, Norway).

In broad terms, there are three philosophies underlying the provision and funding of VRS in order from strongest to weakest: functional equivalence, access to telecommunication services, and social welfare/responsibility. In contrast to the “access to telecommunication” philosophy, functional equivalence requires that deaf people can use telecommunications in the same way and at similar costs as hearing people, which is compatible with the universal design philosophy. Finally, although the social welfare/responsibility angle blurs the boundary between VRS and VRI, it is subject to “reasonable accommodations” considerations, which can result in funding caps (e.g., caps on reimbursement of minutes for business calls in Germany, or a limited number of interpreter hours in Finland).

Mixing multiple philosophies can lead to conflicts that reduce access, as evident in Germany. There, business VRS calls have been financed by a fund aimed at increasing the labour market participation of people with disabilities, which corporations contribute to. In contrast, personal calls are financed by the telecommunication carriers, under the principle of telecommunication access. This led to carriers having to pay for calls twice, under both funding models. The rules then were amended to separate personal and business VRS, with the result that business calls are far more expensive and restricted than before.

There should be a clear funding model for relay services with a strong legal and policy framework. Experience in the USA have shown that the principle of functional equivalence grants deaf people the most comprehensive access to telecommunications, and this principle should guide implementation of VRS worldwide. However, this principle also implies a strict separation of VRS and other interpreting services, so care must be taken that it is not applied to the detriment of access to sign language interpreters in other areas.

### Operating Hours:

All but one VRS covered in this paper have limited hours of operation. Although in some cases, deaf people are able to schedule their calls around these limited hours, they run counter to the principle of functional equivalence. Worse, emergencies can happen at any time of the day and night, and do not follow the schedules imposed by VRS. Note that not all emergency calls entail contacting a public responder, but also involve personal calls during family crises, suicide watches, contacting next-of-kin, and similar. Hence, providing a dedicated 24-hour VRS for calling 112 or 911, or equivalent, is not sufficient for overcoming limited operating hours (although it still makes sense to have interpreters trained specifically



to handle emergency calls, in the interest of quick turnaround times and extracting vital information).

Worker protection laws with restrictions on night shifts may stand in the way of providing 24-hour VRS in some countries. Nevertheless, they need to be balanced against public safety concerns and well-being: deaf people should be assured of having access to the same resources in emergencies as the mainstream world.

#### **Interpreter confidentiality and quality standards:**

Functional equivalence implies that VRS calls must be subject to the same degree of confidentiality as an analogous voice call. This area is of particular concern to the medical, financial, and legal professions, which themselves are subject to strict rules (e.g., TeSS, a German VRS provider, had to use power of attorney forms to work around this problem, and some U.S. banks have refused VRS calls). To ensure that legal uncertainties do not cause hearing parties to refuse VRS calls, it is recommended that confidentiality rules are coded in the laws and regulations pertaining to VRS, and that these are strictly enforced.

Sign language interpreter quality standards are also a concern. Misunderstandings between the VRS interpreter and the deaf client can have severe, even life-threatening, consequences. In addition, hearing parties are not always aware that interpreter skills vary widely, and consequently poor interpreters tend to reflect poorly on their deaf clients, even if the problem lies with the VRS interpreter, rather than the deaf person. Unfortunately, policies for certifying interpreters vary widely across countries, so it is not enough just to insist on some type of nationally accepted certificate. Rather, policies for interpreting standards need to be coordinated with both VRS providers and national interpreter certification bodies. In addition, voice carry over should be available as a standard option for all VRS calls to allow deaf people to bypass sign language to voice translation problems altogether, if they are able to voice for themselves and have the desire to do so.

#### **Conclusions**

VoIP and video services are poised to expand rapidly in the mainstream world, so there is a unique window of opportunity now to ensure that they are accessible and to realize their full potential. From a technical point of view, the thorniest problem is interoperability – if standards and functional requirements are addressed and implemented now with VRS and universal design in mind, next-generation videophones will have a large impact on the deaf. In addition, international policy guidelines and standards would do much to improve the availability and quality of VRS across the world.

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### 6.3. ADIBIB – A Customized Digital Library For Students With Impairments In Written Communication

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#### Abstract

ADIBib is a customized digital library that provides textbooks to students at elementary and secondary level. These digital books are readable by various text-to-speech software programs.

The service provided by ADIBib creates new opportunities for individuals with impairments in written communication. It gives them coping skills and enables them to fully participate in society. Not surprisingly, they are encouraged to achieve higher academic levels. The project targets students with severe reading and writing disorders (dyslexia, dyspraxia, visual and physical impairment).

The files supplied by the publishing companies are converted into software independent tagged PDF files. This conversion is partly automatic.

#### Keywords

Digital books, education, text-to-speech software, dyslexia, dyspraxia, visual impairment, physical impairment

#### Introduction

Eureka ADIBib (Adapted Digital Library) is a unique service designed to make text books digitally available. They are converted into the most commonly used text-to-speech software programs. What makes this program innovative is not its objective but the unique partnership with publishing companies, the tool it uses and the broad target audience.

During 2007-2008, the Flemish government agreed to finance a project analysing all aspects of digitalising textbooks. The goal was to make text books accessible to students with a written impairment. Eureka ADIBib was born, a project unprecedented in Europe.

The project is managed by Eureka Die-'s-lekti-kus, a Flemish organisation for people with dyslexia, and draws on the expertise of Eureka Education, a school for children with severe learning disabilities.

Since 2005, people with severe reading impairments have increasingly relied on software to compensate for their disability. The software in question was predominantly text-to-speech software. This software however also served as a study aid. It provided visual support during reading, possibilities for structuring and various other adaptable features. This caused a lot of problems for students in elementary and secondary schools as only a small percentage of text books was available in digital form. Often textbooks were scanned page by page to make the document "ready to read" for the compensating software. An unsustainable situation.



Important initiatives such as the United Nations Convention on the Rights of People with Disabilities and the European Commission Green Paper of 16 July 2008 on Copyright in the Knowledge Economy were the catalysts behind the growing call for customized digital text books.

### Target Audience

Eureka ADIBib targets primary and secondary school students with an attested learning disability. For those students (with dyslexia, dyspraxia, a physical or visual disability) classical textbooks are a real struggle. Reading is very time consuming and frustrating. Often students become demotivated and underachieve, which causes new frustration and school tiredness.

Eureka ADIBib addresses this problem by offering students their textbooks converted into the most commonly used reading programs. This allows students to read and hear the text at the same time. Also, the books are digitally accessible. This way, they can study at their own pace and difficulties caused by their impairment are minimized.

### Partners

ADIBib consolidated a structural partnership with the Flemish Union of Educational Publishers (GEWU) in a memorandum unique in Europe. As such people, resources and expertise can be used with great efficiency.

On a European level, agreements were made with the EDA (European Dyslexia Association), the FEP (Federation of European Publishers) and the EBU (European Blind Union).

The collaboration with educational publishers has evolved significantly. Initially, there was a certain amount of reluctance. The publishing companies raised important objections to the delivery conditions of the digital text books and the security of the files.

This situation always evolved. Agreements and constructive cooperation led to remarkably good results. At present, the educational publishers have agreed to allow people who meet the necessary requirements to download secured ADIBib digital files from the ADIBib website. A few years ago this would have been unthinkable.

Eureka ADIBib also works closely together with Luisterpunt, a Flemish organisation that provides audio books. They target in the first place people with visual impairments, but more and more they are also oriented to dyslexia. Luisterpunt has extensive experience in burning digital files on CD and distributing them.

The remarkable results so far have been achieved only because of the high quality of the specific software that was developed for people with severe reading difficulties. In Flanders this is Kurzweil 3000 and Sprint. The producers/distributors of this software are just as indispensable in his network as the publishing companies.

ADIBib thus provides cross-pollination and a win-win situation where the target audience, publishers and software companies encourage each other to continue to raise the level. In Flanders ADIBib is considered the "trusted third party". It is an independent service financed

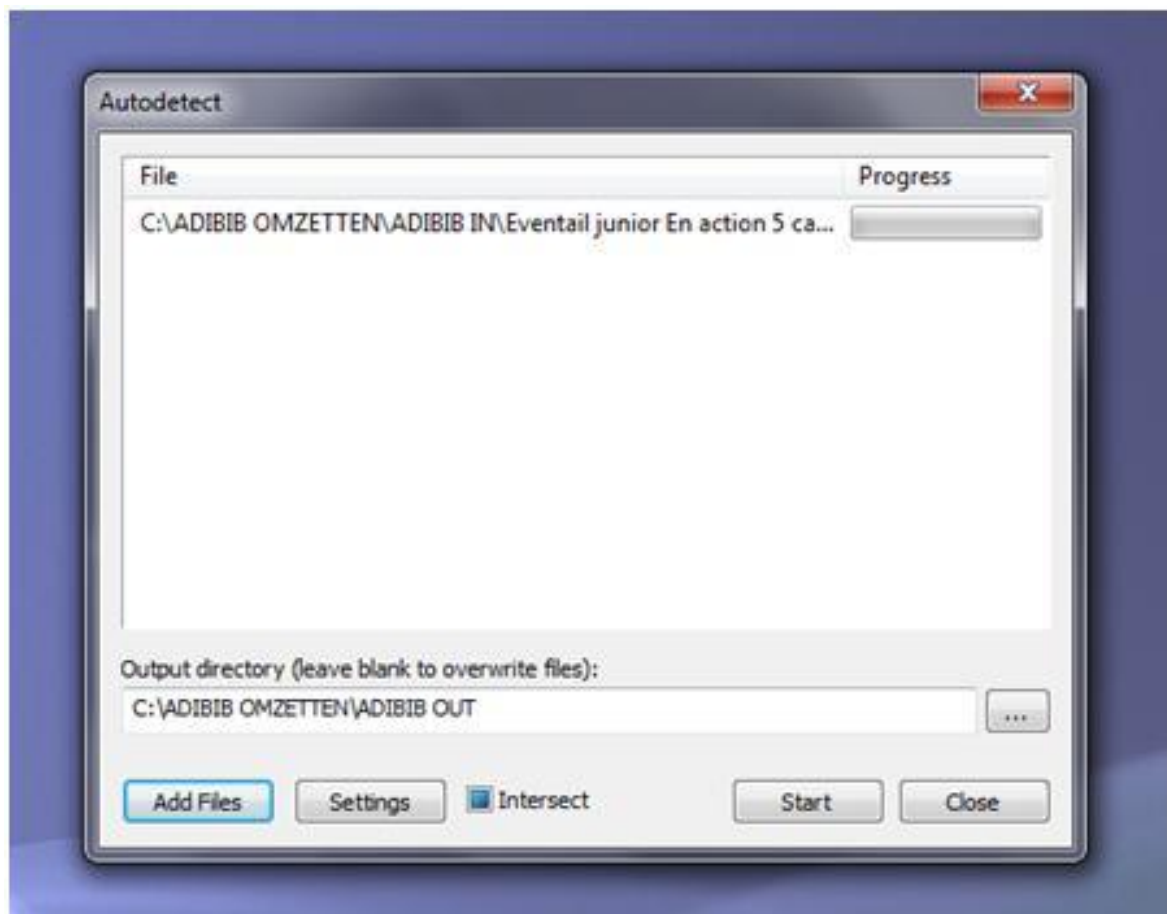


by the Flemish government. ADIBib is not required to make a profit and can focus on its target audience. ADIBib also performs the task of go-between for not only schools but also teachers and parents. Conversion centres for people with visual impairments too can apply for digital versions of textbooks. Without mutual trust and proper agreements with educational publishing companies this wouldn't be possible.

### Conversion Software

Eureka ADIBib is unique, not only because of its close cooperation with publishers but also because of its use of a newly developed, software-independent tool for the conversion of textbooks. This tool guarantees automatization of the conversion process and reduces the conversion time by a factor of 5 to 10. It delivers textbooks in tagged PDF-format.

The universal format and the high quality of the actual text-to-speech software allows students with different impairments and different requirements to use the converted books. A converted text book may be used by a student with dyslexia, a student with visual disabilities as well as a student with intellectual or physical disabilities. Similar initiatives throughout Europe all target one specific group. The Eureka ADIBib tool signifies an increase in efficiency and user friendliness.



Conversion software



## Security

The security of the digital files remains a highly sensitive issue. Publishing companies are anxious about freely available printable digital books. Both clear agreements and structural measures are necessary to make this work.

During the past years they actively searched for a modus operandi that would provide maximum security on the one hand and a minimum of inconvenience to the user on the other hand.

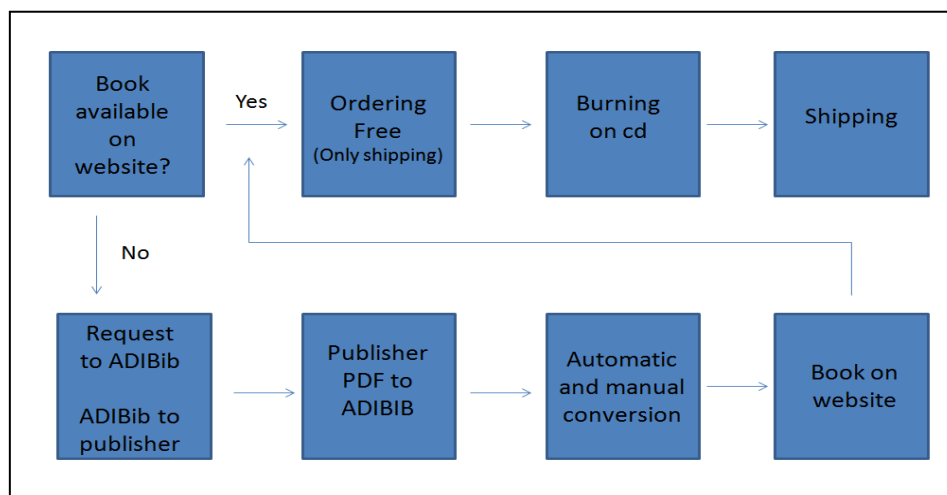
Since November 2011, ADIBib initiated the watermarking digital files. This means that books are only delivered when the name of the student and the school is known. The name of the student will be integrated within the digital file so everyone will be able to see who the book was ordered for.

To prevent the publishing companies from incurring financial losses it was agreed that the ADIBib user is required to not only give his name and school but also to confirm he possess a paper copy of the textbook.

## Procedure

The ordering process is almost entirely automated. The candidate user checks online on the website whether the book he wants is available. Books can be simply ordered by paying the shipping costs, if they are already converted and if they meet the candidate user's requirements. These requisits are related to the individual (certificate of dyslexia, dyspraxia or a special education certificate) and related to the textbook. The ordered books are burned onto a CD by "robots" and mailed to the user. It will be possible in 2012 to download the digital books directly from the website. If the book is not yet in the library the user can complete a digital request.

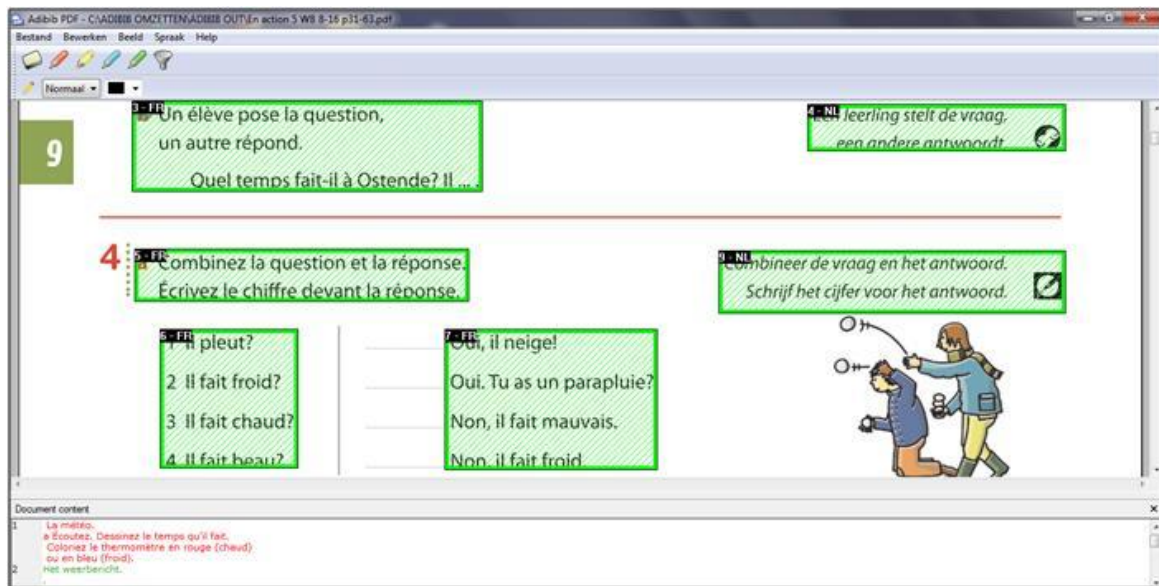
The textbook is requested by ADIBib from the educational publisher and processed into a digital book by the conversion tool. The digital textbook can then be read by the same text-to-speech software that students with severe dyslexia already use to read and study. The automatic conversion software is not perfect though. After conversion every digital textbook has to be visually inspected and corrected.



### Procedure ADIBib

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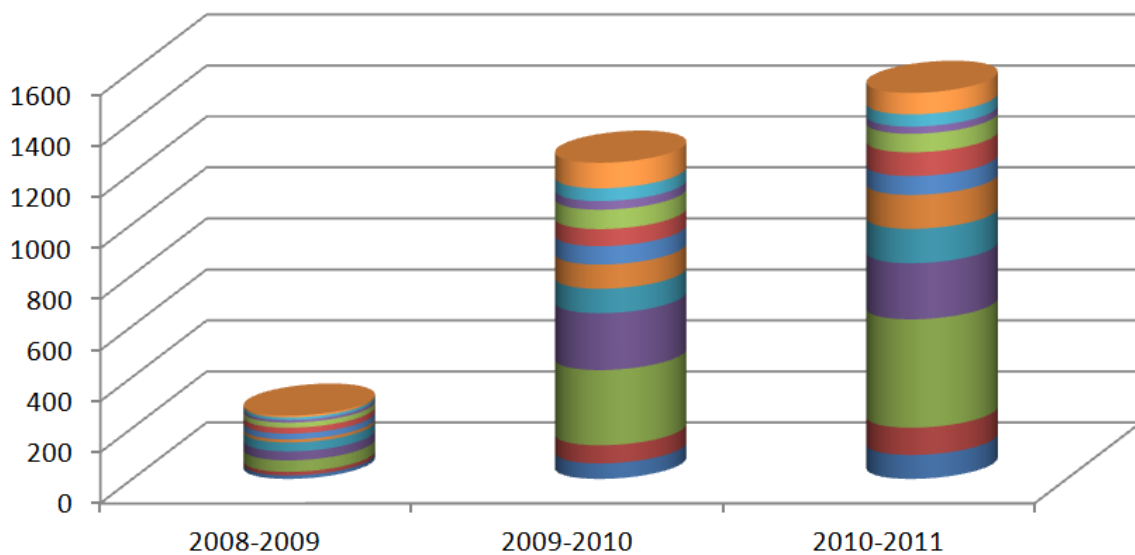




Tool for final visual correction

## Results

The initial scope of Eureka ADIBib was limited to 15 textbooks. However the project has grown exponentially and in May 2011 760 titles were available. But ambitions run high and Eureka ADIBib is aiming to convert 1.500 titles yearly. In 2010-2011 more than 1.500 clients order more than 10.000 titles.



Evolution clients during the first three years

## Discussion

Once converted, the digital textbook allows students to study the information dynamically and at their own pace. They no longer experience the loss of time and the inevitable frustration of struggling through a text.



However at present some critical points remain. The conversion software works well but several market factors are clearly not ready to handle this new and innovative technological development, specifically textbooks that do not meet the principles of Universal Design for Learning (UDL). In this context an increased awareness of the professionals who develop this material is absolutely imperative/crucial. Schools and teachers will require additional training to learn to work with digital textbooks in the future. In this regard, the rapid rise of digital whiteboards is a positive evolution.

The aim is to broaden the projects horizon and to expand its reach to other segments of the pupil population which to date have remained unserved. Eureka ADIBib could potentially be of benefit to 35% of the total student and pupil population. People with poor written language skills, non-native speakers, illiterate people but also adult students could all profit from this service.

A growing group of users will ensure that all parties involved are motivated to get on board of the universal design for learning. This will ensure that digital textbooks will be available and usable by all people, with and without disabilities.

### Acknowledgement

Eureka ADIBib would like to thank the Flemish ministry of education for funding this project.

### Websites

- ADIBib: [www.adibib.be](http://www.adibib.be)
- EBU (European Blind Union): [www.euroblind.org](http://www.euroblind.org)
- EDA (European Dyslexia Association): [www.dyslexia.eu.com](http://www.dyslexia.eu.com)
- European Commission Green Paper of 16 July 2008 on Copyright in the Knowledge Economy: [http://ec.europa.eu/internal\\_market/copyright/docs/copyright-infso/greenpaper\\_en.pdf](http://ec.europa.eu/internal_market/copyright/docs/copyright-infso/greenpaper_en.pdf)
- FEP (Federation of European Publishers): [www.fep-fee.be](http://www.fep-fee.be)
- GEWU (Flemish Union of Educational Publishers): [www.boekenvak.be](http://www.boekenvak.be)
- Luisterpunt (Audio books): [www.luisterpuntbibliotheek.be](http://www.luisterpuntbibliotheek.be)
- United Nations Convention on the Rights of People with Disabilities: [www.un.org/disabilities/convention/conventionfull.shtml](http://www.un.org/disabilities/convention/conventionfull.shtml)



## 6.4. Accessibility To Broadcasting And Telecommunications: The Canadian Experience

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### Abstract

Accessibility to broadcasting and telecommunications is critical to full participation and integration in society, as well as an important component of public safety. The Canadian Radio-television and Telecommunications Commission (CRTC) mandates accessibility for broadcasting and telecommunications services in a variety of areas. Its approach uses Canadian human rights principles that recognize that equality is a fundamental value and central component of the public interest, and balances the needs of persons with disabilities with other key objectives of the CRTC's mandate.

### Keywords

Accessibility, Audio description, Broadcasting, Canada, Closed captioning, Customer service, Described video, Emergency service, IPRS, Mobile wireless handset, Pay phone, Portrayal of persons with disabilities, Relay service, Telecommunications, Television, TTY, VRS.

### Introduction

The Canadian Radio-television and Telecommunications Commission (CRTC) is an independent public tribunal that regulates and supervises the broadcasting and telecommunications systems in Canada.

The Commission's mandate is derived from the Broadcasting Act and the Telecommunications Act, both of which contain objectives pertaining to accessibility, among other things. The objectives pertaining to accessibility set out in the Acts reflect the principle that access to communications is critical to full participation and integration in society, as well as an important component of public safety. As communications technologies become more prevalent in our daily lives, the need for accessible communications is becoming increasingly important for Canadians living with disabilities.

The Commission must balance the needs of those with disabilities with the myriad of other objectives it is charged with realizing, including those that promote and safeguard Canada's cultural sovereignty, the country's economic fabric, our official languages, as well as efficiency and competition. In evaluating approaches to provide accessibility to broadcasting and telecommunications services, the Commission assesses whether a proposed accommodation is reasonable in terms of financial, technical and other resources. The Commission also uses leading Canadian human rights principles that recognize that equality is a fundamental value and central component of the public interest.

The Commission's approach to facilitating access to broadcasting and telecommunications has evolved over the years. Its current policy framework was established in 2009 following a

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public review of unresolved issues related to the accessibility of broadcasting and telecom services to persons with disabilities.

The Commission's regulatory framework on accessibility includes a variety of tools. These include strict requirements for the broadcasting and telecommunications industries as well as "softer" expectations and encouragements, and emphasizes the importance of consultations between the industry and persons with disabilities in achieving solutions. The Commission also mediates and monitors complaints which can sometimes lead to the review of system-wide issues.

## Broadcasting

The Commission is committed to improving the accessibility of the Canadian broadcasting system for persons with disabilities. This objective is prescribed in the *Broadcasting Act*, which states, as part of the broadcasting policy for Canada, that "programming accessible by disabled persons should be provided within the Canadian broadcasting system as resources become available for the purpose."

The importance of achieving increased accessibility also springs from the fact that television is a key tool for social integration. As a primary source of information for Canadians, television news and information reflects the wide range of ideas and perspectives that are part of our society, thereby enabling Canadians to involve themselves knowledgably and effectively as members of society. As a vehicle for entertainment, television also allows Canadians to participate in a shared culture and shared social values.

The Commission considers that it is important for people with audio and visual impairments to be able to receive television broadcasts in as complete a form as possible, so that they are included in this everyday medium. The Commission also considers that the broadcasting system should be a mirror in which all Canadians, including persons with disabilities, can see themselves portrayed accurately, fairly and without stereotypes.

The Commission's approach to facilitating accessibility to television services focuses on requirements to provide closed captioning, audio description and described video. CRTC policies also address the representation and portrayal of persons with disabilities in programming and employment.

## Closed Captioning

Captioning is the on-screen textual representation of the audio component of a program. It is presented as a banner, usually at the bottom of the screen, and provides a text rendition of all significant audio content, including on-screen dialog, sound effects and non-speech information such as the identity of speakers and their manner of speaking.

The Commission's approach to closed captioning has evolved since the 1980s at which time the Commission asked broadcasters to make individual commitments to provide captioned programming. Over time, as captioning technology improved and costs declined, the Commission began to impose more stringent obligations on larger broadcasters with more significant resources. In 2007, the Commission set out a policy on closed captioning that required all television broadcasters to caption 100% of their English and French language programs over the broadcast day. In 2009, the Commission revised its policy to require broadcasters to also ensure that advertising, sponsorship messages and promos are

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captioned by the fourth year of their licence terms. The Commission imposes these requirements on television broadcasters as licences are issued or renewed.

Recently, the Commission has focused on issues related to the quality of closed captioning. In response to significant concerns raised by users of captioning over the poor quality of captions, the Commission directed the television industry in 2007 to establish working groups consisting of broadcasters, captioning providers and users of captioning. The purpose of these groups was to develop and implement universal standards and other concrete solutions to address captioning quality, including style and consistency of captioning, captioning errors and technical problems such as dropped or garbled captioning, or captioning that is cut off by commercials.

The working groups submitted proposed standards for the English and French language markets to the Commission in February 2011. In August, the Commission launched a process to seek public comments on the proposed standards. Once the standards are finalized and approved by the Commission, all television licensees will be required to adhere to them through conditions of their licence.

## Audio Description and Described Video

Television broadcasters in Canada provide access to television programming for those with visual impairments through two means: audio description and described video.

### Audio description

Audio Description refers to an announcer or program host reading aloud the textual and graphic information that is displayed on the screen during information programs to ensure that viewers who are blind or visually impaired have access to this information. The CRTC's definition of audio description is different from the definition of audio description set out in the Web Content Accessibility Guidelines (WCAG) 2.0. The WCAG 2.0 concept of audio description – "narration added to the soundtrack to describe important visual details that cannot be understood from the main soundtrack" -- is similar to what the CRTC defines as Described Video.

The Commission requires television licensees to provide audio description for all the key elements of Canadian information programs, including news programming. This requirement is imposed on broadcasters at the time of issuance or renewal of their licences.

### Described video

Described video (DV) is a technique whereby a narrator provides a description of a program's key visual elements - such as settings, costumes, or body language - so that persons who are blind or have visual impairments can understand what is occurring on the screen. It is best suited for, but not restricted to programs such as drama, documentaries and children's programming that contain significant visual elements that are key to the storyline. Described video is typically a post-production technique and is transmitted using a separate audio track that is embedded into the broadcast signal.

The Commission began to impose requirements to provide minimum levels of described programming on certain major television broadcasters in 2001. It extended these requirements to certain genres of specialty programming services in 2004. In 2009, the Commission extended the DV obligations to additional broadcasters.

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These obligations require licensees to broadcast a minimum of four hours of described programming per week, of which two hours must be broadcast in described video for the first time on the service. Broadcasters are also expected to display a standard described video logo and make an audio announcement that indicates the presence of described video in a program.

The Commission is currently monitoring the costs of described video and the economic situation faced by television broadcasters. The Commission intends to conduct a proceeding to consider increasing the minimum amounts of described video that licensees must provide when it appears that resources may be available for this purpose, for example, through technical or other developments lowering the costs of providing described video.

In the meantime, the Commission has an expectation to the effect that broadcasters' annual spending on described video should not decrease over the period of their licence terms. Thus, should the cost of described video decrease, broadcasters will be expected to use the savings to provide more described video.

The Commission has also taken measures to improve viewers' access to described video and increase information on and awareness of described programming. The Commission requires distributors of broadcast signals to pass through all DV signals to viewers as well as provide a simple means for subscribers who are visually impaired to access the DV audio track with little or no visual acuity. The Commission has also directed the establishment of a working group to develop recommendations, common practices and other solutions for improving viewers' access the DV audio track as well as increasing the promotion of described programming. The working group is expected to submit its final report to the Commission in Fall 2011.

The Commission has also licensed a specialty programming television service that is distributed nationally called The Accessible Channel which provides exclusively described video programming. The description is not embedded into the signal; therefore no special equipment or extra steps are required to access this programming.

### **Broadcasting Accessibility Fund**

In March 2011, as a condition of approval of a major broadcasting ownership transaction, the Commission required the licensee (BCE Inc.) to allocate \$5.7 million (Canadian funds) to create a Broadcasting Accessibility Fund with a goal of ensuring accessibility of all broadcasting content. The Commission specified that the fund should focus on innovation and the provision of platform-neutral solutions. The focus on innovation reflects the Commission's view that it is more cost-effective to make new technology, applications and services accessible to persons with disabilities early in the development process.

In August 2011, the Commission launched a process to seek public comments on the proposed mandate and governance structure of the Accessibility Fund. Following receipt of comments, the Commission will issue its determination with respect to the specifics of the fund.

### **Representation and Portrayal of Persons with Disabilities**

Broadcasters can play an important role in helping create and reinforce positive attitudes towards persons with disabilities. In recognition of this, the Commission requires

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broadcasters to file corporate plans and annual progress reports outlining efforts taken to improve the representation and reflection of persons with disabilities, as well as other underrepresented groups, in programming as well as behind the scenes. Such reports include corporate initiatives to address hiring and employment practices, measures to improve the representation and portrayal of persons with disabilities on-screen as well as community outreach initiatives.

In addition, Canadian broadcasters have developed an *Equitable Portrayal Code* to address, among other things, the fair and equitable portrayal of persons with disabilities in programming. The Code was developed in response to concerns identified in research undertaken by the private broadcasting industry about problematic portrayals of persons with disabilities as well as visible minorities and Aboriginal peoples. These concerns included stereotyping, negative and inaccurate portrayal, unbalanced portrayal in newscasts and the use of inappropriate language. The Code, which was approved by the CRTC in 2008, is obligatory for all radio and television broadcasters.

## Telecommunications

The Commission considers that, as a general principle, telecommunications services should be accessible to all persons in Canada. This is consistent with the Canadian telecommunications policy objectives set out in the Telecommunications Act, which include rendering reliable and affordable telecommunications services of high quality accessible to Canadians in all regions of Canada as well as responding to the economic and social requirements of users of telecom services.

The Commission's policy framework recognizes that Canadians with hearing, speech and visual disabilities should have the same ability as other users of wireline telephone services to communicate using such services. As wireless internet-based communications have become increasingly prevalent, the Commission has also turned its attention to ways of improving accessibility for persons with disabilities to wireless service. CRTC determinations relate to the provision of technical means to enable persons with disabilities to access services, the provision of customer service and information to assist persons with disabilities in making informed choices, and access to emergency services.

Although the Commission may forbear from regulating a particular territory or service, the Commission has generally kept the power to regulate with respect to accessibility issues when it forbears from regulation.

## Relay Services

Relay services provide persons with hearing or speech disabilities with the means to make and receive telephone calls from people without such disabilities. A relay operator serves as an intermediary between the caller and the recipient of the call by translating and relaying the messages between the people on the phone call.

Several forms of relay services are available internationally, including Teletypewriter Relay Service (TTY Relay), Internet Protocol Relay Service (IP Relay) and Video Relay Service (Video Relay). From the perspective of a person with a hearing or speech disability, the key difference between types of relay services is the method of communicating with the operator:



TTY Relay and IP Relay are text-based services and Video Relay is a sign language-based service.

### **Text-based Relay Services: TTY and IP Relay**

A TTY is an electronic device that enables text communication via a telephone line. In a TTY Relay call, the relay operator transmits messages via TTY-based text conversation with a person with a hearing or speech disability and via voice conversation with a person without such a disability.

The Commission first required a major telephone provider to provide relay service to its subscribers using TTY technology in 1985. Over the following years the Commission expanded such obligations and in 1997 required all home telephone service providers to provide TTY Relay service.

Recently, the Commission expanded its requirement regarding the provision of relay service to include IP Relay. IP Relay was implemented nationally in Canada in 2011.

In an IP Relay call, the person with a hearing or speech disability communicates with the relay operator via the IP Relay provider's Web page or an Instant Messaging application using a web-enabled device, such as a smartphone.

IP Relay enables faster communication between the user and the relay operator than TTY Relay, including to emergency service (9-1-1). It is also more portable than TTY Relay service because users can access it using a web capable device wherever there is internet access. IP Relay permits much faster typing and allows users to see significantly more of the conversation on their computer screens than they can see with a TTY. It allows users to print out and save conversations as well as make conference calls.

The Commission does not consider the provision of TTY and IP Relay service to be a service enhancement or additional service for persons with disabilities. It views the provision of text-based relay service by a telephone company, to rate paying subscribers who have hearing impairments, as the means to use the telephone on a basis that attempts to provide access comparable to that of other subscribers. Accordingly, TTY and IP Relay service must be provided 24 hours per day, 7 days per week. Furthermore, the costs of TTY and IP Relay services are funded by all telephone subscribers. That is, a telephone service provider cannot fund the cost of the service by charging a customer with a hearing or speech impairment a higher rate for using TTY or IP Relay than the rate charged to a customer without a hearing or speech impairment for using a telephone. Message relay rates are approved by the CRTC and are generally charged on a per customer telephone line basis.

### **Sign Language Based Relay Service : VRS**

The Commission is currently exploring the feasibility of Video Relay Service (VRS). Video Relay enables communication with a relay operator using sign language (rather than text). The relay operator communicates with the person with a disability in sign language and the person without a disability via voice. The person with a hearing or speech disability accesses the service via an IP video camera device and broadband internet connection to reach the relay operator.



The Commission examined the issue of Video Relay as part of its Accessibility proceeding in 2008/09. It concluded that VRS would provide a significant benefit to persons with hearing and speech disabilities who communicate via sign language. However, it had concerns about the significant cost of the service, particularly considering the need for highly skilled interpreters in American Sign Language and Langue des signes québécoise, the English and French sign languages used in Canada.

The Commission determined at that time that further investigation was necessary to acquire accurate information on the cost of the service, the size of the relevant markets and the projected use of VRS. The Commission intends to assess in 2012 whether a follow-up proceeding is warranted to determine whether or not Video Relay should be mandated.

Currently, TELUS Communications Company, a major telecom provider in Canada, has been conducting a VRS trial in three Canadian cities. Information resulting from this trial, as well as information from a VRS feasibility study being conducted by Bell Canada and VRS models in other jurisdictions, will be used by the Commission in 2012 to study the feasibility of VRS in Canada.

### Payphones

The Commission has mandated various requirements for pay telephones. When replacing, upgrading or installing new pay telephones, telephone companies must provide specific functions to assist persons with disabilities. These include key pads with larger buttons spread further apart; bright, contrasting-colour coin and/or card mechanisms; a screen displaying context-sensitive dialing instructions in larger size; and voice prompts to assist in placing a call or using features. In addition, access for persons with physical disabilities must be provided and pay telephones must be hearing aid compatible. There are also requirements to include a minimum number of TTY-equipped payphones.

### Mobile Wireless Services

The provision of accessible mobile wireless devices is becoming increasingly important as new technologies and applications are rapidly becoming standard offerings for the consumer and as mobile devices are becoming the preferred web access device for many. Wireless communications needs have evolved from receiving and making phone calls to text messaging, internet access and other uses of smartphones, resulting in an ever increasing significance of such devices in people's daily lives.

In its 2008/09 review of accessibility, the Commission became aware of an acute lack of mobile wireless handsets that are accessible to persons with disabilities, particularly devices that are accessible by persons who are blind, persons who have moderate to severe mobility impairments and persons with cognitive impairments.

In response, the Commission requested Canadian wireless service providers to offer at least one type of mobile wireless handset that is accessible to users from each of these three "categories" by October 2009. The Commission stressed the need for wireless carriers to consult with parties representing persons with disabilities on an ongoing basis to determine which solutions to offer. It also requested that service providers provide reasonable technical and lifecycle support for handsets in order to address special needs and assistive technologies.



To date, this policy has been met with some success. The CRTC commissioned the Inclusive Design Research Centre (IDRC) of Ontario College of Art and Design University (OCAD) in 2010/11 to undertake an independent study that provides, among other things, an assessment of the accessibility of mobile wireless handsets available in Canada. According to the report's findings, the state of accessibility of late-2010 in the Canadian market for mobile wireless handsets was mixed, with effective accessibility features existing for some groups of people with disabilities, alongside substantial accessibility gaps for some other groups.

According to the findings of OCAD's report, wireless devices that meet the needs of persons who are blind are generally offered by wireless providers. However, the report stated that not all providers offer handsets that support screen reader software and that in certain cases where mobile phones pre-loaded with screen reader software technology are available, they are becoming obsolete.

The report found that people with mobility impairments were most affected by accessibility gaps in the Canadian market. It found that while mobile wireless handsets that are accessible to persons with moderate mobility impairments are being offered, there is a lack of accessible devices available for persons with severe mobility impairments; specifically smart phones that have hardware and software interfaces that allow for addition of specialized peripherals (assistive devices) as well as software capacity to add pertinent third party applications.

Similarly, the study findings indicated that there are no solutions being offered in Canada to serve the needs of persons with severe cognitive impairments. Specifically, the report found that while handsets are widely available with the option to display images in the contact list and in some cases to download graphic-enhanced reminder applications, they do not provide for simplified messaging capabilities that allow users to compose and send messages from a user interface comprised of graphical symbols.

The Commission is aware of the numerous and significant challenges that exist in this regard, including the rapid development and change of new technologies and applications, the lack of standards to define the accessibility requirements and features needed to ensure accessibility on mobile devices, a lack of compatibility of many third party applications with built in accessibility features of smartphones, and the lack of a standardized evaluation mechanism that could be used by wireless service providers for assessing accessibility of handsets. The Commission recognizes that many of these challenges are not unique to Canada. It is currently watching developments on this front domestically and internationally in order to determine the best approach to ensuring that these gaps are addressed in order to serve the mobile wireless telecommunications needs of persons with disabilities in Canada.

### **Emergency Telecommunications Services: Text to 9-1-1 service**

Access to emergency telecommunications services is critical to the health and safety of citizens. In Canada, the universal emergency telephone number is 9-1-1. Most voice calls are compatible with Enhanced 9-1-1, which automatically provides 9-1-1 operator with the caller's location information and phone number. The automatic provision of this information improves the speed of the emergency response and enables the operator to resume



communication with the caller if the call is disconnected. This also enables the call operator to route the call appropriately to ensure the closest emergency services personnel are dispatched to the caller's location. In contrast, Canadians with hearing and speech disabilities face several significant limitations that affect their ability to communicate clearly, quickly, or directly with emergency call operators.

Some Canadians with such disabilities have proposed that their access to emergency services would be improved if they could communicate directly with 9-1-1 operators via text messages. Currently, there are several significant technical obstacles that would impede a person with a hearing or speech disability from being able to text directly to a 9-1-1 operator and receive a comparable level of service to a person making a voice call. Most significantly, text messages do not automatically provide the 9-1-1 operator with the caller's location. This is particularly problematic due to Canada's large size and the significant number of emergency services locations to which a call might be routed. Second, as text messages do not provide "priority handling" on the network, there can be a significant lag time before such messages are received. Alternatively, under high volume periods, text messages might not be received at all. Further, 9-1-1 call centers are not currently equipped to respond to SMS or other forms of text messaging.

In 2009, the Commission directed the CRTC Interconnection Steering Committee Emergency Services Working Group to investigate the benefits, uses and limitations of access to 9-1-1 services by persons with hearing or speech limitations via various forms of text messaging.

The working group examined short- and long-term solutions and considered that any text to 9-1-1 approach should involve automatic routing to the designated emergency services location and provision of location information automatically, to reduce response time. The working group reported that the development of longer-term solutions that would enable users to contact the 9-1-1 operator using multiple methods of text messaging would depend on the development level of new generation of the IP networks and 9-1-1 platforms.

As a near-term solution, the group proposed a technical trial of an SMS text to 9-1-1 work-around that would provide the 9-1-1 operator with the caller's location and enable the caller to communicate with the operator via text messaging. Under this model, a person with a hearing or speech disability pre-registers to use the service. In an emergency situation, the caller would initiate a "silent" call to 9-1-1, which would enable the 9-1-1 operator to immediately route the call to the closest emergency services personnel and would also direct the operator to initiate an SMS conversation to obtain more information about what emergency assistance is required.

The Commission approved the trial and it is underway. The Working Group will file a report with findings of the trial and recommendations at the conclusion of the trial in Winter 2012.

### Customer Service and Information

The Commission considers it important that persons with disabilities have access to information on disability-specific products and services as well as general information that would improve access to telecommunications and broadcasting services and products available to all customers. Accordingly, the Commission requires telecom service providers and distributors of broadcast signals to promote information on their disability-specific services and products in an accessible manner. In relation to general consumer information,

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the Commission requires that general call centers be accessible, and that general information on services and products be provided on websites in an accessible format by July 2012.

Furthermore, persons who are blind or visually impaired have the option to receive bills and information setting out the rates, terms and conditions of a telephone service, as well as other important information in an alternative billing format such as in Braille, large print or electronic version.

Two further services are Directory Assistance (DA) and Automatic Directory Assistance Call Completion (ADACC). Persons who are registered as having a disability with their telephone company can receive free DA and free ADACC to assist with finding and dialing telephone numbers.

## Conclusion

The CRTC recognizes the importance of communications for maximizing citizens' participation in society, in terms of access to news, information and entertainment, social interaction and integration, employment and emergency service. As a result, and accordance with its legislative mandate, the Commission has taken important steps to facilitate accessibility for persons with disabilities to broadcasting and telecommunications services.

The active participation of organizations and individuals representing the interests of persons with disabilities in bringing issues to the attention of the CRTC has been critical to the development of the Commission's accessibility policies. This work will continue to evolve, as the rapid pace of technological change provides new opportunities and challenges for the development of accessibility solutions.

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## 6.5. Accessible Digital Office Document (ADOD) Project

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### Abstract

The W3C-WAI provides a central hub of accessibility guidance for developers of web content and web content authoring tools. The guidance includes high-level guidelines and lower-level techniques and is available in a range of translations. A similar hub has been lacking for office applications (word processors, spread sheet tools, and presentation tools). Instead, information was scattered on a variety of sites, in a variety of formats, making comparisons difficult. The Accessible Digital Office Documents (ADOD) Project has brought this guidance together with an Assessment Framework and a series of Authoring Techniques documents for OpenOffice, Microsoft Office, WordPerfect, Google docs, iWork and Adobe Acrobat.

### Keywords

Office document accessibility, accessible Microsoft office, accessible PDF, accessible OpenOffice, accessible iWork, accessible WordPerfect, accessible Google docs

### Introduction

While the last decade has seen a massive increase in the use of web-based documents, digital office documents (hereafter “office documents”) remain a critical means of communication in domains as diverse as commerce, education, and government. The ubiquity of office applications has been generally positive for accessibility because digital documents, unlike printed documents, have the potential to be accessible to the millions of individuals globally who face barriers to using print. This includes individuals who are blind, have compromised vision, have dyslexia, cannot turn pages or handle paper due to motor restrictions, or who face cognitive access or literacy barriers.

Unfortunately, despite this potential and despite legislative and policy commitments to equal access, many office documents produced globally are still not prepared inclusively. Factors contributing to this situation include the still under-developed state of accessibility support (e.g., accessibility checkers) in office applications and a general lack of awareness by users about accessibility features that are already present.

The Accessible Digital Office Documents (ADOD) Project [1] is an attempt to address this state of affairs by (a) providing a framework for assessing the accessibility of office documents and the accessibility support provided by office applications and perhaps more importantly by (b) providing practical accessibility guidance to the users of these systems. ADOD is based on the accessibility guidance provided for Web content and Web content authoring tools by the W3C-WAI Web Content Accessibility Guidelines (WCAG 2.0) and Authoring Tool Accessibility Guidelines (ATAG 1.0).



## Background

### Office Documents

We must begin by being clear about what is meant by “office documents”. The simplest definition would be documents produced by “traditional” desktop office applications (e.g., Microsoft Office, Corel WordPerfect, OpenOffice, Apple iWork) or newly emerging web-based office applications (e.g., Google Docs, Microsoft Office 365).

However, this is inadequate because these applications are actually far more flexible than what is intended, since they allow word processors to output computer code, spread sheet to be used as video players and presentation formats to store binary data. This is unhelpful because these are clearly not typical uses of office documents. So for clarity we define “office documents” somewhat arbitrarily as computer files encoded in office document formats (word processor, spread sheet, and presentation formats) that are:

- Intended to be used by people (i.e., are not computer code),
- Text-based (i.e., are not simply images, although they may contain images),
- Fully printable (i.e., dynamic features are limited to automatic page numbering, table of contents, etc. not audio, video, and embedded interactivity),
- Self-contained (i.e., without links to other resources), and
- Typical of office-style workflows (Reports, letters, memos, budgets, presentations, etc.).

The exclusion of documents making use of dynamic and interactive content (audio, video, hyperlinks to other resources, forms, programmability, etc.) is not a problem because the accessibility of documents with these features is better assessed using WCAG 2.0, see below.

### Web Content Accessibility Guidance

Since 1997, the W3C’s Web Access Initiative (W3C-WAI) [2] has provided a comparatively open and effective forum for developing accessibility requirements related to the Web. W3C-WAI working groups include many “Invited Experts” from non-member organizations and the working groups generally operate in public view with public list discussions, meeting minutes and comments submissions. Importantly, all completed W3C Recommendations are available without charge.

Two W3C-WAI Recommendations are most relevant to the current work: the Web Content Accessibility Guidelines (WCAG), which apply to web pages and web sites, and the Authoring Tool Accessibility Guidelines (ATAG), which apply to applications that are used to create web content.

The current version of WCAG is version 2.0 (published 11 December 2008). WCAG 2.0 is supported by several documents including “Understanding WCAG 2.0” [3] and “How to Meet WCAG 2.0” [4] which provides a quick reference to a series of technology-specific technique documents such as “HTML and XHTML Techniques for WCAG 2.0”. The quality and transparency of the W3C-WAI process has meant that many governments have included reference to either WCAG 1.0 or 2.0 in their accessibility regulations. For example, the Government of Ontario includes reference to WCAG 2.0 in the recently released Information



and Communication Standards of the Accessibility for Ontarians with Disabilities Act [5]. In Belgium, the Flemish Government, in line with the European recommendations, states that all governmental websites should reach the WCAG 2.0 based AnySurfer checklist [6].

The current version of ATAG is still version 1.0 (published 3 February 2000) with a supporting Techniques document. ATAG version 2.0 is still under development [7].

### Need for Office Application Accessibility Guidance

In contrast to the centralized guidance provided by W3C, guidance for office documents and applications has been more fragmented. Individual developers do provide documentation (e.g. [8], [9], [10]), but this is developed from a variety of standpoints complicating direct feature comparisons. Some external accessibility organizations, such as WebAIM [11] and others have also developed techniques documents, but these tend to cover only a few of the most popular applications. Another common source of best practices has been the Section 508 standards for “Software applications and operating systems (1194.21)” [12], but these date from 2001 and are being refreshed.

Some have suggested that WCAG 2.0 and ATAG 1.0 might be applied directly to office documents and applications. Before developing ADOD, we considered the feasibility of this approach and noted the following issues:

- Terminology. WCAG 2.0’s definition of “Web Content” is “information and sensory experience to be communicated to the user by means of a user agent, including code or markup that defines the content’s structure, presentation, and interactions”. This might technically apply to office documents, but office document users never experience code or markup and office applications are not referred to as user agents. Also, the reference to the definition of “User Agent” does not help make any additional connection, as it reads “any software that retrieves and presents Web content for users. Example: Web browsers, media players, plug-ins, and other programs — including assistive technologies — that help in retrieving, rendering, and interacting with Web content.” Furthermore, the definition of “Web Page” includes four examples and none of them include typical office document usage.
- Numerous non-applicable WCAG 2.0 success criteria. While in almost every case, one could imagine an office document that was constructed so that the WCAG 2.0 success criterion would apply, such documents would have been border cases compared to the typical use of office documents, see “Office Documents” above.
- Multiple conformance levels in WCAG 2.0. Whereas WCAG 2.0 Level AA conformance is the level that has typically been selected for regulatory use.
- ATAG 1.0 references WCAG 1.0. Whereas it would be preferable to refer to WCAG 2.0.
- ATAG 1.0 is prioritized differently than WCAG 2.0. In WCAG 2.0, “success criteria” are assigned a “Level” between Level A and Level AA. In ATAG 1.0, “checkpoints” are assigned a “Priority” between priority 1 and priority 3. “Relative Priority” items take their priority level from the WCAG content in question.



## Accessible Digital Office Document Project

### Assessment Framework

The ADOD Assessment Framework [13] is an attempt to adapt the W3C-WAI guidelines to the context of office documents and application with as little “adjustment” as possible. The adjustments are as follows:

- Terms such as “web content” and “authoring tool” were mapped to “office documents” and “office applications”.
- WCAG 2.0 success criteria concerned with dynamic or interactive content were not included in the ADOD subset. Instead, a note directed evaluators to WCAG 2.0 in the event that dynamic or interactive content was present.
- Only Level A and AA success criteria were included in the ADOD subset.
- The ADOD office application requirements based on ATAG 1.0 no longer refer to WCAG 1.0 and do not refer to conformance levels.

In order to reduce the risk of being seen to be “fragmenting” the guidance provided by W3C-WAI, ADOD uses the W3C-WAI numbering schemes and the original W3C-WAI wording except where vocabulary adjustments are indentified with square brackets. Also, ADOD does not include a conformance model. Developers seeking to make a conformance claim should only do so to the W3C Recommendations.

The full ADOD Assessment Framework is not included with this paper due to length. It can be found at: <http://adod.idrc.ocad.ca/framework>.

### Authoring Techniques for Accessible Office Documents

While the ADOD Assessment Framework provides a view of how WCAG 2.0 and ATAG 1.0 might be applied to office documents, the most popular product of the ADOD Project are the “Authoring Techniques for Accessible Office Documents”. These are all based on a common template that is loosely based on the sequence of actions needed to be taken by users. The sequence is “loose” because there will be individual variation according to author preference and the type of content being authored.

The sequence of techniques for word processing is:

- Technique 1. Use Accessible Templates
- Technique 2. Specify Document Language
- Technique 3. Provide Text Alternatives for Images and Graphical Objects
- Technique 4. Avoid “Floating” Elements
- Technique 5. Use Headings
- Technique 6. Use Named Styles
- Technique 7. Use Built-In Document Structuring Features
- Technique 8. Create Accessible Charts
- Technique 9. Make Content Easier to See
- Technique 10. Make Content Easier to Understand
- Technique 11. Check Accessibility

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- Technique 12. Use Accessibility Features when Saving/Exporting to Other Formats

The sequence of techniques for spreadsheet authoring is:

- Technique 1. Use Accessible Templates
- Technique 2. Set Document Language
- Technique 3. Provide Text Alternatives for Images and Graphical Objects
- Technique 4. Format Your Cells
- Technique 5. Use Cell Addressing
- Technique 6. Create Accessible Charts
- Technique 7. Provide Structure for Tables
- Technique 8. Use Other Content Structuring Features
- Technique 9. Make Content Easier to See
- Technique 10. Make Content Easier to Understand
- Technique 11. Check Accessibility
- Technique 12. Use Accessibility Features when Saving/Exporting to Other Formats
- Technique 13. Consider Using Accessibility Support Applications/Plugins

The sequence of techniques for presentation authoring is:

- Technique 1. Use Accessible Templates
- Technique 2. Set Document Language
- Technique 3. Use Built-In Layout and Styling Features
- Technique 4. Set a Logical Tab Order
- Technique 5. Use Slide Notes
- Technique 6. Provide Text Alternatives for Images and Graphical Objects
- Technique 7. Use Built-In Structuring Features
- Technique 8. Create Accessible Charts
- Technique 9. Make Content Easier to See
- Technique 10. Make Content Easier to Understand
- Technique 11. Check Accessibility
- Technique 12. Use Accessibility Features when Saving/Exporting to Other Formats
- Technique 13. Consider Using Accessibility Support Applications/Plugins

Importantly, the Authoring Technique documents are produced on a product-by-product basis, so the documents can include a high degree of product-specific detail including step-by-step instructions and screen shots. The Authoring Techniques are available for the following office applications (\* indicates Dutch translations are available, see below):

- Word processing:
  - OpenOffice Writer (v3.2)\*
  - Microsoft Word 2003 | 2007 | 2008 for Mac | 2010\*
  - Corel WordPerfect X5
  - Google docs: Document\*
  - iWork Pages '09\*
  - Adobe Acrobat 9 Pro\*
- Spreadsheets:

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- OpenOffice Calc (v3.2)
- Microsoft Excel 2003 | 2007 | 2008 for Mac | 2010
- Corel Quattro Pro X5
- Google docs: Spreadsheet
- iWork Numbers '09
- Presentations:
  - OpenOffice Impress (v3.2)
  - Microsoft PowerPoint 2003 | 2007 | 2008 for Mac | 2010
  - Corel Presentations X5
  - Google docs: Presentation
  - iWork Keynote '09

### Validation Process

An important factor in the widespread acceptance of W3C-WAI guidelines is the open process by which they are produced. The timelines and budget for ADOD were, unfortunately, much more limited. However, a public review was still held from 8-22 October 2010 with an announcement on the WAI Interest Group mailing list [14].

We received comments from 11 contributors, including two office application developers. We judge this to be reasonable given (a) the 2 week time window, (b) the fact that the IDRC is not a standards organization, and (c) the 16 documents to review. For comparison, the six-week call to review the July 2010 Public Draft of ATAG 2.0 received 12 comments [15]. The feedback was used to revise the Assessment Framework and Authoring Technique documents before final release in February 2011.

### Partnerships And Next Steps

While ADOD was initially developed by the Inclusive Design Research Centre (IDRC), the goal is to transition further maintenance and development to the community of accessible office application users. The first partner has been the “AnySurfer” project, which contributed Dutch translations of several ADOD documents as well as an entirely new Techniques document for Microsoft Office for Mac 2011 (currently only available in Dutch) [16]. Additional partners for development and/or translation are welcome.

AnySurfer has also used the same Techniques format for a document on how to use Adobe InDesign CS5 (currently available only in Dutch). This provides a user-friendly level of product-specific documentation that supplements the existing technology-specific WCAG 2.0 techniques, which explain how to use web technologies as if the content was being authored from within a text editor.

A challenge moving forward is the increasing delivery of office applications via the web as demonstrated by Google Docs and Microsoft Office 365. This trend has the potential benefit of allowing vendors to continuously introduce and improve accessibility features for authors and end-users. However, this does complicate the task of documenting these features compared to the more static distribution model of the past.



## Conclusion

The Accessible Digital Office Document (ADOD) Project fills an important gap between web content-oriented accessibility guidance provided by the W3C-WAI and the specific, but often fragmented, office guidance provided by office application vendors and others.

While ADOD includes an “Assessment Framework” that is essentially a subset of WCAG 2.0 and ATAG 1.0, with some terminology adjustments, the primary contribution of the project has been the “Authoring Techniques”. These user-friendly documents provide step-by-step instructions complete with screen shots to guide authors in creating accessible word processing, spreadsheet and presentation documents within many of the most popular office application suites in use today. Looking to the future, the ADOD Project is seeking additional community participation to maintain and expand its resource offerings.

## Acknowledgments

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## 7. Session 6: Desktop applications

Being able to access content on the desktop is for many still a challenge. This session showed how initiatives from Asia and Europe go all in the same direction: disclosing content to the beneficiary via a plethora of assistive technologies, ranging from an open source screenreader, to gazer techniques, and graphic symbol support..

### 7.1. Explore ORCA As A Possible Alternative To Commercial Screenreaders

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#### Abstract

About 284 million people are visually impaired (VI) worldwide: 39 million are blind and 245 have low vision [1]. About 90% of the world's visually impaired live in developing countries [1]. The scenario related to education and consequently the employment of visually impaired people in Developing countries like India is not very encouraging. One of the major reasons for this is high cost of technology and hence its poor reach to visually impaired. This paper explores ORCA an open source screen reader, as a possible solution to the above mentioned problem.

#### Keywords

ORCA, Screen reader, Open source technology, Visually Impaired, Assistive technology.

#### Introduction

The world today is powered by technology, fuelled by information and driven by knowledge. Knowledge has become a currency today and quality education is essential to empower the population to succeed. Advancements in assistive technologies like screen readers are empowering visually impaired individuals. And they are able to compete and contribute like never before.

While assistive technologies hold a huge promise for visually impaired, exorbitant costs of the technologies often impede the revolution. Especially this is true in context of developing countries [2] [3]. Research suggests that organisations working for VI individuals are usually inclined towards commercial screen readers like JAWS (Job access with speech), Windows-Eyes etc [3].

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Given a scale of visually impaired population in India and rest of the developing countries, the cost of provisioning assistive technology to every visually impaired individual is astronomical.

This necessitates availability of low cost and yet feature rich screen reading technology. Orca, one such free and open source screen reader that can be a potential solution.

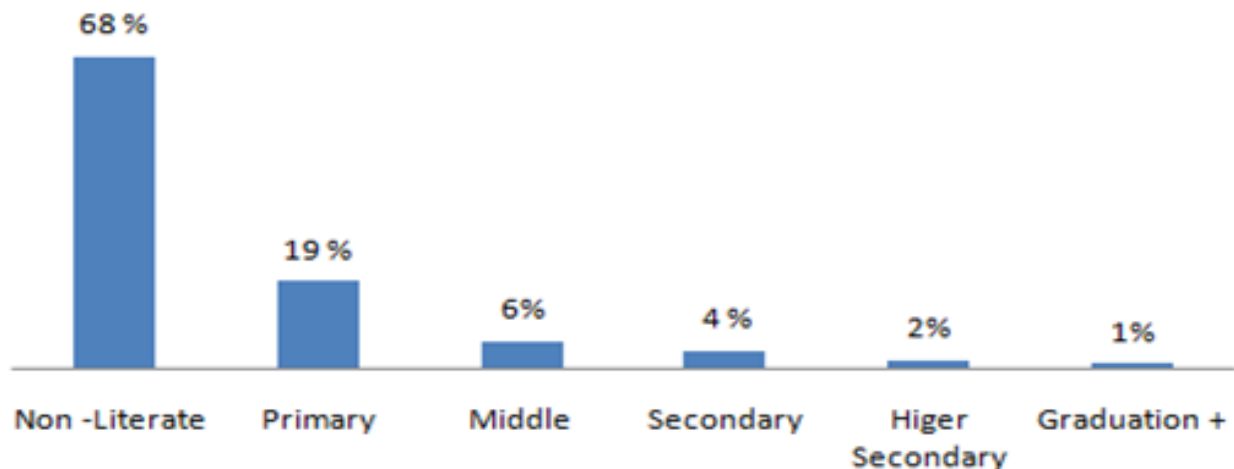
This Paper explores the potential of orca to be a primary screen reader for visually impaired in India.

In today's competitive global economy knowledge is one of the most sought assets. And providing quality education to all of its citizens is imperative for every nation to be successful. Constitution of INDIA guarantees quality education as a fundamental right for each Indian citizen, including people with disabilities. Empowerment of disabled individuals without access to quality education is futile.

The statics shows that visual disability is the most predominant disability amongst all. 49% of the disabled people in India are visually impaired. While we dare to dream India becoming a world's super power by 2020, we cannot afford to have such a large segment of population disadvantaged in any manner. Thus imparting quality education to visually impaired citizens is a necessity and not an option.

But the data portrays quite a miserable reality.

#### Graphical Representation of Dropout rate of VI population in Indian Education system



**Education Wise Population Distribution of Visually Impaired in India – Census 2001**

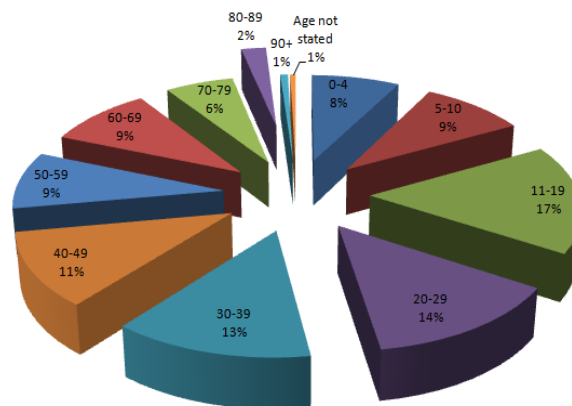
As the shown by the above Figure the situation of education of visually impaired is quite discouraging.

The dropout rate of visually impaired students is huge. 68% of VI population in India is Non-Literate. 19% of the population is enrolled in primary education, 6% in Middle level education, 4% in secondary, 2% in higher secondary and only 1% of enrolment is in the graduate level education [5]. Factors like unfavourable economic condition, lack of sensitization about people with disabilities, state policies, and cost of technology infrastructure are responsible for the high dropout rate of visually impaired from schooling [4].

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At this juncture it is important to understand the magnitude of the task of imparting education to the visually impaired in India. The following data depicts the number of people who are to be educated is approximately = 86, 28,378 Individuals



**Age Wise Population Distribution of Visually Impaired in India – Census 2001**

It is impossible gainsaying the fact that the Assistive technologies (ATs) form an integral part of the life of people with disabilities. ATs are the tools and technologies that assist a person with disability to accomplish those tasks which otherwise he cannot perform. Efficacious enablement of a disabled individual cannot be imagined without arming him with appropriate assistive technologies. As far as visually impaired individual is concerned, screen reading program commonly known as a screen reader (SR) is the must to have assistive technology. Commercial SR are prohibitively priced and simply unaffordable to households in developing economies. [2] [3] [4] [10] The following calculation shows the national expenditure that will be required to provide screen reading technology and necessary software and hardware to 86,28,378 visually impaired individual in India. [5]

Hardware / Software	Cost
Proprietary SR [10]	INR. 50,000 / - , (approx USD 1010.101)
Hardware (laptop)	INR. 30,000 / - (approx USD 606)
Proprietary OS License and other Proprietary software's	INR. 20,000 / - (approx USD 404)
Total cost of technology	INR. 10,0000 / - (USD 202)
Cost of providing assistive technology VI Population in the main stream	= 86,28,378 (people) x INR 100000 = INR. 862838 Million (approx USD 14737.07 Million)

**Cost of providing assistive technology using proprietary software**

The total provision of funds in Indian Union Budget 2011 for disabilities is merely INR. 45000 Million (approx 905 Million USD) [6] and that too for all disabilities, senior citizens, many backward classes all put together. The budget provisioning covers everything from scholarship schemes, sign language centres to assistive hardware and software all put together. Though the assistive technology procurement cost is one time expenditure, cost of

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upgrades both hardware and software is a recurring cost and amounts to few hundred USD if not thousand [10] [11]. All the above mentioned costs do not include the cost of training infrastructure, which are substantial. Considering the magnitude of the required expenditure, it is absolutely impossible for a developing country to afford the cost.

If we embrace open source technology then the cost reduces drastically as shown in the table below:

Hardware / Software	Cost
Open Source Screen Reader ORCA	INR. 0.00
Hardware (laptop)	INR. 30,000
OS Licenses and other open source software's	INR. 0.00
Total cost of technology	INR. 30,000
Cost of providing assistive technology VI in the main stream	=86,28,378(People) x INR . 30,000 = INR 258850 Million (approx USD 5229 Million)

#### Cost of providing assistive technology using open source technology

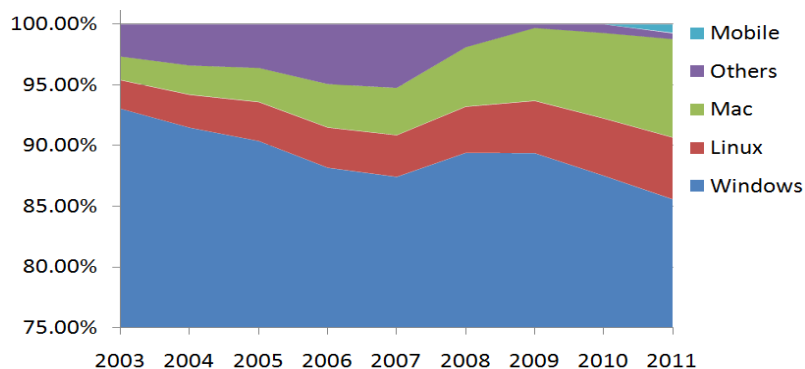
The above calculation shows that there is a 70% reduction in the cost incurred to provide assistive technology to VI Population in the main stream.

Despite of this cost reduction, the required expenditure is still far more than the allocated budget. However this will surely help in reaching more number of visually impaired beneficiaries.

While use of open source operating systems is increasingly becoming a part of mainstream in the global economy the perception about open source and free screen readers is also improving over a period of time [7].

This economics of assistive technology motivated us to evaluate open source assistive technology as a possible option to proprietary screen reading products.

The graph below shows the increasing adoption of open source operating system- Linux. [8]



#### Usage pattern of operating systems since 2003 till 2011

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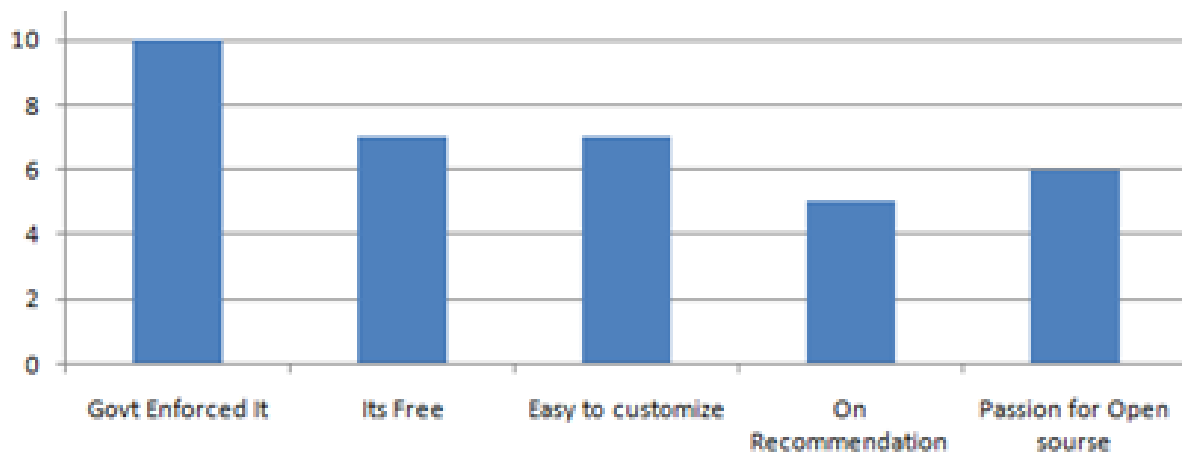
To validate our claim that the orca holds the potential to be a primary screen reading technology for Indians we conducted a survey. The major stake holders in the use of assistive technology are:

- Heads of the institutions (the decision makers who decide to implement a particular assistive technology in their respective organisations)
- The visually impaired students and their teachers (end-users of the technology).

Therefore we began by conducting an opinion survey of these stake holders to capture their perception of ORCA screen reader on Linux.

Following graphs summarize the results of the survey. The respondents for this survey were Heads Of the institutions and end-users from the schools for visually impaired and NGOs which work for visually impaired.

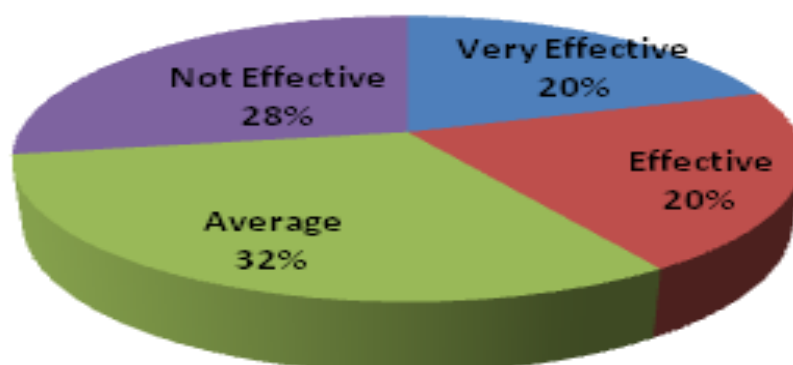
### Perspective of Heads of the institutions



### Reasons for choosing ORCA by Heads of the Institutions

The graph shows that government policies play a very important role in the adoption of the technology; other significant factors are cost and ability of the technology to support local languages.

### Perspective of end-users



### effectiveness of ORCA as perceived by end-users

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Our survey results shows that more the user explores orca, more he/she gets comfortable with the software. 40% of users who find orca as an effective screen reader have been using ORCA for more than one year. During the survey end users expressed their requirement of well researched and documented training modules and tutorials to reduce the Learning curve of ORCA.

However the study also showed that the users of JAWS or Voice over screen readers do not prefer switching over to orca. This feedback motivated us to understand where does orca stand with respect to Jaws and Voice over [12].

We conducted a comparative study of these three screen readers, based on 37 different parameters. The parameters were derived from the 12 principals which are used to design an ideal screen reader [9].

The conclusions of our comparative study are as follows:

#### Advantages of ORCA in Indian scenario over other two SR

- Free and hence can serve the masses.
- Available in many Indian languages, which are not supported by the other two screen readers
- Can be customized to speak in any Indian language

#### Road Ahead

- Sound quality of orca needs to be improved by developing a better quality speech engine
- User friendly Training and User manuals have to be prepared
- Quality of end-user support has to improve and become more user centric
- State IT policies need to be amended to promote open source amongst its people and organisations
- Establish NGOs to promote and support ORCA, these NGOs will form a bridge between the orca development team and the users

#### Conclusion

As we move ahead in the highly competitive and knowledge driven global economy, knowledge and quality education becomes absolutely essential. In the light of increase incidence of disabilities, no nation can afford to have its people with disabilities to be deprived of quality education and the necessary assistive technologies.

Especially in developing economies like that of India, blindness prevails as the most prominent disability and therefore need for screen reader products is huge. Good screen readers are available however they are exorbitantly priced and are not easily affordable to the households. The research suggests that adopting open source approach is an effective way to make the screen reading technology easily affordable to the visually impaired in India and other developing economies.

However the IT policies of a state have to promote adoption of open source technology. This will encourage organisations to adopt open source technologies resulting into more and more



jobs which require the skills on open source platform like linux. This will encourage more people to learn and adopt Linux and consequently ORCA. Although ORCA has progressed a lot and holds a great promise for visually impaired, lot needs to be done to make ORCA a primary screen reader for visually impaired in India.

### Acknowledgement

We would like to thank all the Heads of the Institutions, ORCA users and Domain experts who participated in this survey.

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## 7.2. Enhancing Orca For Document Navigation For Visually Impaired

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### Abstract

Any well-designed software application must be usable, functional and user friendly. A well structured navigation system at each level is a key element of this and particularly important for the vision impaired persons. An effective navigation is very important at the GUI level of an application. All document processors do not pay enough attention to this; some mainly rely on the user's vision. For a visually impaired person, this poses a major challenge. The inability to use vision driven mechanism like the point-and-click makes the problem worse. Because a vision impaired user relies on the keyboard to navigate. Without adequate support from underlying applications including document processors, the screen readers are largely helpless. In this paper, we look at some of these issues of navigation and proposed revisions in screen reader (Orca) to address some of them.

### Keywords

Screen Reader, Accessibility, Structural Navigation.

### Introduction

To fulfil the basic requirements of a well designed s/w application, its user interface must be usable, functional and user friendly. Navigation plays an important role in this. By definition [7], "Navigation is the science of determining the position, location, distance travelled, and the course to a known destination". Working on a document, navigation is the common action performed by a user for an initial skimming, a quick reading, analysis and editing of content. The layout of a simple text document mainly contains formatted, editable text in one or more pages. A user may scan the content sequentially line by line or may want to skim the document as required by page, paragraph, or document objects. The document object list includes headings, tables, lists, graphics/images, links, pages, paragraphs, text frame, active form controls and more. Commonly used word processors provide related navigation facility to move by various objects up/down or next/previous. A user can select the navigation object from the navigation browse window and can navigate to next/ previous objects using the buttons provided. On the document layout the title, tool bar, menu bar, scroll bar, status bar, header and footer are part of the global navigation and need to be accessible from each page. As compared to the text document, the layout of a web page is very different and contains the homepage, main section, and subsections with many dynamic and graphical elements. A user can navigate the page elements horizontally, vertically, in grouped manner or can navigate the information according to the visual feedback. The news, events, recent updates, last modified, are the dynamic elements to navigate. Back, forward, reload, the link to related websites, the object based navigation are part of related navigation. Home, contact, about, login are elements of the global navigation. Site map is an alternate way to navigate the information on a web page. When a user cannot easily find what s/he is looking for, s/he will turn to the sitemap. As a result, the HTML sitemap helps a user by showing her

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where to find a specific piece of information. Using a document, if it is difficult to navigate to an item available on screen or to switch from window to window, then the user quickly becomes frustrated and gives up. To provide easy navigation, designing layout of a document as per the requirements of an end user is a must.

In addition to the layout of an application, most users would acknowledge that the vision plays a critical role in the process of document navigation. A person with a proper vision is able to determine the current element and broadly where what items are under focus with the help of the visual feedback s/he gets. But for a vision impaired person, in the absence of visual feedback, it is difficult to find out where s/he is, where to go next and what can be done. Assistive technologies like screen reader, braille display are helpful to navigate an interface. However it is also important to understand the difficulty involved in navigating a visually oriented computer with the non-visual technology of a screen reader. As the visual feedback (through eyes) helps a sighted user to scan the entire interface, in the same way a screen reader can help a visually impaired user to get a sense of interface.

In the initial explorations, we have tested the commonly used interfaces like a text document, a file browser, a web-page, the desktop, and the evolution mail for navigation related issues using the screen reader Orca. The objective is to have a better understanding of the document navigation for a visually impaired user and to improve the screen reader interface to address the need of the vision impaired users. In this paper, our focus is on the navigation related requirements of vision impaired users, the available support using the screen reader Orca and providing solutions to some commonly reported navigation issues/gaps in the desktop environments.

### Screen Reader Support For Document Navigation

Compared with other assistive technologies, screen readers are the most common and inexpensive form of assistive technology used by the visually impaired persons. A screen reader software can substitute the monitor to some extent and enables a blind user to use a computer. A screen reader does not just read out the screen from top to bottom, but also helps the user to navigate the interface by telling the current position where s/he is, where to go next by giving the feedback about the current, next and previous navigable elements. A correct pre & post speech output given by a screen reader for an action on an element makes the navigation process easy & effective for a visually impaired user. Input devices such as a mouse and keyboard can be used to navigate on the user interface by clicking or keystrokes. Kevin J. mentioned [2], most of the screen readers support use of a mouse for navigating the interface, but they are basically designed for interaction via a keyboard. Visually impaired users generally use keyboard to navigate elements of any interface because they are unable to use mouse as using the mouse depends on visual feedback of the mouse pointer location. Every application has defined keys/key-combinations to navigate elements on that interface and in most of the applications, a screen reader generates related speech output. In addition to the general interface and speech specific shortcuts (like WhereAml), a screen reader also provides application specific keyboard shortcuts.

Any application software provides information to a screen reader through interfaces like AT-SPI (Assistive Technology Service Provider Interface). Screen readers rely on the underlying application to expose the details of a document, and do not look into their functionality, or see what is displayed on screen. And provides the available speech output for the element

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on focus. Mary F. mentioned [9], screen reader users scan an interface with their ears and the cognitive skill they have. For them, it is a must to get a good mental model of the assistive software as well as of the interface they are going to scan. In addition, the correct information provided by an application interface to a screen reader also minimizes the navigation efforts. Popular screen readers such as JAWS, Orca, Windows Eyes, NVDA are mature enough to work with the commonly used interfaces and applications for the basic operations. But many screens & applications are not designed to be compatible with a screen reader and blind users face challenges when attempting to access them.

### Issues With Document Navigation

We have explored different interfaces such as a text document, a web page, the desktop icon view, and the file browser for navigation using Orca on the GNOME desktop. Orca provides standard as well as application specific keyboard shortcuts to generate speech output and works reasonably fine with common interfaces. But sometimes it fails to give a proper speech output or feedback and the user feels lost on the current interface or it is difficult for the user to decide the next action. The reason may include a problem with screen reader output or may happen that an application does not provide the information required for navigation support to the screen reader. The following list includes some of the navigation related issues using Orca with different interfaces:

- There is no easy way to get a list of the available Orca keyboard shortcuts.
- A quick overview of a document is not available.
- A feature to navigate document by sentence is not available.
- The structural navigation feature is not available for word processor documents. This feature is available for web-pages. The structural navigation feature allows a user to quickly go to the previous/ next document element of a particular category. For example, a user can go to the previous/ next heading using H/Shift+H or go to the previous/ next table using T/ Shift+T.
- The navigator window in OO writer displays a document in the form of a tree of various elements like headings, tables, images etc and provides the facility to change the order of elements. But speech output is not provided on navigator window.
- There is no easy way of navigating through the icons on the desktop.
- PDF documents are not fully accessible using Orca.
- Multi-line text on form control label is not announced by Orca in web browser.

After a detailed analysis and exploration of various applications with Orca different reasons are found in reference to these issues. The reasons may include a communication gap between the application and the screen reader communication. That means information about the application feature is not fully or correctly exposed to the screen reader and as a result in the absence of correct information the screen reader may misguide the user. It may include the fault of the application development like s/w does not provide the accessible element so that user cannot access the information. Some of these navigational issues are addressed in detail in the coming section and possible solution with community acceptance is also included.



## Enhancing Orca For Document Navigation

Of the issues mentioned above, some are very small to resolve but are important to help in navigation process. Some of the issues may require to do more research to get the details to resolve. A few of them may require changes in application like the openoffice or x-window-desktop or browser application and few will be resolved by updating the concerned screen reader. Solutions may involve additional functionality to make the job easier or better use of an existing feature or to better expose the information for screen reader. Many of the above mentioned issues are already identified by the community and included in the to-do list. Following issues related the document navigation are addressed here in detail:

- List shortcuts: Application sensitive help to navigate interface
- Skim read: Document object navigation
- Navigation support for PDF document in HTML format

### a) List shortcuts: Application sensitive help to navigate interface

A user can open a file either by pressing the key sequence Alt+f, Down, Enter (to select File -> Open), or just by pressing the keyboard shortcut Ctrl+O. Keyboard shortcuts or hot keys expedite common operations by reducing long input sequences to a few keystrokes. To a visually disabled user who cannot use a mouse, they are invaluable! Knowing the correct shortcut in a given context is a must for using an application efficiently. But aren't there too many of them, at least for a new user? For example, Orca has 57 default shortcuts, 12 shortcuts for Open Office and 77 shortcuts for Firefox. If a user does not remember the keyboard shortcut for a particular function, she has to search the list of available shortcuts. To do so, she has to start the Orca Preferences dialog, go to the Key Bindings tab and navigate the list of key bindings by pressing the Down key. This takes at least 10 key-strokes to reach the first item in the list, and then one key-stroke per item. If there is a command to speak the list of available shortcuts, preferably with an option to get a context sensitive subset, this operation can be performed with only one or two key strokes. We have filed an enhancement request (Bug 616820) and enhanced Orca to add this feature. After a number of user feedbacks and patch revisions, the command has become a standard Orca feature from Orca 2.32.0 (Sep 2010) onwards.

It works like this. The user enters the 'List Shortcuts' mode by pressing Orca + H (double click). Pressing '1' lists Orca's default shortcuts. Pressing '2' lists Orca's shortcuts for the current application. The user can navigate and hear the listed shortcuts by pressing 'Up/Down', can toggle to the other group of shortcuts by pressing '1' or '2', or can exit by pressing 'Escape'. For the community feedback refer link [11].

### b) Skim read: Quick overview of document

Before reading a document containing a large quantity of text, the user may first want a quick overview. Or, having already read the document once, she may want to navigate quickly to a specific point she remembers. The "Say All" command in Orca reads the document from the current cursor position to the end. Orca provides another way of moving through the text, by using the Up/ Down arrow keys. Both these methods read each line encountered along the way. So they are not useful in quickly accessing a specific portion of the text and to get a "feel" of the whole document.

We have enhanced Orca to add the "Skim Read" feature ([Bug 577481](#)) to meet the above requirement. When a user issues "Skim Read" command (Ctrl + KP\_Add in desktop, Orca +

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Ctrl + semicolon in laptop), Orca skims through the entire document. It starts at the current line/ sentence, and then reads only the first line/ sentence of each subsequent paragraph. Whether it reads the lines or sentences depends on the Say All By setting. If the user presses the Ctrl key, then skim reading stops at the line/ sentence just read. The submitted patch was tested by many users and found to work satisfactorily with Open Office Word Processor, Evolution email client, Gedit text editor and Firefox web browser.

There are suggestions to make “Skim Read” a more versatile feature. Can it read all sentences/ lines containing given key words or text patterns? Can it read all table/ image captions? Also, Orca code has gone through a number of changes after the “Skim Read” patch was submitted. Therefore, the patch has to be rewritten with respect to the latest code. Thus, “Skim Read” will take some more time to become a standard Orca feature.

### c) Navigation support for PDF document in HTML format

Portable Document Format (PDF) is the most widely used format for document sharing. The biggest advantage of PDF is the page description language that makes it possible to display PDF identically on any computer system irrespective of the hardware or the operating system being used. The main requirement to make a PDF document more usable is the accessibility of the rendering software that should provide the content information to the assistive technology. Excluding the Adobe Acrobat with JAWS, no other PDF viewer is able to access PDF document fully. Alternate solutions like converting the PDF to text or HTML have many issues related with the display format and the content navigation.

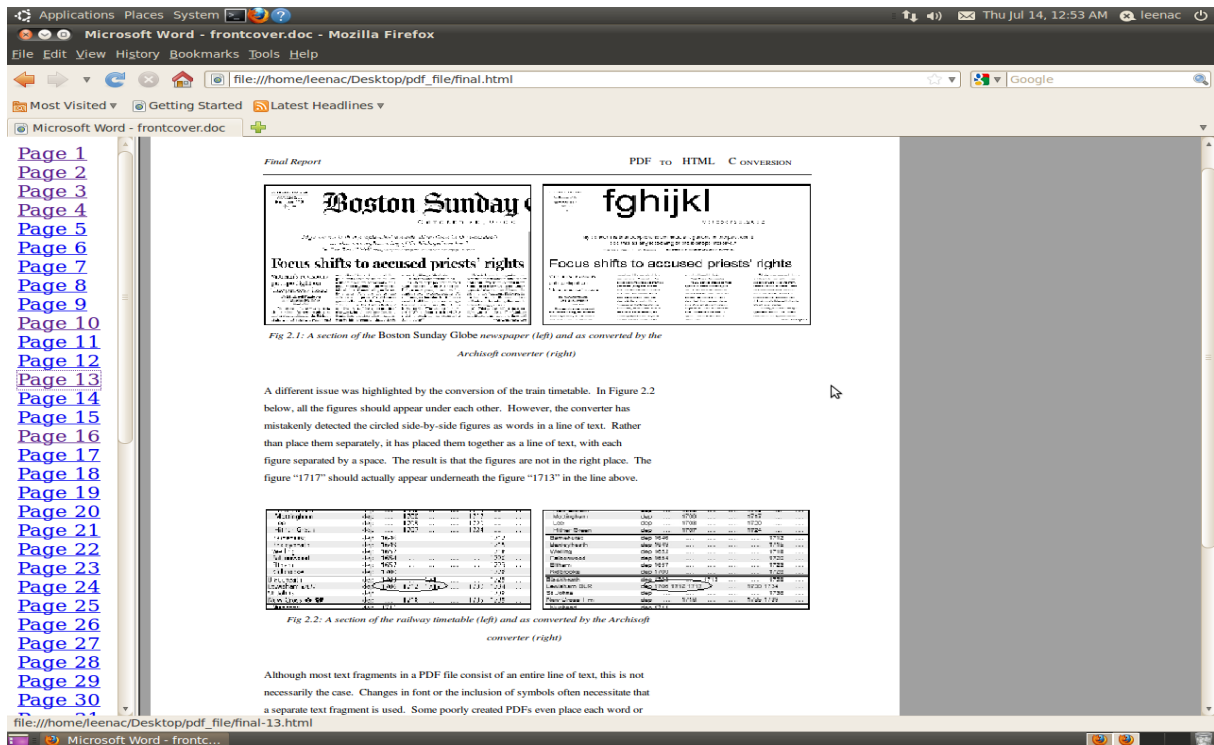
The complex output option of Poppler (an open source library) utility 'pdftohtml' converts each PDF page into a separate HTML page, with an image file per pdf page and other supporting files like an index file and an outline file. However this retains the format of the original PDF document in the HTML format too, and that has been tested for different formats like two column, doc with pictures/images, different font style, size and more. Using the main HTML file (see next Figure), it is possible to display the content in the side frame and to switch on the pages sequentially with the tab key. But it is not possible to navigate content in the content frame because the frame is not an accessible element and Orca is not reading the content. This problem is due to the issues of Orca with browser (Firefox).

Alternatively, the user has to open the corresponding HTML page in a separate tab of the same browser window or in different browser windows and the content is read by Orca. But navigating between multiple tabs/windows for a single document is confusing even for sighted user then how can a vision impaired user keep track of many tabs/windows. And identifying the required browser tab is very difficult if there are more than 3-4 pages in a pdf file because screen reader reads the same title for every tab as the name of pdf file.

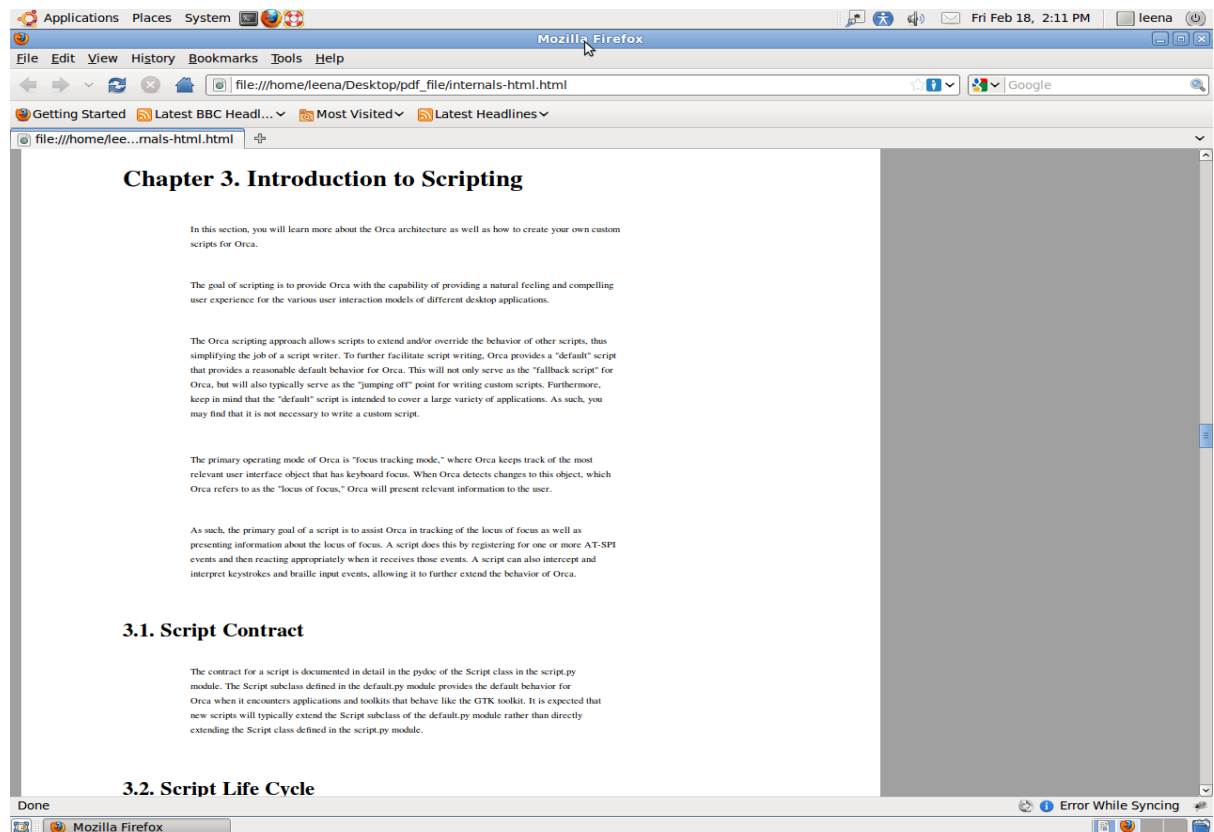
To resolve the navigation related issues, the 'pdftohtml' utility is enhanced to generate a single HTML file (see next Figure) for complete pdf document with number of pages. A user can navigate the pages in a sequential manner and can jump from one page to another page in a single browser tab/window using page up/down keys. If a visually impaired user faces problem to run this utility from command prompt then a user interface is also provided to make their work easier. Using this the resultant HTML file automatically opens in a separate browser window. This option reduces the navigation complexity on the required page and increases the accessibility of a PDF document. The concerned community has accepted this



step towards making a PDF document more accessible and as a result this enhancement is included in poppler-0.15.1 version. For the community feedback refer link [10].



### Index page for a PDF file



### Single html page corresponds to PDF file

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## Conclusion

A simple and easy navigation interface is crucial but important for making a document accessible specially for disabled users. While working with different interfaces with monitor less mode, we have also experienced that poorly designed interface can increase the navigation efforts for a vision impaired user. Developers should consider the navigation related requirements of the specially abled community too, that can increase the usability of the product. The modular approach of Orca code structure makes it quite easy to understand and modify Orca code as required. Therefore developers can easily contribute to Orca by fixing bugs or by making enhancements. Such efforts are well supported by the active community of Orca developers and users. Every small improvement will add to Orca utility. Individual package development community should also ensure that appropriate information is exposed for probing by Orca (and such applications), using supported APIs.

## Future Work

This paper discusses some issues related with the document navigation, that we have worked. Other navigation related issues like structural navigation support for the open office word processor or an easy navigation of the desktop icon view are in progress.

## Acknowledgement

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### 7.3. A Joint Force-Position Measurement System For Accessibility Quantification

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#### Abstract

This paper introduces the use of measuring both position and force in interacting with a touchscreen for neuromotor performances assessment. The system measures directly 2D position and force in interacting with images generated by an LCD. By means of those 'primitive' measurements it is possible to develop tests which estimate: reaction time, movement time, speed and accuracy, path deviation, jerk, dwelling time in target, contact force control parameters as a function of position, percentage of success in accomplishing different tasks, the root mean square errors in the previous parameters, their frequency content. About Cognitive aspects of human being it is possible to measure: Reaction Time, Attention and Memory. Estimation of those parameters is fundamental to enable the quantification of accessibility and usability of human interfaces. Furthermore, to our knowledge, such a system has not yet been implemented for this purpose, neither in the framework of computerized assessment tools, nor in standards.

#### Keywords

Touchscreen, Neuromotor Performance, Accessibility Quantification, Design For All.

#### Introduction

A large variety of motor disabilities have neuromuscular cause (e.g., diseases classified under the WHO ICD-10 G block, such as Parkinson's disease, Cerebral Palsy, Multiple Sclerosis etc.). These ultimately happen as reduced ability to control movements. Cardiovascular accidents such as stroke may also have similar effects.

From the functional point of view, several limitations can be observed, ranging from muscle tone functions to control of voluntary movements (such as bradikinesia, akinesia, apraxia, etc.), to involuntary movements (such as tremors, tics, etc.), to loss of sensations related to muscles and movements. These ultimately cause problems in interacting with products, services and environments encountered in all aspects of daily life. Those systems, intended for the consumer market and the workplace, should be designed to be accessible for all people including those with special requirements, such as older persons and persons with disabilities.

To assess human functions, a large number of clinical scales exist, specific for each disease. For example the Unified Parkinson's Disease Rating Scale [1-5], or the Gross Motion Function Measure [6,7] for Cerebral Palsy. However, clinical scales rely on the expertise of examiners, are disease related. For these reasons, several attempts have been made to use objective indicators that can be derived from measurements. Computerized assessment tools have been proposed in several types of motor disabilities.





For example, computerized spiral tests in Parkinson's disease are described in [8]-10]. In [9] wavelet transforms are used to process spiral data collected on a PDA, and to derive an overall "spiral score" which is found to agree with PD specialists scores. In [11], a protocol where an individual tracks a sinusoidal or pseudorandom target force is used to produce several indicators, later combined into a synthetic UPDRS-like score. A tool similar in concept to the Fitts's test is proposed in [12] which produces indicators related to accuracy, contact duration, tremor, movement time, irregularity, speed, etc.. For Stroke, paper [13] describes a series of computerized tests. These used a force-reflecting joystick, and were target acquisition tasks, tracking tasks, and disturbance rejection tasks. The collected data have been summarized in a number of performance metrics, concerning accuracy [14], smoothness [15], quickness, reaction time, etc.

We may classify basically four types of tests, depending on the type of task that is measured:

- 1) Point-to-point aiming tests, which assess movement time, reaction, time, dwelling time and accuracy of target achievement;
- 2) Continuous tracking tests, which assess motion jerkiness and tracking errors (both lateral and longitudinal deviations);
- 3) Hold tests, in which the ability to reject perturbation forces is assessed;
- 4) Force control tests, which measure the ability to achieve and control forces.

On the side of standards, ISO/IEC Guide 71 [35] introduces the concept that taking care of the needs of older persons and persons with disabilities is fundamental in developing relevant International Standards for products and services design.

Technical report ISO/TR 22411:2008 [36] presents ergonomics data and guidelines for applying ISO/IEC Guide 71. It provides ergonomics data and knowledge about human abilities like sensory, physical and cognitive, as well as guidance on the accessible design of products, services and environments.

In this framework it is possible to find data about hand/finger dexterity. Two subcategories that regard the interaction with a 2D interface are listed. One is "Data on hand steadiness", the other "Grip strength". Data about hand steadiness is defined as the minimum hole diameter of a plate through which a person can pass a pencil or needle without touching the edge. Results as a function of age are provided.

Computerized assessment tools have a deep connection with accessibility of many of the different products of everyday life. Accuracy, smoothness, quickness, reaction time are all related to the ability of the different users to interact with human machine interfaces. The principal mean of interaction is by the use of keyboards, fingerboards, touch panels etc. In all these cases both finger position and touch force are fundamental. Unfortunately, almost all of the computerized assessment tools are able to characterize position parameters like accuracy, movement time, smoothness etc. and force parameters separately, i.e. without considering position-force coordination issues.

On the other side, the ISO/TR 22411 give some data about the accuracy in controlling the hand position but, for example, does not consider limbs coordination for trajectory tracking

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with the related motion jerkiness and tracking errors. Furthermore, grip strength data are given only for maximal-effort contraction in clench grip that uses all fingers wrapped around the controlled object. Data regarding the ability to achieve and control different level of forces are also lacking. (finger force?)

For the above reason we developed the Force Panel, a system which is able to measure simultaneously 2D position and force in the interaction with images generated by an LCD. By means of those 'primitive' measurements it is possible to implement extended tests already existing in the literature or develop new ones extending the parameters under consideration. In addition, with this instrument, it is also possible to design something very similar to the actual interfaces and record all relevant parameters with real users.

### Computerized Systems And Tests Commonly Used

The Fitts' law [17], proposed by Paul Fitts in 1954 [18], is a heuristic model of human movement which describes the time required to move to a target area as a function of the distance to and the size of the target. Fitts' law is used to model the act of pointing, either by physically touching an object with a hand or finger, or virtually, by pointing to an object on a computer display using a pointing device. The resulting model of the Fitts' law is inherently linked to the aim of minimizing the final positional variance for the specified movement duration and/or to minimize the movement duration for a specified final positional variance determined by the task. Fitts' law has been used to assess functional disabilities in point-to-point aiming tasks in a large number of diseases [19] -[31] . A number of variations, which measure different aspects of aiming tasks, have been proposed. For example, the Eurythmokinometer (EKM)[12], or the Advanced Sensing for Assessment of Parkinson's disease (ASAP) [11]. Examples of continuous tracking tasks and hold tasks in the context of rehabilitation from Stroke are given in [13]. Lastly, an example of force control using a isometric joystick in a target acquisition task is described in [32].

A purely handling test is also possible. Paper [20] reports a test that aimed to analyze the movements in childhood dystonia. The equipment of the test consisted of buttons of different sizes that the subjects attempted to contact with the finger tip. The outcome measure was the movement speed, in order to evaluate the Fitt's Law parameters.

Paper [9] is inherent the assessment of impairments in Parkinson's disease. The test consisted of a continuous tracking task and a series of point-to-point motion tasks. These tests were implemented on pocket PC device with 3.5" touch screen with 240x320 dots resolution. The analysis was based on both speed and accuracy in the execution of the tasks.

Paper [19] aimed at measuring the Fitt's Law parameters in children with congenital spastic hemiplegia, through the use of an LCD screen to implement a tapping test. The patients had a real object (a puppet) in their hands, rather than using the fingertip, to contact the targets as quickly and as accurately as possible, while the experimental setup recorded the XY coordinates of the moving object.

Paper [22] compared an isometric and a position joystick (again focusing on position vs. force control) in a point-to-point motion task, for people affected by cerebral Palsy.

Paper [13] presented a procedure for the assessment of upper-extremity stroke, through the use of a joystick in continuous tracking tasks under force perturbation.

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For the assessment of the Parkinson's disease, paper [11] proposed a protocol in which the patients tried to modulate the pinch strength exerted by their fingers in order to track a target waveform.

These examples show that position skills and force are intertwined.

In this study we thus investigate a system that measures at the same time 2D position and force in interacting with images, through the use of a 15" LCD touch screen display, mounted on three force sensors. The outcomes measures are basically: the response time interacting with the panel, fingers 2D position and its repeatability/accuracy, hand/fingers contact force.

The cited studies laid down the methods for developing kinematic and force control metrics. However the kinematic indicators were not correlated with the exerted strengths. On the other hand robotic systems (such as the cited Ameo) could produce simultaneous force-position measurements, but the cost and dimensions of this kind of technology seems to limit its large diffusion, particularly for the home rehabilitation domain.

Besides the indicators listed in the cited papers, since kinematic and force measures could be obtained simultaneously, the system proposed in this study permitted to infer relations between the kinematic parameters and the exerted strength. For example, by means of "Space-Force tracking tasks", the patients are asked to track a semi-random trajectory while keeping contact force as constant as possible. The measured parameters are the simultaneous deviation in force and position along the displayed path. Moreover, this kind of tasks is also suitable for rehabilitation purposes of impaired people.

More sophisticated large robotic systems, allow kinematic and force measures in 3D with the hand in grasp configuration that through virtual reality gives the impression of interacting with objects. This equipment permits to estimate the attributes of direct touch interaction with a 2D interface, furthermore its reduced dimensions and cost make the system suitable for home setting rehabilitation and for portable purposes.

### Description Of The Proposed System

The proposed apparatus is able to display trajectories and targets to the user, to acquire a touch position and force. Its main components are:

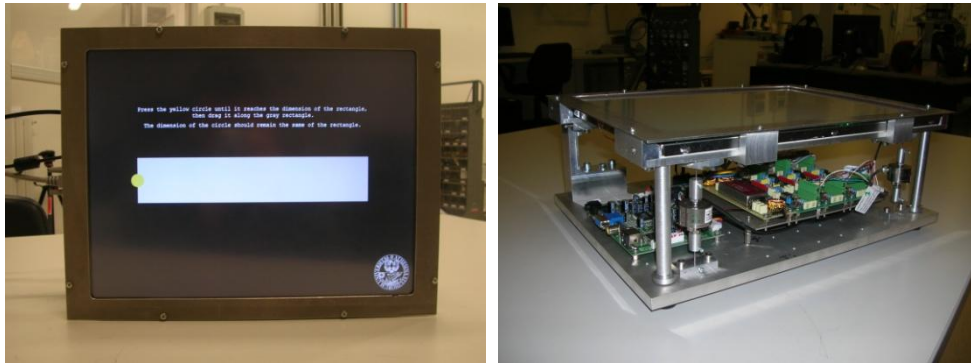
- a PC to compute the image displayed on the LCD;
- an embedded system that drives the LCD, reads the three force sensors and send data to the PC;
- three force sensors and conditioning electronics;
- a touch panel in front of the LCD.

The idea to measure the force in interacting with a panel is not new. Actually this came even before the touch screen technology because, by measuring three restraint forces, it is possible to estimate the touch position. In this way it is possible to make a piece of stone or whichever solid material a touch panel

[[http://www.google.com/patents/about?id=NFB\\_AAAAEBAJ](http://www.google.com/patents/about?id=NFB_AAAAEBAJ)]. But, when resistive and, more significantly, capacitive touch technology provided a better accuracy and stability of the touch position, the force method was no more pursued except in special applications.

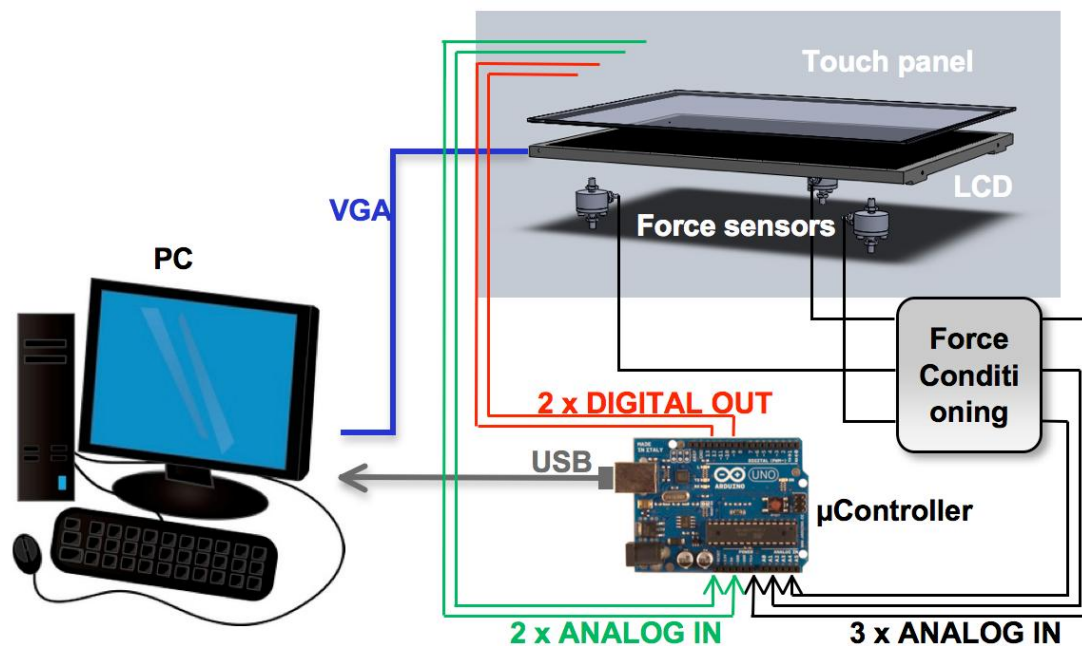


The Figure below shows the assembled system. The LCD is mounted onto the base by means of three load cells that measure the contact force modulus and position. The electronic drivers of the LCD and the force transducers conditioning system are hosted under the screen.



**Instrument view from the user perspective and instrument side view.**

In next Figure it is shown the relations between the principal modules. Both the touch and the transducers are driven and acquired by the embedded system while the PC control the LCD to generate the images for the user interaction while, via USB, the touch and force intensity are acquired and the screen, whose appearance depend upon these parameters, updated.



**Functional connections between the principal modules.**

The software developed for the described test has three parallel tasks, one of which runs on the embedded system, while the other two execute on the PC.

The embedded system acquires the touch panel and the force transducers analog signals, converts them to digital signals and sends the results to the PC, which converts the values

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into position and force quantities. The second task of the PC manages the LCD appearance, and, at the same time, elaborates and stores data.

The Force Panel has a spatial resolution of 0.4 mm with an accuracy of  $\pm 1.8$  mm. The system composed by the force transducers operates with a resolution of 0.05 N while its accuracy is  $\pm 0.1$  N. The maximum working frequency is 100 Hz, limited by capacitive effects of the resistive touch panel.

### Tests That Have Been Implemented

The system novelty is its ability to add the possibility to measure the force to the position of the touch in interacting with images generated by the LCD. Therefore 2D position and force can be measured simultaneously as a function of time thus extracting its time and frequency attributes and correlations.

By means of those parameters it is possible to develop tests by which is possible to estimate the accessibility of human interfaces.

In the following a synthesis of the tests already implemented on the platform, the corresponding measurable quantities and accessibility features that can be extracted:

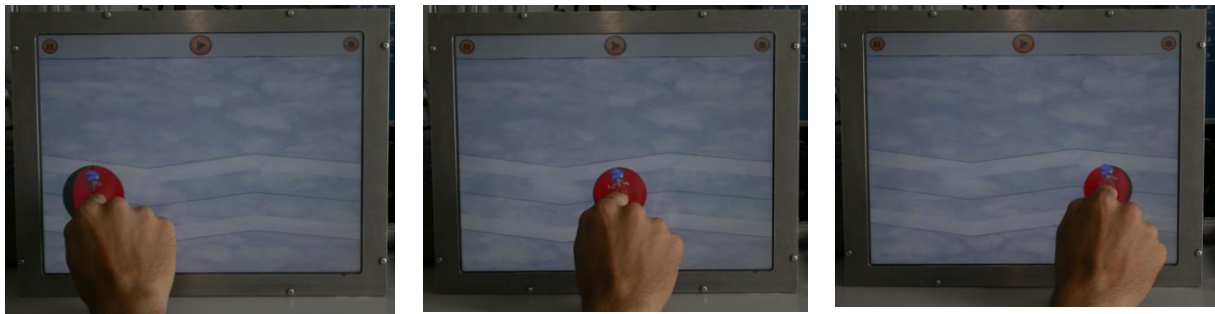
- Point to point motion task allow to estimate reaction time, movement time, path deviation in point to point motion, movement speed, peak speed number, dwelling Percentage Time in Target, percentage of success. This kind of test allows to estimate the accessibility of interfaces structured in discrete items that must be reached and hold for a predefined timeframe. A keyboard can be one example.
- Continuous tracking tasks allow to estimate percentage time in target (PTT) , root Mean Square Error (RMSE), deviation to trajectory, mean speed, standard deviation speed. This kind of test allows to estimate the accessibility of interfaces that require to follow continuous paths. A drag and drop touch sequence can be one example.
- Human Transfer Function allows to estimate gain, cut frequency, delay, noise RMS and PSD. Those parameters allow the gesture simulation of human interaction.
- Space-Force tracking tasks allow to estimate position MSE, force MSE and its spectral contents. This kind of test allows to estimate the accessibility of interfaces that require to control simultaneously force and position.
- Fitt's law allow to estimate reaction time and the index of performance. This kind of test allows to estimate the accessibility of interfaces that require to reach predefined locations while optimising movement time and accuracy. A series of buttons to configure or control an instrument can be one example. This test was developed for military aircraft interface design.

### Position and Force path assessment

A test to assess the ability to control the force and the position simultaneously has been implemented as follows. A path and a circle are shown as in next Figure. The circle follows the touch position and its diameter is proportional to the force applied by the subject. The goal is to drag the circle onto the specified path while controlling the force so that the circle diameter is as close as possible to the width of the path. In other words the subject is facing a simultaneous position-force control tracking task.

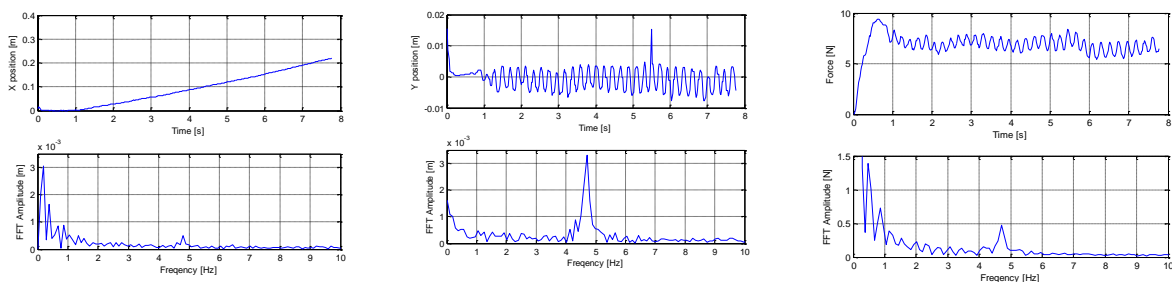


The data acquired during the experiment (time, position and force) are analyzed to extract path deviations and speed and their frequency content via FFT or Welch analysis.



**A short sequence of the test. The middle line sets the starting position in its left side and the end position at its right side. The force value setpoint is defined by the width of the upper with respect to the lower line. The circle follows the touch position and its radius is directly proportional to the exerted force and must follow the shadow band while moving the finger along the path.**

A technical test with an able-bodied people voluntarily simulating a tremor in position superimposed to the reference path was carried out. The following figures show the horizontal and vertical position of the contact point and the applied force.



**From left horizontal position as a function of time and the FFT of its de-trended signal. Vertical deviation as a function of time and its FFT. Force as a function of time and its FFT.**

In the recordings of horizontal motion, vertical deviation and force, shown in above Figure, it is evident a frequency content at 4.7 Hz that indicates a strong correlation between those parameters while controlling simultaneously a desired path and a desired force setpoint.

### Fitt's law

In executing the task, subjects are asked to touch as fast and accurate as possible two circular markers. The 'starting' marker is white and has always the same dimension, the 'final' marker is red and has randomly variable dimension and distance from the previous one. In order to achieve a statistically meaningful number of data at least 28 iterations are repeated.

The main criteria of trajectory planning is to minimise the variance of the limb's position. Variance is due to noise in the neural control signal (i.e. in the firing of motor neurons) that causes trajectories to deviate from the desired path. These deviations, accumulated over the duration of a movement, lead to variability in the final position. Noise in the neural control signal increases with the mean level of its signal.

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This explanation of signal-dependent noise is consistent with psychophysical observations that the variability of motor errors increases with the magnitude and the velocity of the movement, as captured by the empirical Fitt's law.

In the presence of such signal-dependent noise, moving as rapidly as possible requires large control signals, which would increase the variability in the final position. As the resulting inaccuracy of the movement may lead to task failure or require further corrective movements, moving very fast becomes counterproductive. Accuracy could be improved by having low control signals, but the movement will be slow.

Thus, signal dependent noise inherently imposes a trade-off between movement duration and terminal accuracy. The key point is that, for a given amplitude and duration of movement, the final positional variance will depend critically on the actual neural commands and the subsequent velocity profile. For these reasons the temporal profile of the neural command is selected so as to minimize the final positional variance for the specified movement duration, or equivalently to minimize the movement duration for a specified final positional variance determined by the task [34].



**Example of an interaction sequence for the test of the Fitt's law.**

The Fitts's law, proposed by Paul Fitts in 1954 [18], is a heuristic model of human movement in human interaction and ergonomics which models the time required to move to a target area as a function of the distance to and the size of the target. Fitts's law is used to model the act of pointing, either by physically touching an object with a hand or finger, or virtually, by pointing to an object on a computer display using a pointing device.

According to Fitts' Law, the time to move and point to a target of width  $W$  at a distance  $A$  is a logarithmic function of the spatial relative error ( $A/W$ ), that is  $MT = a + b \log_2(2A/W + c)$ .

Where:

- $MT$  is the movement time;
- $a$  and  $b$  are empirically determined constants, that are device dependent;
- $c$  is constant and equal to 1;
- $A$  is the distance (or amplitude) of movement from start to target centre;
- $W$  is the width of the target, which corresponds to accuracy.

The term  $\log_2(2A/W + c)$  is called the index of difficulty (ID). It describes the difficulty of the motor tasks.  $1/b$  is also called the index of performance (IP), and measures the information capacity of the human motor system in bit/s.



Mathematically interpreted, Fitts' Law is a linear regression model. The regression coefficients are 'a' the intercept and 'b' the slope ( $1/b$  is the index of performance (IP)).

Fitts' law has proven to perform well for a variety of limb and muscle groups like wrist flexion and rotation, finger manipulation, foot tapping, arm extension and head movements [17]. For this reason can give a quantification of interfaces accessibility and meaningful criteria for their design.

## Conclusions

It was introduced a system that adds the measurement of force to the usual touchscreen already available in several instruments that assess HMI. The system measures directly 2D position and force in interacting with images generated by an LCD. By means of those 'primitive' measurements it is possible to develop tests able to estimate position and force parameters simultaneously. This certainly fills the gap open both from the point of view of computerized assessment tools already available and current ISO standards.

Details and experimental data about two tests, the Position and Force path assessment and the Fitt's law, are provided. Acquired data clearly show a strong correlation between path and force control of human gesture.

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## 7.4. Vision For Assistive Technologies

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### Abstract

Computer Vision is a promising technology for new Assistive Technology (AT) solutions, because vision based tracking of body features enables computer usage, interaction with the environment and new skills acquisition by people with severe impairments by a non-invasive technique. An important objective of the AsTeRICS project is the development of scalable and adaptable computer vision based interaction techniques which can be tailored to the individual needs of end-users. This paper proposes an overview of the existing vision technologies for upper limb motor impaired and outlines vision technology developments and strategies in AsTeRICS.

### Keywords

Vision Technology, Eye /Gaze Tracker, Interaction, Computer Vision, AT For Upper Limb Motor Impaired.

### Interaction And Human Capabilities

Interaction is a key concept of our modern societies. Based on human intention, it can involve different actors, real or virtual, objects and ubiquitous computing environments. In other words, interaction offers the accessibility to all computer based ICT solutions, allows new skills acquisition and development, leads to new communication modes elaboration such as ART (Attention-based Responsive Technology) and multimodal paradigms.

Today, newly developed assistive technologies (AT) consider a mix of human capabilities not integrated in classic interactive tools, such as brain physiological signals (BCI), brain plasticity or visual perception, and more complex “pure” technological means such as haptic or tactile, robots, orthotics and computer vision.

In this work, we propose a mix to support one of the basic interaction operations: pointing.

The rest of the paper is organised as follows: Section 2 overviews vision techniques for AT and several academic and industrial prototypes. Section 3 outlines the contributions of the FP7 ICT project AsTeRICS (Assistive Technology Rapid Integration and Construction Set) to computer vision based AT design, while Section 4 addresses the expected impact of the presented solutions for the end users. Section 5 concludes the paper and proposes some extensions of the on-going research and developments.

### Vision Based Technologies For Interaction With Pointing

The pointing operation in the case of healthy subjects means usually the designation of an object by mediation of the arm, hand and sight; aligned sight and arm form a “natural pointer”.



The natural pointing operation is usually performed in two steps:

- pointed object localization in space and identification via sight (point of regard, PoR, “touches” the object);
- arm/hand lifting for /physical or virtual (distal) “touch” of the object (in the PoR).

In the case of upper limb impairments the second step should be executed by other means. Indeed, other body parts should be used for object touching. In this section we present some pre-prototypes that investigate also new alternatives to natural pointing for upper limb motor impaired through different body parts (finger, limbs, shoulder, elbow, head and face, eye and gaze). From the design point of view, almost all of the investigated systems use image and vision processing for targeted body part(s) detection and tracking, and for mouse different operation simulation. For further details please refer to provided bibliography, as here we present only the system functions for end-user interactions.

**Finger as a pointer:** the Ishikawa Komuro Laboratory from University of Tokyo [1] has realised a system which implements the concept of a distal touch: fingertip spatial movements are interpreted as different gestures linked to a usage of a standard mouse [2].

Fingers are detected with a single high-frame-rate optical camera attached to a portable device (named “In-air typing system”) having a small (PDA-size) screen (see below Figure). Through convenient image and vision processing, this device can simulate operations of a standard PC mouse classic operations such as: mouse spatial displacements (by tracking the fingers) and mouse click (by dwell time).



**Distal touch typing system (University of Tokyo)**

**Limb as a pointer:** the University of Southern California [3] works on a system which uses the concept of a pictorial structure (not fully connect graph) [4] to represent the investigated part of the human body. The system detects and tracks in the acquired images the human upper limbs (a tree structure) in the acquired images from a monocular video stream. A combinatorial exploitation of the solution space over affine transforms and scales is guided by body-global model. The limb tracking is optimized via the gradient-descent approach [5].

**Shoulder and elbow as a pointer:** in the frame of EU 6th FWP IST IP AMI, University of Twente has proposed an approach oriented at the estimation and recognition of poses [6] which generalizes detection of different body parts, and in particular different limb sections



(shoulder, elbow) proposed in [7]. The system detects and tracks human limbs from video monocular stream. A combination of image descriptors (edges, skin colour and texture, motion, etc.) is used in order to make the detection most robust.

**Face and head as a pointer:** Different facial features such as nose, global face, eyebrows, and their combination, etc., are commonly used for man-computer interaction. Frequently, the targeted feature is detected in acquired images during the calibration, and tracked during the interaction. All mouse functionalities can be emulated by exploiting the detection and tracking of facial features; for example the mouse spatial displacements can be deduced from nose/head/eyebrows movements, while the mouse click (or object selection) is implemented through the (left or right) eye double blinks or through dwell time. Any other combination is possible though, depending on the skills or the user needs. For example in [8] [9] and rely on the tracking of nose and eyes for interfacing a drawing software while [11] [12] also integrate several mouth gestures to encode interaction commands.

**Eye and gaze as a pointer:** object selection via gaze is a fundamental interaction modality, as the gaze position anticipates and finally allows, an action execution on the gazed object. The gaze based interaction is one of the most promising interaction and accessibility methods for upper limb motor impaired [13] [14] [15].

In general, two configurations for eye- and gaze trackers are possible: remote eye trackers and head-mounted eye trackers; see below Figure.



**Gaze tracker: wearable (head mounted, Rochester Inst.) on the left and remote on the right.**

The main advantage of remote systems is that no devices or sensors have to be mounted on the subject's body, which may increase the comfort for the users, especially in long-term use. The main advantage of the head-mounted systems is that eye movements can be measured with high accuracy and that gaze-estimation in natural viewing context becomes possible while remote eye trackers are not well suited for applications where mobility is predominant; in fact, remote systems usually restrict the interaction space to the surface of a monitor.



Even if there has been always significant interest in remote eye tracking, head-mounted eye tracking systems are experiencing a renaissance due to new challenges [16]. There are several configurations that depend on the application scenario. Usually they are built around at least two cameras purposely placed on the head, where one observes the scene in front of the user and the other(s) track the movements of one eye (or both eyes).

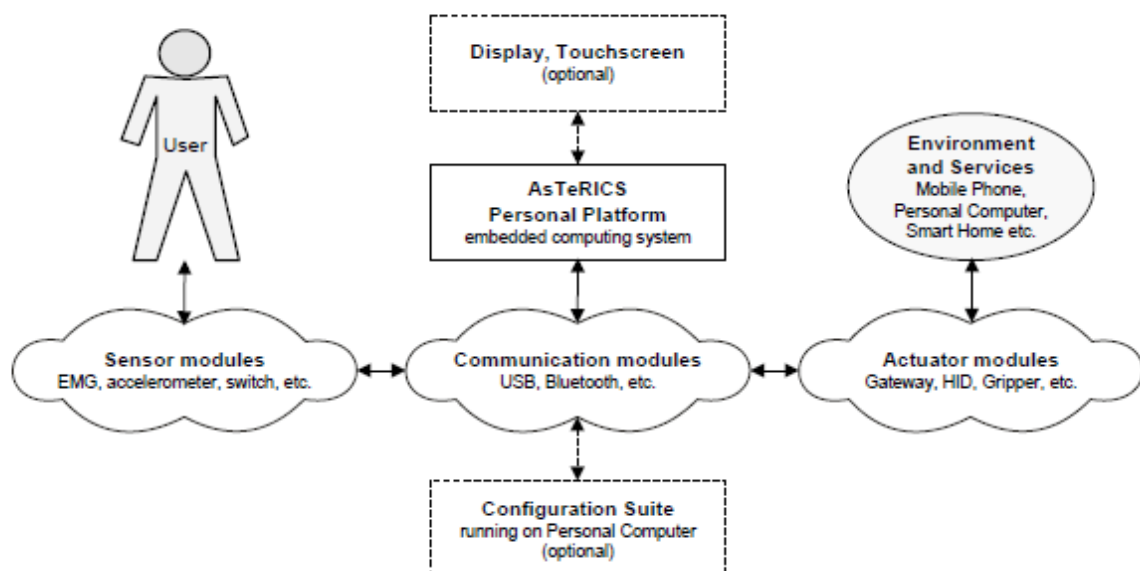
In order to work precisely, the system must be calibrated to establish the mapping between eye-movements and the projection of the gazed point on the scene camera, thus opening the possibility to interact virtually with all the space in the field of view of the subject.

Environmental control is probably the domain in which a wearable system for gaze tracking could be fully exploited.

In specific cases where the interaction is restricted to a monitor and the user has limited motor capacities, it is possible to develop assistive applications using information solely from the eye-tracking cameras. The EyeWriter [17] initiative is an example of a wearable eye-tracker system, demonstrating its potentiality through a graphic drawing application driven by eye movements.

### AsTeRICS Project Contribution To Vision Technology Design

The AsTeRICS project aims at the design of an adaptable and scalable system supporting also unconventional peripherals (BCI, vision, etc.) for people with severely reduced motor capabilities interactions and at the evaluation with primary and secondary users. The fundamental parts of the AsTeRICS system are the AsTeRICS Runtime Environment (ARE), which allows the execution of plugins for sensors, processing components and actuators, and the AsTeRICS Configuration Suite (ACS), which allows to model a combination of existing plugins, in order to link to end-user specific equipment and to his/her interaction needs (see Figure below).



**AsTeRICS concept**

In the frame of AsTeRICS both wearable and remote systems are being pursued to support face and gaze based interactions:

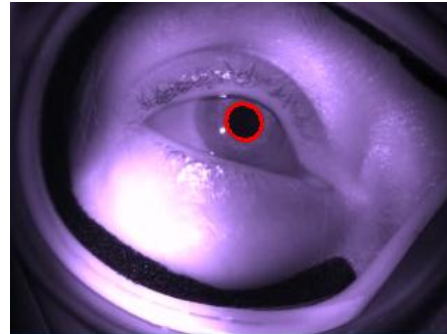
Also available via the conference website [www.aegis-conference.eu](http://www.aegis-conference.eu)



Wearable gaze tracker: although infrared lighting is a ubiquitous technique in eye-tracking applications for enhancing the contrast of the image of the eye, there are still no clear safety guidelines in the case of long-term exposition [23]. For this reason, AsTeRICS is considering both, infrared and visible light approaches in order to cope with different operational needs. Below Figure shows on the left the result of Iris tracking in visible light [18] while on the right an instance of pupil tracking with IR illumination [19].



Left: Iris detection performed in visible lighting.



Right: IR based pupil detection.

Below Figure outlines the targeted lightweight head-mounted gaze tracker as a peripheral for a system supporting different interaction modes which can be configured in the ACS.



Pre-prototypes of the AsTeRICS low cost gaze tracker.

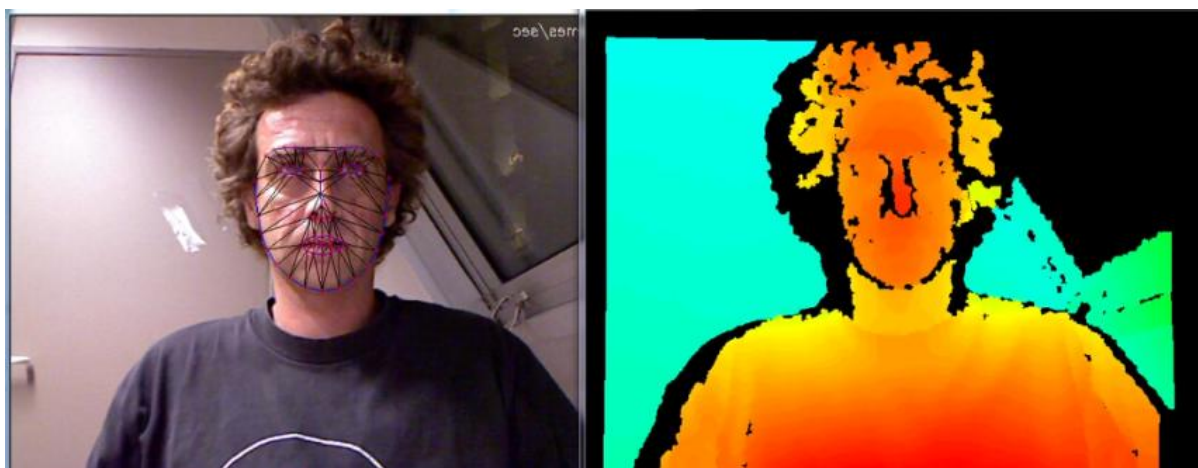
The gaze tracker will be adjustable to the end-user anatomy (head size, distance eye/camera, etc.) and specific needs (small-amplitude head movements compensation, easy to wear, precision of detection compatible with targeted skills for interaction, etc.). It will incorporate also different structuring elements such as hot-mirrors or telescopic arms depending on the presence of IR emitters and will be equipped with multiple combinations of sensors coping with different capabilities and interaction complexities. The foreseen combinations are: a three camera system using only visible lighting for full gaze tracking in 3d-space (aimed at environmental control applications); a 'minimal' set with only one IR eye-camera and a custom PCB integrating an IR tracker, a gyroscope and a Sip/Puff sensor. The latter system will be used for supporting eye-movements interaction with a computer monitor coupled with a range of actuators driven by the sip/puff sensor.

Remote head/gesture tracker: For simple interaction purposes via head pose on low performance computing platforms, a nose- and chin-tracking procedure using normal



webcams has been designed. This algorithm uses a cascade of Haar-like features [20] and the Lukas Kanade Optical flow [21] tracking. The tracked coordinates can be used for mouse simulation (mouse displacements and an object selection/clicking).

The encoding of more complex facial expressions is being developed with the support of deformable models for the face [22] (Active shape models or ASM). Deformable Active shape models (ASM) use meaningful labelled data to allow precise and efficient tracking of a sparse set of facial locations, see below Figure (left). The integration of ASM with the 3D point cloud delivered by the Microsoft Kinect 3d-sensor will enable the tracking of gestures in a three dimensional space, below Figure (right).



**Left:example of ASM detection and tracking and (right )3D landmark detection.**

It is crucial to highlight that the AsTeRICS construction set supports a wide range of user input and actuators (switches, grippers etc.) that can be integrated with the vision-based system via the ACS, thus tailoring the interaction scheme to the specific end-user needs and capabilities and giving the possibility to explore completely new sensor combinations for human-computer interaction.

### Results Of First User Evaluations

During the first qualitative user evaluations of the AsTeRICS system (prototype 1, June-August 2011), different sensors and sensor-combinations have been tested with 50 users in Austria, Poland and Spain. The remote (webcamera-based) system was already available for these tests and reached the highest level of acceptance in the evaluations of users with given fine motor control of the head.

For this system type, spasms and involuntary head movements represented a big problem, preventing precise pointing or computer mouse control. In the upcoming development stages of AsTeRICS, we will try to find solutions for these problems by applying tremor reduction algorithms and evaluation of the head mounted eye tracker.

### Conclusion





Vision technology has without a doubt a vast impact on the quality of life, in particular of people with motor disabilities, as it can offers new interaction modes to access ICT and internet-based services (games, e-library, e-shopping, e-health, e-rehabilitation, e-learning, etc.) Smart environments provide the infrastructure for gaze interaction with environmental control systems, for example lighting control, heating/ventilation or usage of home entertainment devices. Moreover, new skills acquisition (such as navigation in virtual worlds) becomes possible through training, increasing the opportunities to interact with the outside. Therefore, vision technology development for gaze tracking, attention based technologies and learning of new skills remains a promising direction for future research. In the second phase of the AsTeRICS project, the head-mounted gaze estimation system will be finished, and both, the remote and the head-mounted solution, will be evaluated in qualitative and quantitative user tests.

### Acknowledgement

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## 7.5. Graphic Symbol Support In Open/LibreOffice Shaping Up Graphic Symbol Server And Inline Symbol Font Display Based On The CCF

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### Abstract

The requirements for a CCF Symbol Support extension for OpenOffice Writer, for a range of users with difficulties to access text content, were defined in the original user needs studies of the AEGIS project, and were further refined after feedback from the first user pilot testing. These requirements are basically supported in the second alpha version, including: Introduction of a stand-alone CCF Symbol Server, full symbol representation above words using Ruby Annotation [1] format and symbol fonts, added tools to handle ambiguous word-to-concept/symbol matches, etc. Plans for further enhancements for the final version of the extension will be discussed.

### Keywords

Accessibility, AAC, Cognitive Support, Literacy, OpenOffice, LibreOffice, AEGIS

### Background

The graphic symbol support extension for OpenOffice/LibreOffice Writer [2] [3], built on the CCF (Concept Coding Framework) [4], has been further developed into a second alpha version ready for the second round of user pilot testing within the AEGIS project [5] in June – September 2011. The extension is now also ready for wider public display and feedback as part of the Open Source software repository of AEGIS.

Providing graphic symbol support for literacy development and access to text content in an open source cross-platform office suite, is a part of the AEGIS ambition to include people with cognitive difficulties in the efforts towards more general accessibility in standard ICT environments.

The results from the pilot testing of the first alpha version confirmed and emphasized previous experiences of the varying needs between different potential target user groups, leading to a range of preferences for the implementation and presentation of the graphic symbol support. The basic functionality of the first version of the symbol support was appreciated by the pilot testers as a promising start but, as expected, not fully satisfactory for any of the target user needs. These may be divided into three major groups:

- The needs of struggling text users to support and confirm comprehension while writing and reading text, often in combination with text-to-speech (TTS) support. These users may typically not prefer full symbol representation and display within text, but will choose to use symbol support on-demand in a side display alongside a text document.



- The needs of AAC (Augmentative and Alternative Communication) symbol users to have access to full symbol representation (as far as possible) with symbols displayed on top of each word (or multi-word phrase). This is especially for writing symbol (with text) documents – with the help of an on-screen symbol display to select and input words/symbols to a Writer document – but sometimes also to read texts transferred into symbol with text documents. These users will typically use TTS together with the symbol support, and may prefer to rely on occasional symbol support alongside the text while reading with the TTS.
- The needs of helpers (parents, teachers, therapists etc.) to support the above needs by preparing and presenting documents with graphic symbol support. These helpers will adapt to the preferences of their target users, and may also prefer to have access to symbols displayed as graphics as part of the text, allowing them to move these graphics around in custom layouts.

These requirements are now all basically supported in the second alpha version, and will be described in more detail below. The major enhancements include:

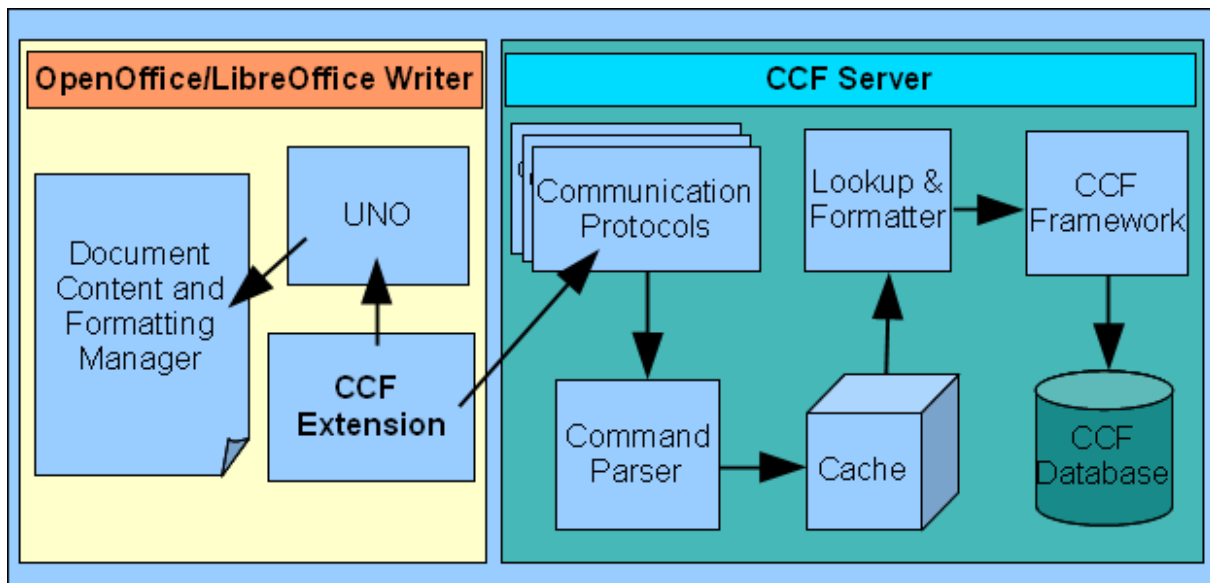
- Introduction of a CCF Symbol Server that runs locally on the system. It is currently only serving the CCF Symbol Support extension within OpenOffice or LibreOffice Writer, but will in the future serve other clients requesting graphical symbol or other alternative language representation support, such as an on-screen symbol selection chart. (This same CCF Symbol Server is already also used as an on-line cloud server for the Android mobile AAC app that is being developed within AEGIS in parallel with the desktop application presented here – see some more information on pp 11 - 12.)
- Optional full symbol representation above words, using the Ruby Annotation format and added graphical symbol fonts – currently for Blissymbolics [6] and ARASAAC[7] symbols
- The user can now handle ambiguous word-to-concept/symbol matches and incorrect representations within the text by selecting an alternative symbol, offered by the CCF Symbol Server, using a shortcut key command.
- Faster word-concept-symbol lookup by employing cached data.

Further enhancements of the user interface as well as the basic language support for the final version, are now incrementally implemented, in interaction with the results from the continuous pilot testing. Some preliminary plans will be discussed below.

## Description Of Software

The current version of the CCF Symbol Support for OpenOffice/LibreOffice Writer consists of two main parts: 1) the CCF Symbol Server application (with its language and symbol database resources), and 2) the CCF Symbol Support Extension for Writer (See Figure below).





**Block diagram over the relation between the CCF Symbol Support extension for OO/LOWriter and the CCF Symbol Server**

As shown in above Figure, the Writer Symbol Support extension sends requests for concept IDs and graphic symbol representations for words (currently in English and Swedish) to the CCF server. The server first looks in its cache for the requested word. The CCF cache consists of 1) a "white cache" for previously found word-ConceptCode-representation triplets, and 2) a "black cache" for previously looked up words without a found ConceptCode and symbol representation match. For new not previously looked up words the CCF Server passes the word lookup request on, via a "Lookup and Formatter" layer to the CCF and a search in the local CCF Apache Derby database. If one or more ConceptCode matches are found for the word, they are sent back to the Writer extension together with the corresponding symbol representation references. The CCF symbol server is currently only serving the OO/LO Writer CCF Symbol Support extension. It will in the future serve other clients requesting graphic symbol and other alternative representation support, either as a local or online service. It is already applied as an online service for the Android AAC app that is being developed within AEGIS, and is also planned to be applied for enhanced CCF empowered on-screen symbol selection charts in an updated version of the open source on-screen keyboard tool "Special Access to Windows" (SAW) [8].

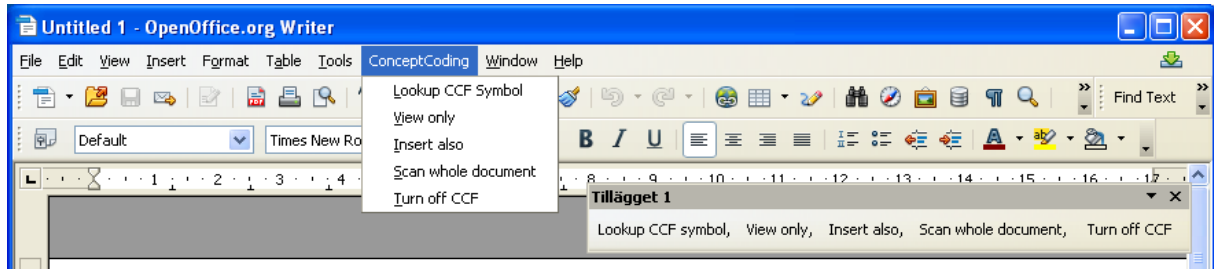
The CCF Symbol Support is (in principle) available for all platforms where OpenOffice or LibreOffice are supported. This is however so far only well tested for the Windows (XP or later) and Mac OS X platforms. When the package is installed on a system, the CCF Symbol Server is placed in the user's home directory, and the Writer extension is placed on the desktop, together with two private area Unicode symbol font files containing the Blissymbol and ARASAAC symbol libraries for display within/above text in Writer. The font files need to be added to the system's font library, and the extension needs to be registered via the Open/LibreOffice Extension Manager. Additionally, the CCF Symbol Server is a Java program that requires Java 6.x to be installed on the system.

When the CCF extension is registered it adds a menu item "ConceptCoding" to the menu bar, and a ToolBar button field, in Open/LibreOffice Writer, each with five items; "Lookup



CCF Symbol”, “View only”, “Insert also”, “Scan whole document” and “Turn off CCF” – see the screen snapshot image in Figure below.

The CCF Symbol Server should be started and running in parallel with Writer for the symbol support extension to be functional.

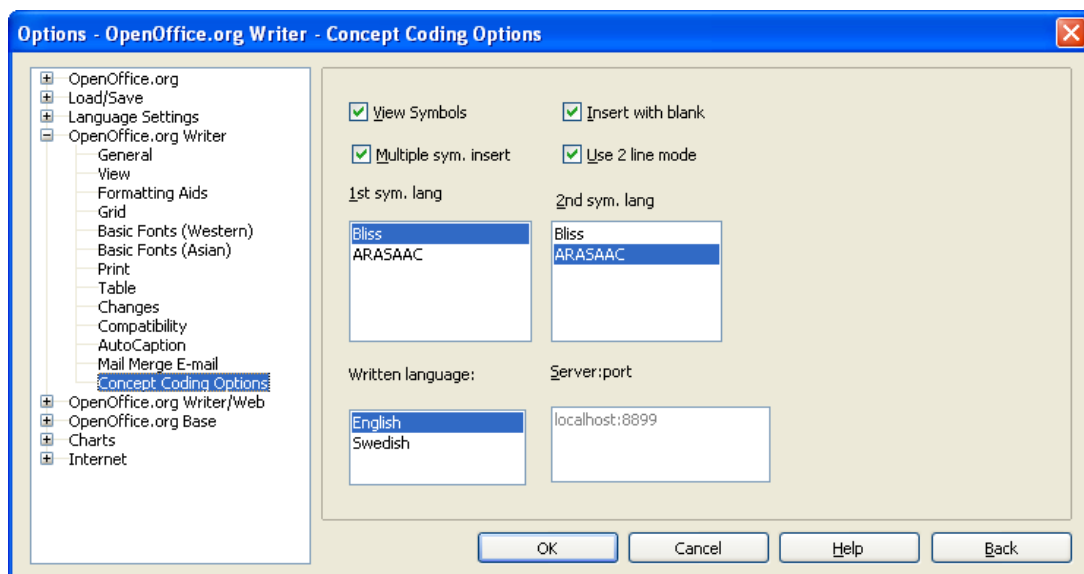


**Concept Coding Menu and Toolbar options**

By selecting “Lookup CCF symbol” a live link is established between the CCF Symbol Extension in OO/LO Writer and the CCF Symbol Server. When a word is ended by a Space character, or when the text caret is moved to another word in the document, the extension sends the current word to the CCF Symbol Server. The server looks up the concept(s) and symbol(s) representing each word, according to the settings, displays the symbols in its display window, and communicates the relevant information back to the CCF Symbol Extension in Writer as needed – see the screen snapshot images in Figures below.

By selecting “Turn off CCF” the concept and symbol lookup is halted. The “Scan whole document” option allows you to perform the symbol lookup in one go for all text in a document. The remaining “View only” and “Insert also” menu items will be commented further below.

Note: this on/off state is set per document, and is indicated in the CCF Symbol Server Window!



**Concept Coding Options dialog**

Also available via the conference website [www.aegis-conference.eu](http://www.aegis-conference.eu)



Settings are found under Tools → Options → OpenOffice.org Writer → Concept Coding Options. The prototype is partly localized for Swedish at this point. An English OpenOffice.org installation uses the English system messages that can be seen here.

The settings options are:

- “View symbols” – this setting turns a live lookup link to the CCF Symbol Server on or off – making the symbol server window display the current symbol(s) when moving the cursor through the text, while on.
- “Insert with blank” – will insert symbols into the text – according to the following settings ...  
Note; that the menu options “View only” and “Insert also” allows the user to temporarily turn this setting off and on without going to the options dialog to change the basic setting!
- “Multiple sym. insert” – will, if on, insert all available symbols for a word into the text in front of each word – but only if “Use 2 line mode” is turned off
- “Use 2 line mode” – will, if on, insert the first found symbol for a word in a so called “Ruby Annotation” field above the word (in a black and white font format). If this option is turned off, the first found symbol (or all found symbols, if “Multiple sym. Insert” is turned on) for each word will be inserted before the corresponding words.
- 1st sym. lang and 2nd sym. lang options, which select which symbol set, Blissymbolics or ARASAAC, to use as primary and secondary representation. If a word does not have a representation in the primary symbol set, the plugin will look for a representation in the secondary and, if found, display it. If only one representation is wanted, the same symbol representation may be selected in both lists. Words that do not have a matching representation in either set will appear as text only.
- The “Written language” setting selects which of the available text lookup languages to use (currently just English or Swedish)
- The “Server:port” is currently no real option, but is just displaying the port setting for the communication between the OO.org extension and the CCF Symbol Server

The default settings after installation is: All toggle options on, Bliss + ARASAAC and English

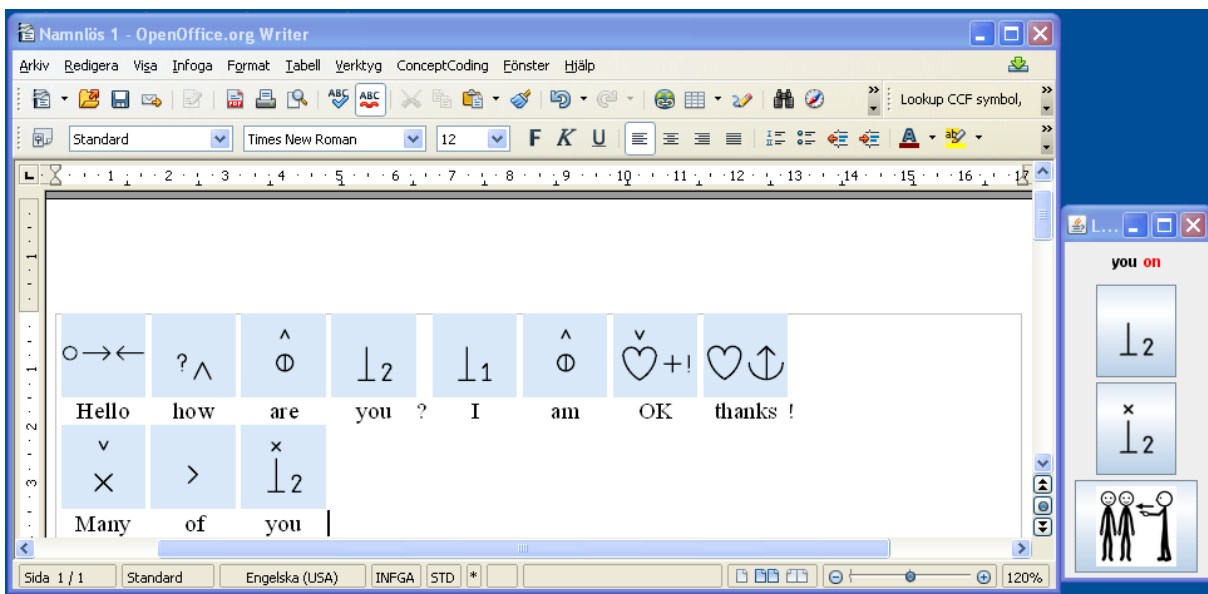
When the “2 line mode” (Ruby Annotation mode) is on, the user may choose between available symbol representations by tapping the Ctrl+G shortcut key. The user may also choose to use none of the presented symbol alternatives in this way.

The CCF Symbol Server and the CCF Symbols Extension handle inflections of words to some extent, but gaps and imperfections will still be found. If a word is deleted or changed, the present image needs to be deleted, and space character needs to be hit again to look up the new word.

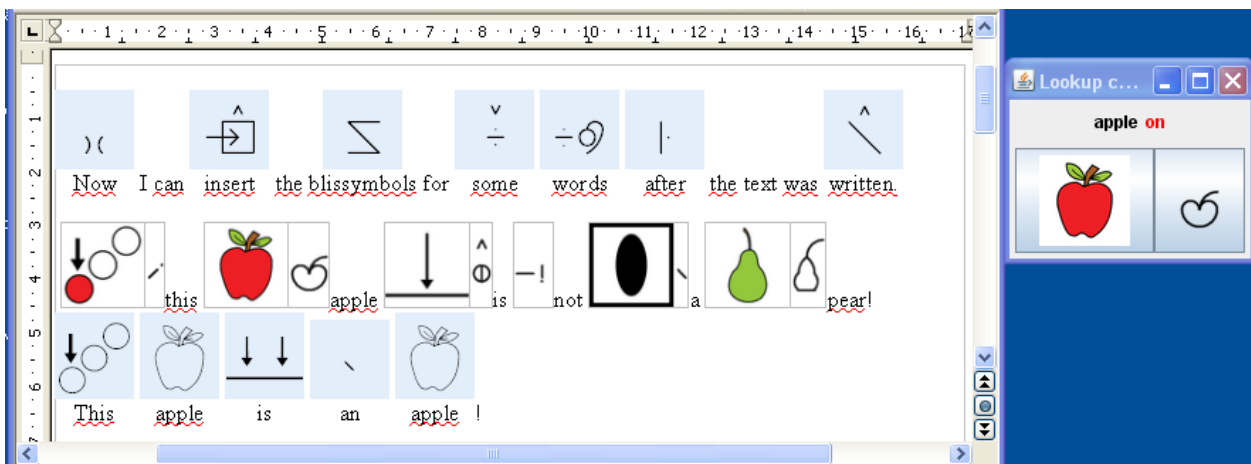
In this version the word-concept-symbol look-up is quite fast for words contained in the pre-cached vocabulary. When new non-cached words are looked up, the user will experience a shorter or longer delay during the first look-up (depending on the number of possible concepts and representations), but after this the word will be included in the cach for future quick retrieval.



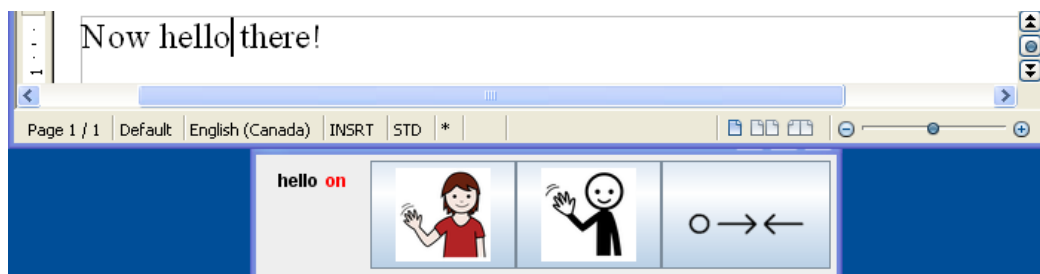
Below follows a couple of screen shots from OpenOffice Writer with the CCF Symbol Support Extension and Server in operation with some different settings:



**CCF Symbol Server window at the right hand side. Blissymbols (as font) inserted above text in the two line Ruby Annotation format**



**Mixed mode symbol representations: Blissymbols as font above words; ARASAAC and Bliss as graphics (black & white and colour) within base text; ARASAAC (and Bliss) as font (black & white) above text; CCF Symbol Server to the right**



**No symbol insertion in text: The CCF Symbol Server (below the text window) is displaying looked-up concepts and symbols as words are written, and/or as the text cursor is moved within the text.**

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This second alpha version of the CCF Symbol Support extension has been evaluated in the AEGIS second pilot testing round performed during the summer 2011. Some preliminary outcomes are presented in the next chapter.

## Preliminary Results From The Pilot Testing

### Potential target users and user needs

This second alpha has overall been appreciated as an already fully usable and valuable application for a wide range of users and user needs. Those suggested by users, tutors and experts include:

- AAC symbol users, as a tool for communication, writing and reading – typically supported by additional AT such as on-screen symbol charts for input, and text-to-speech (TTS) feedback
- Users with cognitive disabilities of different kinds, rendering a need for anything from extensive to occasional graphical symbol feedback for functional reading and writing – typically in combination with TTS
- Temporary support in early stages of second language learning
- Mainstream use for early literacy introduction

### Advantages and disadvantages compared to competitive alternatives

Main listed advantages and disadvantages in relation to existing commercial software with corresponding functionality (e.g. the Widgit Communicate: series [9]) include:

Advantages:

- Standard office software base with freely available extended functionality – accessible across a wider range of socio-economic circumstances and environments (school, home, public, private)
- Cross-platform availability (Windows, Mac OS X and Linux/Unix)
- Based on openly defined technologies and open-source software (allowing novel integration and innovation in a longer perspective)

Disadvantages:

- Functionality and UI design less tailored (and tailorable) to some special needs requirements
- Less sophisticated language technology and vocabulary support compared to the most advanced proprietary alternatives (though in parity to, or beyond, several other)
- Possible issues in relation to future maintenance and support

### Remarks on existing or missing features of the second alpha version

General comments:

- Those who also tested the first alpha version appreciated the substantial improvements made since then, and which were judged to have transformed the CCF Symbol Support Extension from an interesting proof of concept into a practically useful tool.



- The general environment and installation (not tested but only described for expert and tutor focus groups) was regarded to be somewhat complex to manage, and in need of simplifications. Remarks included the division between the server and the Writer internal extension, and the demand to start the server separately (with several display options) and to manually position the server window, the manual installation of the symbol fonts, etc.
- Some experts asked about, and remarked upon, the still open issues about the saving, restoring and sharing of Open Document Text (ODT) [10] documents with concept coded content and included symbol representations.
- As expected, experts and tutors comment on several of the still obvious limitations of the vocabulary resources, and request improvements. However, they also expressed an understanding and acceptance of limitations (compared to the best commercial alternatives in the field) as a trade-off for the advantages of the free and wide availability. Some experts stressed the importance of clear information about functionality and limitations, in order to create realistic expectations among potential users.

#### Specific comments:

- Both users and experts highly appreciated the "out-of-text" symbol display. However, they requested improvements in the management of the CCF Symbol Server display. Suggested solutions included:
  - The CCF server display window floating on top of all other windows – ideally with an option to let the symbol display follow the text insertion caret in the Writer document
  - The symbol display being moved into the Writer window as a floating or docked display panel (similar to the "Navigator" etc. panels)
- Both users and experts also highly appreciate the Ruby Annotation display of symbols over their corresponding words. However, they regret the loss of colour in the ARASAAC due to the necessary transfer to the font format for this symbol display (due to the current lack of support for graphics in the Ruby Annotation format of ODT and in OpenOffice and LibreOffice). A specific request has been:
  - Option to control the background colour of the symbols, which by some evaluators was now thought to be in a slightly too dark shade of blue-gray
- The option to select among several alternative symbol representations offered for a word via the Ctrl+G keyboard shortcut was highly valued, but users and experts also wanted to be able to select their preferred symbol alternative by pointing and clicking at it
- There was a strong request from some experts and tutors to allow the user to enter a base word to find a symbol and then swap the original word to a new custom one accompanying the same symbol, e.g. "dog" represented by a Bliss or ARASAAC symbol and then replacing the word "dog" under that symbol with "Pluto"
- Specific requests for improvements of the word-concept-symbol look-up included:
  - Better priority (based on frequency and probability) for first choice among concept alternatives
  - Capability to handle two word (and potentially multi word) concepts



- Word-concept-symbol "prediction", i.e. Suggestion of matching concepts and symbols while typing a word (and not only after completing the word with Space, as now)
- The obvious requests for support of more text languages and other preferred symbol libraries

## Conclusions And Future Plans

### Preliminary plans for the beta and final versions (within AEGIS)

Based on the input from the first and second pilot tests, and the revised user needs and requirements specifications, the following issues will be addressed:

- Usability and UI enhancements:
  - Smoother integration of the CCF Symbol Server and the OO/LO Writer extension, including
    - automatic start of the CCF server, if it's not running, when called from the extension
    - CCF server symbol display window always floating on top, possibly with text cursor/caret following, alternatively adding a symbol display panel to the extension for presentation within the Writer window
    - Selection of preferred concept-symbol representation by point and click (in addition to the current shortcut key command)
  - Easier access to the settings panel, better grouping of the settings options, and improved design of the toolbar panel
- Functional enhancements:
  - Providing an option for the user to change text word for a symbol represented concept
  - Support for two word (possibly three word) concept-symbol lookup (e.g. "all right" and "to go" to be joined to one concept representation)
  - Possibly providing word-concept-symbol "prediction" (while typing)

### Further perspectives (beyond the Writer extension and AEGIS)

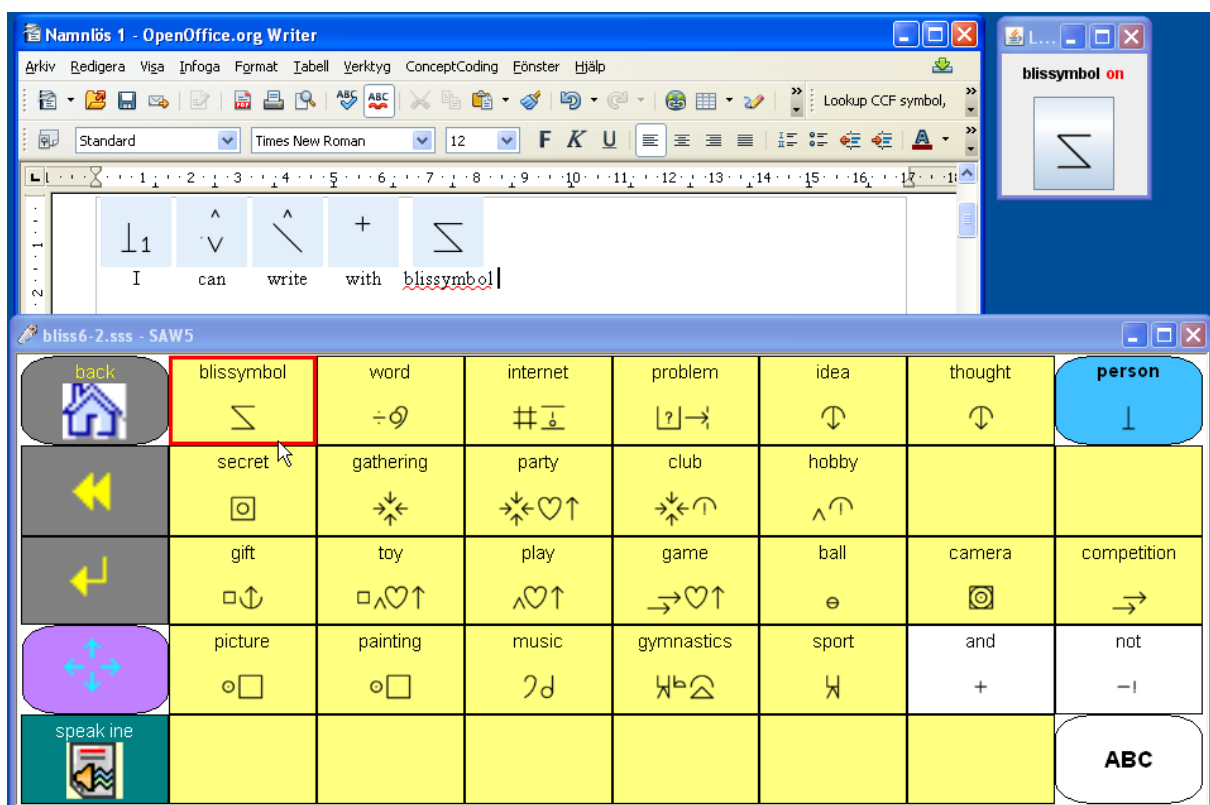
The discussion may here be divided into two main parts; a) the wider plans for the CCF developments within the scope of AEGIS, and b) further plans for CCF developments and maintenance after AEGIS.

- Within the scope of AEGIS:
  - The CCF ontologies and databases used by the CCF Symbol Server are still in a provisional state and are in need for continuous upgrades on several levels:
    - The current resources need to be maintained for the short term perspective with
      - improvements of the representational databases (in particular for ARASAAC symbols)
      - improvements of lexical support for English and Swedish with better coverage, higher hit rate for most probable concept, support for multi word concepts, etc.
      - Additional basic support for Spanish and Dutch is underway

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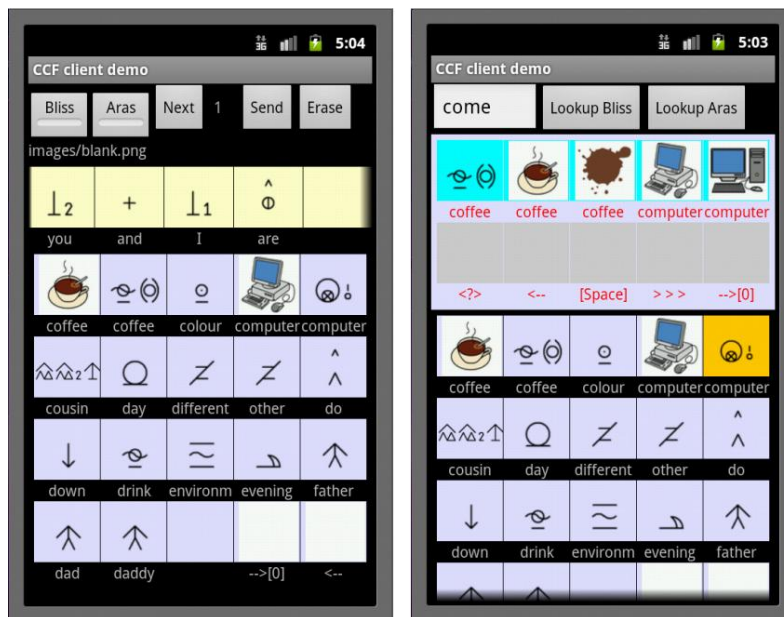


- A more strictly controlled and longer term re-build of the CCF ontologies has been initiated as part of the employment of the CCF technology for the AAC app for Android that is being developed within AEGIS. This will however not be applied to the OO/LO Writer extension within AEGIS.
- Special Access to Windows (SAW) will be upgraded to support integration with the CCF Symbol Server achieving a higher level of vocabulary content maintenance in on-screen symbol selection charts for AAC users (See Figure below). In this way these resources may be managed in a multilingual and multi-symbol library context in a much more efficient and secure way than previously.
- The CCF Symbol Server is already used as an online cloud server for the provision of vocabulary resources for the first prototype of the Android AAC app (see Figure below).



OpenOffice Writer with the CCF symbol support activated. The CCF symbol Server is in the top right corner, and a SAW symbol selection chart providing the text input to Writer is below. Currently the symbol chart content is hard coded. Support for integration with the CCF Symbol Server will allow the selection chart above to be transformed from an English Blissymbol chart to a Swedish ARASAAC chart in a wink. And better still: This may be expanded to support more languages and symbol





The CCF AAC app for Android - in user mode (left) and set-up mode (right)

- The longer term CCF perspectives:
  - The work to integrate the CCF technology, as well as the graphic language of Blissymbolics, as part of the ISO TC 37 multi-modal terminology standards, has been initiated within the AEGIS project. As this is a longer term task, it will continue far beyond the duration of the project.
  - The general maintenance of the CCF vocabulary resources is basically a never-ending task of refinement of the support for the current languages and representational resources, and the subsequent addition of new ones.
  - The above tasks will in turn require maintenance and further development of the exploitation and business plans which are in progress as part of the AEGIS work.

## Final Conclusions

The CCF Symbol Support Extension for OpenOffice/LibreOffice is in preparation for its beta release in early 2012. The second pilot evaluation of the second alpha version has clearly indicated that the innovative approach to provide multi-modal and multilingual language support as part of a standard office suite is fully feasible. This will provide a new basic level support for access to text content, and a new and wider range of opportunities to communicate for people with cognitive, speech and language impairments, and for those with multiple impairments. It is also likely to be appreciated by wider groups of users in general, in particular in connection to early literacy and second language introduction.

This opens up new perspectives for providing more inclusive accessible ICT environments – for people in general, across socio-economic conditions, and for users with more challenging needs due to a wide range of impairing conditions. This will not likely replace the need and space for dedicated ICT products in this area, but will serve as a complementary basic and more widely available entry level for this kind of language support.



## Acknowledgement

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## 8. Session 7: User needs and wants

The user needs and wants should always be at the very heart of any ICT AT, and the different papers illustrated how user driven approaches can ensure an increased accessibility of various tools and applications, while they should also be involved in the iterative development processes. However, the session started by pointing out that this is not always possible for every EU citizen to embrace and enjoy (ICT) AT due to the economic and financial crisis that has hit Europe.

### 8.1. eInclusion Stops Where The Beneficiary Cannot Afford Or Understand ICT Based Solutions

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#### Abstract

ICT based Assistive Technologies (AT) play an increasingly central role in many aspects of everyday life for people with disabilities (without forgetting older people). Whether it is at the workplace, access to public services or serving as a medium for social engagement and leisure pursuits, ICT has provided an important means of access for people with disabilities.

However, as much as it can be beneficial, lack of access to these specific AT supporting ICTs have also created a growing gap between the happy few who effectively are aware of it and use it and those who are unaware of what exists or do not have the opportunity to use it. This gap is substantiated by research in the context of the EC funded projects AEGIS, ACCESSIBLE and ViPi. This is mainly caused by a range of factors often of socio-economic nature (e.g. lack of affordability or lack of opportunities to familiarise with ICTs and learn how to use them) and equally through the lack of well-devised accessibility solutions. In this paper, we first have a look at the findings from the aforementioned projects, identifying the main barriers, and then will focus on how the economic crisis further strengthens the barriers people with disabilities face, and how this affects their abilities to purchase AT ICTs or even get adequate support on how to use it. A special focus will be on the impact of the crisis on the Greek people with disabilities. We conclude with outlining some possible solutions to address observed shortcomings.

#### Keywords

Accessibility, Economy, Financial, Crisis, Social Benefits, ICT, eInclusion, AT, Training

#### Introduction

eInclusion embraces the use of ICT to achieve wider inclusion objectives. It focuses on participation of all individuals and communities in all aspects of the information society. This is the definition stemming from the 2006 Riga ministerial declaration [1] and touches the very core of this paper: participation of all individuals and communities in all aspects of the

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information society. This participation is often only possible when AT is available, which is "any item, piece of equipment, or product system whether acquired commercially of the shelf, modified or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities". [2] This definition implies the wide impact range AT can have on the daily life of those that rely on such solutions. Knowing that Information and communications technology (ICT) plays an important role in every aspect of life, whether at home, work or when on the road, providing accessible ICT (and thus making use of AT ICT) truly can offer a bridge towards inclusion[3].

While the Riga ministerial declaration as well as various funding initiatives pushes for this increased inclusion implementation, in reality AT ICT is not used by all people with disabilities, and in fact often miss those that need it most in society. The following sections aim to give an answer to this, by identifying a number of core barriers, and presents possible solution.

### Benefits Of At Ict

AT ICT are providing a wide plethora of opportunities for those individuals who have disabilities to (again) actively participate in daily life, and communicate and interact with one's environment. AT goes beyond the specialised hard- and software, and provides increasingly creative solutions with consumer goods (e.g. iPad applications for communication support to those with speech impairments) to enable them to become more independent, productive, and included in society and community life.

An efficient implementation of AT requires that it is recognised that people have different needs, abilities and preferences and not a "one size that fits all".

So why is it that not everyone in need of AT ICT support is using it, or has access to it?

### Identified Barriers

Recent research by the AEGIS (2009)[4, 5], ACCESSIBLE (2009)[6, 7] and ViPi (2011)[8] EC funded projects highlighted a vast array of barriers and problems that have hampered the full take-up of AT ICT by every person with a disability. Their main findings can be grouped as following:

- **AT industry issues:** The European AT industry is characterised by a patchwork of small specialised companies who have a limited financial basis to expand and provide a customised approach in every EU country. For example, local language versions of AT software are often missing (only available in English). Equally, because of the limited size of local markets, products tend to be expensive.
- **Policy issues:** A different social policy across European Member States for subsidising/reimbursing AT products makes it by default already incoherent for end-users. While some countries offer full refunds (e.g. Belgium) based on a reference list, some cover basically nothing (e.g. Greece). Most countries also lack specialised agencies and staff to assist people with disabilities in making a correct choice on what AT ICT is most relevant and applicable for the end-user.
- **End-user issues:** End-users are *largely unaware of the available AT solutions* (albeit that mainly people with vision impairments seem to be very well informed about available AT). AT that are easiest to obtain are also the ones most easily abandoned.

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Non-use arises also less frequently among people with repeated provision, compared with first-time users of AT. Another aspect are the *high purchasing costs for end users* which are reported as a major barrier for wider deployment by disability organisations, especially in those countries where no government support exists. Finally, there seems to be an ongoing *mismatch between needs end user and offered AT*. End users are not provided with the required AT, resulting in a high percentage (up to 30% in the USA) of obtained ATs being discarded within a year. AT that is being offered does not satisfy the actual needs of the people with disabilities, hence their refusal to use them. According to some surveys, almost half of the end-users experience problems using AT. This mismatch between the needs of the end users and the actual AT they are being offered can be directly linked to the poor assessment of consumer needs and preferences by AT providers, and the often lacking follow-up. But foremost, the *training* that is needed to use AT, mainly basic ICT skills, and that requires a professional to train the user to manage and use these devices is often lacking [9] and proves to fall short of expectations. Users therefore often rely on friends, family or colleagues to help them out. This results in end users having AT they cannot use to a full extent, or in some cases not at all, and resulting in abandonment.

Having identified these barriers, a number of possible solutions can be suggested. However, considering the current economic climate change which occurred in Europe since the findings of the aforementioned results, the question arose whether this would reinforce these barriers in Europe. While the answer might seem straightforward, our research indicated that the effects are in fact quite different across Europe, again due to a diversified policy approach throughout Europe as we will explain in the next section.

## A New Reality, The Financial Crisis

### The European perspective

Similar to the Great Depression in the thirties of the 20th century, the 2008-2009 financial and economic crises had an escalating effect, with apart from a fiscal and political impact, also a largely neglected social impact. The recent UN "Report on the World Social Situation 2011: The Global Social Crisis" [10] points this out clearly by stating that many governments do not pay sufficient attention to the social implications of the global economic crisis.

The European Union's "Europe 2020" strategy has made social inclusion 1 of the 3 pillars to strengthen Europe. However, the European Disability forum (EDF) recently pointed out that current economic, social and political policies adopted by Member States and the EU may lead to an increase in the numbers of people experiencing social exclusion in Europe. EDF therefore initiated in 2011 a monitoring tool [11]: the 'EDF observatory on the impact of the economic crisis on the rights of persons with disabilities'. Through the collection of adequate examples by its members, the measures taken by EU member states, they aim to monitor the European Union institutions and International financial institutions that affect persons with disabilities.

Because results of this monitoring are not available yet, we undertook a limited survey in August-September 2011 among European Anti Poverty Network (EAPN) [12] members to identify core indicators on how budgets for people with disabilities have been affected by



austerity measures in EU countries, and what corrective measures -if any- have been taken or are planned. A core finding by EAPN in a recent study was that “NGOs who provide key services and support to people hurt by the crisis try their best to address a demand which is on a rapid rise and to still fill their advocacy role, but cuts in budgets and limitation of public services place them in extremely difficult situations.” [13]

Some countries are in fact hardly affected by the current situation. The financial crisis did not impact the national budget for social services or health for Malta up till now [14]. In fact, recurrent expenditure and even capital expenditure has been retained without changes and even increased (the budget for health was increased by €14 million per annum for 2009 and 2010). Cuts in funding have been affected in other areas by government but not in health and social services directly. In Hungary [15], financial restrictions regarding people with disabilities have been also avoided (with even an increase between 2007-2011 for supporting the employment of people with disabilities), but the government is preparing changes, and in 2012 there will be definite decreases in the resources for people with disabilities. Due to the prospering situation in Germany, there are no austerity measures known which are affecting the support for people with disabilities, so far. However, during the last crisis of 2007-08 people with disabilities were affected by unemployment above average. Joblessness of people with disabilities is still higher than the average and not increasing since the economic recovery [16].

Other countries such as Ireland [17] have implemented cuts that affect the supports for carers and also to Special Needs Assistants to support the integration of children with special needs into mainstream schools. There have equally been cuts to the social welfare payments for people with disabilities. Similar effects have been observed in Spain [18, 19].

#### Use case: Greece

This is not different for Greece where the crisis has severely affected the social support for people with disabilities. Social budgets have been cut, and this in a country where the social protection systems were already quite weak. The Greek government was forced to scale down their interventions in order to rebalance budgets and stabilize public debt. The country seeks to reduce its public deficit from the current 12 per cent to less than 3 per cent by 2013. To achieve this, the Greek prime minister announced in December 2009 that his government planned a 10 per cent cut in both social security spending and government operating expenditures. Unemployment is growing, reaching 16.3% in the second quarter of 2011 in comparison with 11.8 % in the respective period in 2010 [20], and a record high of 18.4% in August 2011. Equally, the Greek financial crisis has become a health hazard whereby economically vulnerable Greeks are losing health care access amid dwindling budgets, according to a study released online by The Lancet, a British medical journal [21].

With such conditions, socially disadvantaged groups are arguably hit first. As a result, social support mechanisms become even more necessary for people with disabilities to cope, however these seem to fall rapidly short of needs as we explain in the following.

In the past 2 year (2010-2011), Greece's people with disabilities have been facing a wide array of cuts that have strained their support to an absolute minimum, namely through reductions in disability pensions and provisions in kind (medical supplies, technical aids, community rehabilitation services). There are also significant delays in monthly payments of



disability benefits and disability provisions. At the same time, urgent tax tolls and increased VAT along the whole scale of daily goods and services, endangers the people's capacity to cope in an extensive economic crisis in the country.

Some core data about Greece's population that has a disability [22] shows the already fragile situation before the crisis fully struck the Greek society in 2010:

- 18.2% of the country's population has a health problem or a disability, of whom more than half are over 65 years old [23].
- 304.515 people received disability pension in 2008, out of a total of 2.341.374 pensioners insured through social security funds run by the Ministry for Employment and Social Protection. In addition, 78.527 disability pensioners received a supplementary benefit of social solidarity.
- While primary healthcare and rehabilitation is free of charge under the National Health System, no special rehabilitation measures or benefits are available with the exception of preferential employment for certain categories of disabled people (e.g. the blind).
- The rate of individuals below poverty line was 19.6% in 2005 against EU average 16%. [24] The set threshold for poverty was 5649.78€ annual income for individuals and 11864.54€ for a couple with two dependent children [25].
- Social Expenditure, including pensions, benefits, health and social care, was 21,13% of GDP in 2008, compared with 20,70% in 2007 [26].
- In 2006, disability benefits accounted for 4.7% of all benefits expenditure (both cash and in kind benefits) compared to an EU27 average of 7.5%, the second lowest proportion of any EU/EFTA country [27].

Greece has never had any funding in place for end-users for purchasing assistive technology, hardware or software, nor does there exist any other state support mechanism, such as for instance an exhibition centre or electronic gateway, for gaining information on or testing assistive ICT devices, or even receiving training.

Since end-users are already forced to self finance any assistive technology they need to use with their own resources, recent policies initiated in the period 2010-2011 further affect their capacity to purchase AT overall. In this period, a range of policies were started that affected directly the financial capacity for people with disabilities to take up and use supporting technologies, thus exposing the main barrier, namely the purchasing power of end-users which is being rapidly reduced.

The situation in Greece is a typical example how eInclusion indeed stops where the beneficiary cannot (longer) afford ICT based solutions.

Also the AT ICT training remains a problem. Greece never had any framework in place to support end-users in acquiring experience with AT, nor in providing any support. This is definitely the case when looking at AT ICT training, which is totally lacking.

Above findings are worrying, especially if we look at the high number of unemployment in Greece at present, and especially the disastrous effects the crisis is expected to have on the employment of people with disabilities. Concrete figures or research regarding the real employment of people with disabilities is entirely absent. However, a 2007 survey by MDA

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Hellas under the partnership “ε-ΠΙΜΕΝΩ” (“I-insist”) checked whether the Greek legislation according to which private companies with more than 50 staff are required to employ disabled people amounting to 8% of the total staff, was effectively implemented. Only 20% of the surveyed companies with more than 50 staff employed disabled people. It clearly shows that the law is not implemented.

While the crisis in Greece is deepening every day, and people with disabilities are struck the hardest due to their daily needs no longer being supported, similar situations are in the making in countries like Spain, Portugal, and potentially spreading to other European member states. The fact that poverty and disability reinforce each other, contributes to an increased vulnerability and exclusion of these citizens. Traditionally people with disabilities have been the “reserve army of labour”, “the last to be hired the first to be fired”, seen as expendable at times of economic crisis. Additionally, in times of recession, persons with disabilities face particular difficulties caused by a lack of work and increased isolation [28].

### Possible Solutions To Curb This

A number of the aforementioned problems will necessitate measures that are both private and end-user driven, while also initiated by governments, and this on a national and European level.

A full uptake of AT ICT by beneficiaries first of all necessitates a unified policy with regards to the funding provided by governments for purchasing AT ICT. Currently, this is very diversified, and also applies different delivery models: the medical oriented model whose starting point is the handicap where the physician initiates necessary procedures and must approve the need for listed and reimbursed AT based on medical arguments; the social oriented model which is a system based upon national legislation and local and decentralised execution; and the consumer oriented model where the end-user has direct contact with a retailer in order to get his/her AT product. These procurement models also go together with different reimbursement schemes applied by every country [29]. Where this reimbursement policy is strongly regulated, often the social oriented model can be observed (e.g. Belgium), whereas poorly regulated countries often use the consumer oriented model because the end-user has to undertake all the necessary actions (e.g. Greece).

Additionally, well-organised training programmes are needed that allow people with disabilities to become aware of how they need to use AT. In this respect, basic ICT skills training are often needed ahead of actual AT training. This is in line also with the Lisbon Summit that identified ICT skills as one of the new basic skills for a knowledge-based economy.

End-users should also be more aware of what exists to address their personal needs, what the benefits are for each AT, and how they can use these ATs in an optimal manner. The product driven approach should therefore become a consumer driven approach which puts the end-user at the very centre. A solution to this is the creation of databases of available solutions, detailed description of their functionalities, their pros and cons, and indicating open source alternatives versus commercial solutions. Initiatives such as the EASTIN network [30] with its online database are already of great help, but also should include mainstream products that are used as AT ICT (e.g. iPad).



When looking at policy measures that could be put in place, a new approach towards “lending” of AT could be useful, even across borders, to fill the gap between the have’s and the have not’s among the people with disabilities. This disparity is often the result of financial limitations, the more important with the economic crisis imposing austerity measures.

Any austerity measures will create a burden, but this should be shared more equitably to minimise losses for lower income groups. For the case of e.g. Greece, its policies to reduce its deficit need to be redesigned. In particular, the importance of fighting tax evasion cannot be overstated: it is crucial from a fiscal point of view (improving tax collection would help reduce budget deficits), as well as from a political point of view. In a similar manner, the financing of social NGOs should be preserved from cuts both at EU and national level, and an increased budget should be made accessible to them in order to ensure they can play their key roles and contribute to sustainable recovery. [31]

## Conclusion

The current barriers observed in the efficient uptake of AT ICT are identifiable, and similar across all European countries. The degree to which people with disabilities get support by their governments (through social security) is quite different, and this is worsened by the economic crisis which is having a strong impact on countries like Greece. While the crisis by itself requires a whole plethora of (austerity) measurements, the impact on those within the society that already are burdened by their disability, should be softened. This is a reality that we have exposed in this paper, and which requires a broad range of corrective measures, not only financial but also policy-wise ones.

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## 8.2. Authoring Tools Features To Support E-Learning Resource Creation Fixed To Accessibility Guidelines: From A Critical View

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### Abstract

In this article the necessity of authoring tools for generating accessible learning resources is introduced, emphasizing in the features of this kind of system, which reduce the necessary efforts by part of the users, in particular, teachers and content designer, in many cases, without time and without specialized knowledge to develop this kind of tasks. We also analyse the current situation of distributed learning resources, in particular, according with their fix to accessibility guidelines, discussing the difficulty to different actors involved in the generation of content to implement accessibility guidelines and also the identified difficulties for users when they use tools for content accessibility generation and verification.

### Keywords

Accessibility, e-learning, Learning Management System (LMS), Virtual Learning Objects (VLO), WCAG

### Introduction

Over time, education has been becoming an essential field into society. In this context, many efforts have been made in order to enhance the teaching and learning processes.

The use of information and communication technology to support education have opened a variety of possibilities, among them that more people are able nowadays to carry up their learning processes using what is known as Learning Management Systems (LMS) or Virtual Learning Environments.

LMSs represent an important option for increase the educative offer and delivering learning process to many students, however, for those who have special needs and were not taken into account when designed and implemented the educational digital resources, this technology represents a major barrier to access to education. Due to this fact, it is necessary that some processes linked to technology enhance learning will be reoriented in order to consider the large diversity of users which utilize LMSs, it means people with disabilities, including blindness and low vision, deafness and hearing loss, learning disabilities, cognitive limitations, limited movement, speech disabilities, photosensitivity people among others.

To mitigate this situation, the Web Accessibility Initiative (WAI) have proposed a wide range of recommendations for making Web content more accessible, among them the Web Content Accessibility Guidelines (WCAG). These Guidelines permit to improve and secure the access to online educational materials to diversity populations.





However, the process of assimilation and acceptance of these guidelines around the world is a slow process and most of the web content as well as the learning management systems created until now present serious accessibility barriers. These artefacts are frequently created by people with technical knowledge and expertise in the field of software development or maybe with pedagogy and didactic formation, but they unknown (completely or partially) the concept of web accessibility and usability. This condition makes it difficult to apply the WCAG 1.0 guidelines or similar ones to create accessible content and its evaluation.

In this paper, we present: 1) an analysis of the current situation of online and distributed learning resources according to accessibility; 2) a discussion about the difficulty of following the WCAG guidelines by the different actors involved in the generation of web content; 3) an introduction of some identified difficulties when using the tools for testing accessibility to web content and finally 4) discussions about some conclusions and remarked future works.

## Accessibility Of Web Content And Authorship Tools In E-Learning

### Context Description

It is well known that e-learning projects developed by educational institutions are implemented for professionals and experts convenient from different areas, pedagogues, psychologists, instructional designers, graphic designers, engineers, developers and administrators, which compose a multi-disciplinary teams. In these teams, each member has a defining role according to their area of expertise. Pedagogues have a role focused on the definition of learning methodologies, psychologists supports the difficult task of defining models to represent the users preferences, instructional designers focus on the creation of adequate learning paths or learning scenarios, and graphic designers formulate strategies and develop studies to communicate in a graphic and interactive way the ideas and products linked to the web content.

While this might be the most popular production model for the creation of educational material in e-learning projects, institutions might not always count with this type of infrastructure or human resource. It's usual that this kind of initiatives come from small groups or individual efforts, and in this case the development of web content becomes a difficult task because of the lack of knowledge and expertise in technical topics for developing accessible web design. When this happens, it is very common that content production address the creation of pedagogical contents in PDF form, PPT presentation or DOC documents that lead students, in many case didactically adequate, but not accessible at all because the personalization, and the process to ensure the content accessibility is frequently not oriented.

In this context, the authorship tools which support the difficult task to develop accessible web content become a low cost and adequate solution to create quality educational content for e-learning. By means of user-friendly programs which not require greater technical abilities, a person can create accessible and pedagogically adequate learning objects in reasonable times, focuses all their attention in the pedagogical aspects and leaving the technological and design features to be oriented for the author tool. These tools are able to code the web content, create HTML, XML files, images and CSS styles sheets required by the learning objects creation.



Learning management systems (LMS) and available authorship tools facility important tasks from an increasing number of users, with different profiles, whose have been able to access these technologies and use them in order to deliver, transform or produce objects of knowledge. Unfortunately, to facility the process to create contents could establish barriers of accessibility, since the users are not always conscious of the way in which those contents are publish. In many cases, automatic tools sacrifice the most basic features of web accessibility by automatically generating incorrect HTML code, ignoring the capacity to access information.

Currently, most LMS or open source software owners have accessibility barriers, which makes their use difficult or even impossible, not only for handicapped users but even for those who have full physical and cognitive abilities (Guenaga & Oliver, 2004.). If LMS and other software used to create online educational material were user-friendly, accessible, and would incorporate international standards for the creation of learning objects (such as IMS or SCORM) and would fix accessibility guides for web content generation such as W3C in an effective way, most people could efficiently use these services.

Next section we will introduce the analysis of one selected author tool, exeLearning, in order to show the most common difficulties associated to the web content generation.

#### **eXe-Learning Authorship Tool Evaluation Description**

For our analysis the eXe-Learning authorship tool was selected. eXe-Learning is one of the most used tools by people and educational institutions, it allows to generate quality web material without requiring knowledge in web design or HTML and with a very low costs. Nonetheless, this tool, as the majority of automatic HTML content generators, establishes some barriers of accessibility in the generated contents. The automatic code generation and the errors introduced by the authors when they create content are some of the most relevant identified problems. When the content created by the program was evaluated, it was observed that is not correct at all, we found difficulties in 1) the use the style sheets, 2) the validation of the generated HTML code, and 3) in the validation of the accessibility guidelines for the web content.

For the eXe-Learning evaluation of the accessibility, a simple learning object in HTML (group of HTML pages) was developed. In the learning object were identified basic elements to analyse in order to infer the web content accessibility in AA level. The automatic evaluation results were analysed and the tool was evaluated in a heuristic level. Considering this analysis, a series of recommendations were proposed in order to improve the authorship tool and improve its use considering the user who creates the content. These analysis and recommendations are so important because the accessibility barriers are often produced due to automatic code generation and actually for user's mistakes.

The technical evaluation considers twelve accessibility features, which summarize the most important validation points of the AA level in W3C/WAI - Web Content Accessibility Guidelines 1.0 (WCAG 1.0). Even though not all points are analysed in detail, we consider that these twelve features could be enough to understand the reality of the status of accessibility of the contents generated by eXe-Learning. The verification points are explained separately in order to analysis the results. They are:



- Validation of W3C technologies (priorities 1 and 2 in WCAG 1.0).
- Frames (priorities 1 and 2 in WCAG 1.0).
- Forms (priorities 1 and 2 in WCAG 1.0).
- Textual alternatives to multimedia elements (priority 1 in WCAG 1.0.)
- Headers (priority 2 in WCAG 1.0).
- Relative units in the style sheet (priorities 1 and 2 in WCAG 1.0).
- Comprehensible links (priority 2 in WCAG 1.0).
- Contrast (priority 2 for the images in WCAG 1.0).
- Semantic use of colours (priority 1 in WCAG 1.0).
- Content alignment of tables (priority 2 in WCAG 1.0).
- Data tables (priority 1 in WCAG 1.0).
- Scripts (priority 1 in WCAG 1.0).

### eXe-Learning authorship tool Evaluation Results

Once the contents created by eXe-Learning were evaluated, some conclusions about accessibility issues was identified and described in next paragraphs.

It was observed that eXe-Learning does not correctly use style sheets, because it not formally validates the HTML code generated or maybe it not complete a correct coding in the style sheets.

The automatic generation of frames to layout the content is done incorrectly. In this case the frame has a name, but it has been generated automatically and it is not related to its own content. Unfortunately, this cannot be corrected in eXe without directly modifying the API of the content generator, written in Python programming language, which results to be complex since it is programmed in an intermediate language (Hipóla & Senso, 2007.). This frame is dynamically generated within the eXe Python code and the insertion of the pre-formatted code by means of the TinyMCE HTML editor embedded. In order to correct this error, it would be necessary to reprogram the application, which requires time and experts in the topic.

The accessibility of forms created by eXe was evaluated. Some activities of different types were created (question type, format fields), which in case they are not correctly labelled then they could establish accessibility barriers. Forms are a basic element in LMS contents, they support the interaction of the user and the service intended to be used. In the case of eXe-Learning, the forms generated do not meet with the specifications of accessibility guidelines. The solution lies in the modification of the source code of eXe.

On the other hand, eXe's HTML editor does not allow a correct use of the section headers. The correct usage of headers eases the navigation of contents and allows for semantic structure in the web page's contents. The elements h1, h2... h6 must be used to provide said structure and must be used following the internal hierarchy (without skipping, for example, from h2 to h4 without providing a header h3 in between).

The links generated can be formatted in an accessible form with the HTML editor of eXe. Considering accessibility, it is fundamental that the text and/or image that make up a link, meets its objective autonomously. An adequate text or an image with an alternative description guided in each link is fundamental because some users only look at this element



of the Web to access information they are interested (Sayago & Blat, 2004.). This happens to those who browse the web in devices with small screens and those who access Internet through a screen reader.

In general the solution to these issues lies in the modification of the source code of eXe.

### **A Study Of Accessibility In Learnign Object Repositories**

At the time of implementing e-learning resources, it is necessary to apply high-quality methods of design in order to be able to identify and correct accessibility problems in a simple way when they arise, i.e., it needs to be ensured that the implemented content is accessible for all users.

"Evaluating Web Sites for Accessibility", a document proposed by the World Wide Web Consortium (W3C)'s Web Accessibility Initiative (WAI) [5], which is an effort to improve the accessibility of the World Wide Web (WWW or Web) for people with disabilities, provides orientations to evaluate, efficiently, some problems related to accessibility in a web site. Moreover, the document presents general procedures and tips for evaluation in different situations, from evaluation during Web site development to on-going monitoring of existing sites and to evaluate the accomplishment of the Web Content Accessibility Guidelines (WCAG) [4].

Nowadays, tools that help determine automatically if a Web site meets accessibility guidelines exist. However, it is necessary that a person, who knows about it, controls the process. This is because; Web accessibility evaluation tools just provide an initial revision, i.e, automatically detect some basic mistakes. The use of the majority of these programs is quite simple, just it is necessary to write down the web address that hosts the Web site and run the program.

The other issue to be cover in this paper, in doing a study about accessibility on Websites for Learning Objects Repositories, since our focus of interest is the Open and distance learning.

In recent studies performed to evaluate the accessibility in Websites for learning objects, serious shortcomings were found [3,9,10]. According to Cristòfol Rovira, Mari-Carmen Marcos and Lluís Codina [3] the main reasons for these shortcomings are: the use of discouraged labels by the W3C and the incomplete o wrong codification of HTML labels.

We tested the accessibility of some Websites for managing learning objects with the following accessibility evaluation tools: HERA [7], TAW [6] and INTAV [8]. The aim of this experiment was to verify the existence of accessible learning object repository.

For the evaluation, we just considered the minimum level of conformance of the WCAG 1.0 [4]. The result of the evaluation is a number, which represents the amount of detected accessibility errors. In the following table we show the obtained results for each evaluation tool. Last column represents the average of detected errors.



REGION	HERA	T.A.W	INTAV	%ERROR	COMMON ERRORS FOUND
North America	2	2	1	1.25	*1.1. Provide a text equivalent for every non-text element.  *6.3. Ensure that pages are usable when scripts, applets, or other programmatic objects are turned off or not supported.  *8.1. Make programmatic elements such as scripts and applets directly accessible or compatible with assistive technologies.  *12.1. Title each frame to facilitate frame identification and navigation.
	1	0	0	0.25	
	2	1	1	1	
	2	9	2	3.25	
Europe	1	0	1	0.5	
	3	4	3	2.5	
	1	1	1	0.75	
	0	0	0	0	
Asia & Africa	0	4	1	1.25	
	1	1	0	0.5	
	1	11	1	3.25	
	0	0	0	0	
Central & South America	1	4	2	1.75	
	3	3	1	1.75	
	1	6	4	2.75	
	1	1	1	0.75	
				1,344	

#### Accessibility errors detected in Learning Objects Repositories

For example, for the first repository evaluated whit HERA detected 2 accessibility errors, TAW detected 2 accessibility errors and INTAV detected 1 accessibility error. The average of perceives errors in this learning objects repository are 1,344. The most common error is the failure of criterion 1.1: Images without alternative text.

REGION	HERA	T.A.W	INTAV	%CRITERIA TO VERIFY	COMMON CRITERIA TO VERIFY
North America	9	252	10	65.25	*2.1. Ensure that all information conveyed with colour is also available without colour, for example from context or markup. *4.1. Clearly identify changes in the natural language of a document's text and any text equivalents. *5.1. For data tables, identify row and column headers. *5.2. For data tables that have two or more logical levels of row or column headers, use markup to associate data cells and header cells.
	9	132	11	35.25	
	9	93	12	25.5	
	7	29	10	9	
Europe	7	42	10	12.25	
	8	185	14	48.25	
	8	15	6	5.75	
	7	22	8	7.25	
Asia & Africa	0	0	0	0	
	4	5	6	2.25	
	9	74	8	20.75	
	7	12	8	4.75	
Central & South America	10	94	10	26	
	8	191	12	49.75	
	10	72	34	20.5	
	7	20	8	6.75	
				21.203	

#### Accessibility criteria for verifying in Learning Objects Repositories

The obtained result of evaluation shows the average of suggested criteria to check in learning objects repositories evaluated is 21.203. The most common criteria to verify is the failure of criterion 2.1: Verify that information is not transmitted only through colour.

## Conclusions

The use of open source software favours accessibility. Even though it does not avoid the problem of inaccessible content creation, it makes available its source code and favours reprogramming to make it accessible.



The solution to the accessibility problems produced by the automatic generation applications turns out to be very complex due to the necessity to reprogramming source code, which involves proper management of it and advanced knowledge on programming in many cases.

eXe-Learning needs to be reprogrammed in order to adjust HTML and CSS code to the formal grammar of the W3C. A correct coding can be correctly interpreted by the user's navigation devices and particularly by the special devices used by handicapped people.

It is necessary to count with a textual alternative to the information generated by programmed objects, such as scripts. This work will be done in the long term due to the programming complexity of these scripts in eXe-Learning.

It is necessary that in the mid-term, those in charge of virtual campuses in Universities consider the best conditions of accessibility in their campus. Considering in a special way the decision about the tools that it's offered to main actors in the education. It's an obligation to guarantee that the offered utility orients the access necessities of all of people to the services and contents delivered.

In the long term, it is recommended to reprogram the authorship program, eXe-Learning, because its code generation results with accessibility obstacles. In the short term, style sheets can be improved and in the long term the source code in Python can be improved in order for the code generation to become clean and be able to introduce accessibility characteristics, like the use of section headers, for example, even though the program is written in an intermediate language and there is not enough documentation on it, which makes reprogramming of it more difficult.

The study carried out provides an overview of the current situation of the learning object repositories according to accessibility. The main issue in this point is to offer the appropriated formation to the designers of the learning objects and services (teachers, web designers in the universities) in order to improve the quality offered.

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### 8.3. Accessibility Review Of Open Educational Resources

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#### Abstract

Open Educational Resources (OER) are relatively new for educators in Europe, but are gaining traction with new incentives for creation and adoption.

Trained project staff members surveyed the accessibility of 60 OER textbooks written for a wide variety of courses commonly taught in the first years of college. The texts were evaluated against twenty-six accessibility metrics based on the international Web Accessibility Initiative and the US Section 508 guidelines. Flaws were noted, and recommendations for improvement given to the authors.

In order to build accessibility into open educational resources, authors need to be more aware and better supported.

#### Keywords

Open Educational Resources, accessibility review, education, textbooks.

#### Introduction

##### **Open Educational Resources, accessibility, and European educational institutions**

Open Educational Resources (OER) are openly licensed, digital materials available at low cost. Open Textbooks, part of OER, often originally created with a traditional All Rights Reserved Copyright, have been converted to a Some Rights Reserved copyright. Adopting instructors can modify these materials to fit their instructional needs.

The OER-HE (Open Education Resources in European Higher Education) project called EADTU, catalysed by the William and Flora Hewlett Foundation, is granted by the EC. [1] Its objective is to create a strong European conceptual basis for OER, linked to social and constructivist learning. European OER adoption varies widely by country, and between institutions with different historical backgrounds (such as religious or political affiliation). A non-exhaustive research in November 2010 of 426 European universities showed that 57





European institutions are members of the OpenCourseWare Consortium (OCW) and 101 are members of the European Distance and E-Learning Network (EDEN). These numbers show emerging European interest in OER. See below Table for particulars.

Country	Institutional Members of OCW	Institutional Members of EDEN
Austria	1	4
Belgium	1	9
Denmark	1	-
France	3	7
Germany	-	6
Greece	-	5
Ireland	-	6
Italy	-	11
Netherlands	3	5
Norway	-	12
Portugal	-	7
Spain	40	11
Sweden	-	2
Switzerland	1	5
United Kingdom	7	11

**European members of the OpenCourseWare Consortium and the European Distance and E-Learning Network**

### Disability and accessible education

The prevalence of Europeans with disabilities is generally reported as over 15 % of the population, depending on the definition of disability. [2]

The UN Convention on the Rights of Persons with Disabilities, adopted in 2006, explicitly states: "Discrimination on the basis of disability means any distinction, exclusion or restriction on the basis of disability which has the purpose or effect of impairing or nullifying the recognition, enjoyment or exercise, on an equal basis with others, of all human rights and fundamental freedoms in the political, economic, social, cultural, civil or any other field. It includes all forms of discrimination, including denial of reasonable accommodation." [3] Article 24 deals with the topic of Education, where the State Parties shall ensure an inclusive education system at all levels and life-long learning.

By a series of policy statements, Member States of the European Community committed to improve the accessibility of public websites generally. In particular, the Riga Ministerial Declaration indicated that all public websites should be accessible by 2010. Recent monitoring of the status of web accessibility in Europe shows, however, that progress toward this goal remains slow. [4]

Educators have both an ethical and a legal responsibility to provide materials that can be utilized by all students regardless of disability. By doing so, they can improve the lives of all learners. As an example, video captions enable learners who are audio impaired to follow a sound track. These same video captions also support students who are learning a new language, are dyslexic, or have learning disabilities.



## The Project

### Context

Funded by The William and Flora Hewlett Foundation, College Open Textbooks [5] is a United States-based collection of colleges, governmental agencies, education non-profits, and other education-related organizations that are focused on the mission of driving awareness and advocacy for open textbooks. The work of College Open Textbooks includes providing training for instructors adopting open resources, peer reviews of open textbooks, and online professional mentoring networks that supports authors who open their resources. At the time of writing, College Open Textbooks has reviewed more than 100 open textbooks for use in community college courses and identified nearly 700 open textbooks.

The goal of the project described here was to evaluate 60 open textbooks from different subject areas and in different formats against 26 common metrics for accessibility, reaching an in-depth, consistent and quantitatively comparable scoring. The work was done by Virtual Ability, Inc. Summaries of the evaluations are presented on the College Open Textbooks website (<http://collegeopentextbooks.org/opentextbookcontent/accessibility-reviews-.html>).

### Metrics

The twenty-six chosen metrics were based on the WCAG and Section 508 guidelines, and best practices regarding cognitive accessibility. These metrics were further grouped into the four WCAG POUR principles: Perceivable, Operable, Understandable, and Robust [15]. These metrics and the principles to which they are assigned are shown in below Table.

Principle	Metrics
<b>Perceivable</b> material can be accessed using any intact sense or through assistive technology.	Text alternatives to images, Colour contrast, Screen flicker
<b>Operable</b> content works correctly with assistive technology.	Style sheets, Image maps, Data tables, Frames, Electronic forms, In-page navigation, Timed responses, Structural markup for heading, lists, and quotations
<b>Understandable</b> material makes sense.	Use of colour, Readability, Simple visual formatting, No visual clutter, Definitions, Visual-semantic organizers, Error-free input, Easy recovery from errors, Language identifier
<b>Robust</b> content works now and in the future.	Non-mouse operation, Equivalent alternatives for multimedia presentations, ARIA, Customizable, Captions for any audio, Alternative text for images that provides equivalent information

**The four POUR principles and associated metrics**

Eleven of the metrics were determined to be not applicable for PDF documents. These included image maps, frames, and ARIA.



## Methodology

### Special points of attention regarding the evaluation process

Special attention has to be given to defining the most objective evaluation and scoring methods for each metric. The evaluated textbooks represent 17 subject areas, from history to mathematics. To evaluate metrics of the Understandable principle, the evaluator must have content knowledge of the domain.

Also, it would not have made sense to apply a simple formula for a readability score (in this evaluation process, the Flesch Reading Ease Score) without preparation and selection of appropriate texts. Chemical equations, or sentences containing many non-English nouns, would invalidate the scoring algorithm. Still, the end result of evaluations should be consistent regardless of the different subject areas of the texts. Thorough preparation of the material to be evaluated is a critical success factor.

Another point of attention for this type of project is the project team itself, which should be constituted of very diverse members, with different abilities and disabilities.

A significant number of these texts, 42 %, were published as downloadable PDFs. Specifically regarding PDF textbooks, the assumption is made that only the PDF textbook itself should be reviewed, not the website from which the PDF is downloaded. If the website is inaccessible, the PDF is in effect also inaccessible. Strictly seen, the accessibility of the hosting environment should be reviewed too. In this project, this was out of scope. Also, some website-based textbooks require a login. The evaluation of accessibility for the login activity was out of scope.

The Virtual Ability project team evaluated 999 metrics, both quantitative and qualitative, of which 718 (72%) were for website-based textbooks and 281 (28%) for PDF textbooks. If all metrics had been evaluated in all books, a total of 1560 metrics would have been evaluated. In actuality, 999 metrics were scored and recorded, as shown in Table 3. Textbooks were initially screened for metrics that should be marked “not applicable”, such as books with no images, no audio, or no multimedia. Automated tools were unreliable for detecting images that needed to be evaluated for alt text. They would sometimes give error indications of images without alt texts, whereas manual validation of the automated check might show that these were visual backgrounds to text or some other cosmetic usage, and therefore the images should not have had alt-text.

	Number
Total potential metrics to be screened	1560 (60 * 26)
Total without “Not Applicable” for PDF documents	1296
“Not Applicable” after additional initial screening	297
Actual number of metrics screened	999

**Numbers of metrics**



### Sources of website-based textbooks

Textbooks that reside on websites may originate in three manners. Some authors create their own websites. Other authors use a sponsoring institution's website. Increasing numbers of OER textbooks are collected on platforms where a structured format is provided by the platform developer. This project evaluated textbooks from five different platforms, as shown in below Table.

Platform	URL	Number of Books
Connexions	<a href="http://cnx.org/">http://cnx.org/</a>	8
Flat World Knowledge	<a href="http://www.flatworldknowledge.com/">www.flatworldknowledge.com/</a>	3
Open Learn	<a href="http://openlearn.open.ac.uk/">http://openlearn.open.ac.uk/</a>	3
Open Learning Initiative	<a href="http://oli.web.cmu.edu/openlearning/">http://oli.web.cmu.edu/openlearning/</a>	3
MediaWiki	<a href="http://en.wikibooks.org">http://en.wikibooks.org</a>	4
MediaWiki	<a href="http://en.wikiversity.org">http://en.wikiversity.org</a>	2
MediaWiki	<a href="http://chemwiki.ucdavis.edu">http://chemwiki.ucdavis.edu</a>	1

**Textbook platforms**

## Results

### Results for website-based textbooks

These websites exhibited common accessibility issues, independent of source, generalized in following Table.

Issues	Percent with this issue	Examples of issue
Structural semantic organizers	42 %	Headers not nested or ordered; headers used for page layout; improperly coded bulleted lists
Table headings	39 %	Missing headings
Table attributes	31 %	Missing titles and/or summaries
Fixed width page	23 %	Makes it difficult to change font size or screen resolution
In-page navigation	36 %	Non-sighted readers need non-linear navigation capabilities
Data entry with Flash	8 %	Inaccessible to screen readers
Reliance on scripts	6 %	Inaccessible to screen readers
Non-mouse operation	19 %	Keyboard indicator not shown



Issues	Percent with this issue	Examples of issue
Use of frames	8 %	Excessive scrolling required with fixed size frames; content wrap/line breaks make variable width frames content unreadable

**Common accessibility issues in web-based textbooks**

### Results for PDF textbooks

A set of features required for full accessibility of PDF documents is shown in Table 6. No PDF textbooks evaluated in this project were accessible on metrics in the Operable and Robust principles. Most probably, the authors used Microsoft Word, which did not have any export function to tagged PDFs until version 2010 (release date April 2010).

Required Features
Proper tagging and reading order
Searchable text
Fonts that allow character extraction to text
Interactive form fields (if present)
Non-mouse navigational aids
Specified document or text block language
No security restrictions that interfere with assistive technology
Proper tagging and reading order
Alternative texts for images and interactive form fields

**Required accessibility features in PDFs**

### Results common to all formats

Several major accessibility issues occur across both formats, web-based and PDF. These are mainly issues that are under the author's control and could be included in the author's initial design of the textbook. Common accessibility issues are shown in following Table.

Common Issues	Percent for web-based	Percentage for PDF
Visual appearance	17 %	32 %
Content organization: important/less important	14 %	20 %
Content organization: missing table of contents	12 %	12 %
Content organization: lengthy pages	23 %	4 %
Organizational flow of information	14 %	4 %



<b>Common Issues</b>	<b>Percent for web-based</b>	<b>Percentage for PDF</b>
Inconsistent emphasis	9 %	28 %
Need glossary	54 %	44 %
Inconsistent or inappropriate author's voice	11 %	12 %
Inconsistent visual format	17 %	28 %
Inconsistent reading ease	26 %	44 %
No textual alternatives for missing alt text	63 %	100 %
No alternatives for colour coding	14 %	12 %
Inappropriate comprehension level	27 %	36 %

**Accessibility issues across delivery formats**

### Quantitative results related to the type of textbook

Regarding the use of platforms, the average score across all measured metrics for textbooks within each group is shown in below Table.

<b>Format</b>	<b>Average Score</b>
Connexions	4
Flat World Knowledge	3
Open Learn	4
Open Learning Initiative	2.4
Wikimedia	4.1
Web-based textbooks	3.5
PDFs	2.7

**Average scores for accessibility**

We can safely conclude that the variation between those scores is, for the most part, related to accessibility issues of the delivery mediums. PDF textbooks scored a low of 2.7, mostly due to the lack of tagging as explained above.

In general, although many issues have been noted, the average score of all 60 textbooks was above the median possible score. The scoring model is shown in following Table.

<b>Numeric Score</b>	<b>Interpretation</b>
<b>1</b>	Lowest, not accessible
<b>2</b>	Poorly accessible, many or important accessibility issues

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<b>Numeric Score</b>	<b>Interpretation</b>
<b>3</b>	Average, partially accessible, some accessibility issues
<b>4</b>	Well accessible, but with some accessibility issues
<b>5</b>	Highest, perfectly accessible

**Scoring model**

Most website based textbooks (including those on platforms) did reach level 4 for Perceivable and Understandable metrics, with scores a bit lower on the Operable and Robust metrics. PDF textbooks reached a slightly lower score for Understandable metrics, dropped under the mean for Perceivable metrics, and were inaccessible regarding Operable and Robust metrics due to lack of tagging.

### Positive findings

Lest it seem that all findings were indications of accessibility difficulties, it should be noted that evaluators were requested to mention particularly well-done features of textbooks that they examined. Positive features noted in more than one text include appropriate readability level (3 PDFs), visual-semantic organization (2 PDFs), consistency of formatting (2 PDFs), and well-structured content within a didactic (journalistic) presentation style (2 PDFs and 1 website).

### Conclusions And Recommendations

The accessibility review of 24 PDF textbooks and 36 website-based textbooks, across 17 subject areas, clearly highlighted diverse issues with accessibility, notwithstanding an overall reasonable score. Accessibility concerns may be split in two parts: the delivery medium, and the content of the textbooks. Whether the web base of the textbook is created by a platform, an institution, or the author, lack of awareness of accessibility features is a likely reason for common accessibility concerns. Regarding PDF textbooks, the most obvious flaw was the lack of tagging, making these books completely inaccessible in several ways. The prevalence of issues confirms the general lack of information about accessibility features of both web- and PDF-formatted OER.

Other elements, including most metrics in the Operable and Understandable principles, are within author control, no matter the delivery mechanism. Therefore, we recommend that authors and platform developers be made aware of the legal, ethical, and technical reasons for providing textbooks in an accessible form. Information about accessibility, particularly about the most easily addressed issues, could be provided on the websites of the collections, websites of associations like the College Open Textbooks, or through author seminars, courses, or webinars available through a variety of venues and professional organizations.

Following awareness, authors and platform developers need how-to knowledge, design tools, and other software to build in accessibility features and test that they work properly. In terms of retro-fitting existing OER materials, using the Economies of Scale principle, the immediate benefits of adapting the various textbook-collection platforms outweigh the cost of individual adaptations of textbooks.



Some authors may need additional professional assistance, particularly for the more technical aspects of accessibility. Post-processing their texts to ensure accessibility would need to occur initially and upon updating. This assistance could be provided by institutional media lab support on campus, private accessibility firms, or consortia of like-minded individuals such as College Open Textbooks.

Finally, incentives for creating accessible online textbooks need to be examined. Additional planning and effort are required to make OER materials accessible to students with special needs or those using assistive technology. What will swing the cost-benefit ratio in favour of designing OER materials so they can be effectively used by all students?

However it is accomplished, providing accessible textbooks to a population of 15 % disabled people is, in our opinion, a responsibility of the educational world and a duty of society.

### Acknowledgement

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## 8.4. Accessible Course Materials For Students With Dyslexia

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### Abstract

The Katholieke Universiteit Leuven (K.U.Leuven) has a tradition of supporting students with a disability in order to guarantee equal opportunities to achieve their educational, personal and vocational goals. One of the target groups with increasing numbers consists of students with learning disabilities (including dyslexia, dyscalculia, etc.). The K.U.Leuven implemented the use of assistive technology for this target group but simultaneously needed to provide sufficient access to digital course material. This paper will provide more details on the process and an evaluation of the first academic year (2010-2011) this service was provided.

### Keywords

Accessibility and usability, people with disabilities, dyslexia, assistive technology, accessibility, accessible course material

### Introduction

Dyslexia is a disorder in which a persistent problem arises with acquiring and applying reading and/or spelling at word level [1]. Even though many students develop effective coping strategies, these strategies are seriously put to the test by the high literacy demands that are typical of higher education. Typical problems are slow and inaccurate reading, poor spelling, difficulty with note taking during lectures, and more time required for written tasks. As a consequence of these difficulties, students with dyslexia may also have a lower self-esteem.

At this moment, there are growing numbers of students with dyslexia accessing higher education. The K.U.Leuven has seen a yearly increase of up to 20% of students with a learning disability since 2005-2006. Students with a learning disability like dyslexia now account for 41% of the students with a disability. In the Netherlands, about 14.000 out of 500.000 students have dyslexia; this represents 3% of the total student population [2]. The same evolution is seen in the UK, where the population of students with dyslexia has risen from 21.000 in 2004/2005 (2.4%) to 27.465 (3.1%) in 2007/2008 [3]. At the same time we see that evolutions in ICT have created many possibilities to prevent “handicap situations” (meaning a reduced accomplishment of life habits as a result of complex interactions between personal factors (personal characteristics such as impairments) and environmental factors) [4]. Several studies have demonstrated that using a text reader has a statistically significant impact on student text comprehension [5] [6].

### Methodology

The Katholieke Universiteit Leuven has a tradition of supporting students with a disability in order to guarantee equal opportunities for achieving their educational, personal and vocational goals. The K.U.Leuven policy is striving towards inclusive education in the long



term, by improving facilities and accommodation for certain target groups in the short term. Efforts have also been directed to make the learning environment more accessible for all kinds of students, especially over the last few years. One of the target groups that has increasing numbers are students with learning disabilities (including dyslexia and dyscalculia). To accommodate these students, the K.U.Leuven started a research project to evaluate the impact of the use of assistive technology (AT) for dyslexia [7]. It was clear that technology could alleviate the problems faced by students with dyslexia and other learning disabilities.

### Special-purpose software

Students with special needs, especially dyslexia, are accommodated by the use of AT. For dyslexia, there are two software programs that are widely used in primary and secondary education in Flanders. These programs are also used by students in higher education. These programs are Kurzweil3000 and Sprint. Kurzweil3000 [8] is a comprehensive reading, writing and learning software solution for students with special needs. The software can access documents in print (with the use of a scanner) or on the Web, and electronic documents. Students can use it to read course material with increased speed; they can get visual and auditory feedback and use it for writing assignments. Sprint [9] adds speech and language technology to a computer so that students can listen to documents, Web pages, email,... in fact to any available text on their computer, as Sprint reads them out aloud. Sprint also can read aloud while text is being entered which helps in detecting errors.

### Survey

During the academic year 2008-2009, 21 students participated in a small-scale research on the use of AT for students with dyslexia. All participants agreed to be interviewed three times during the academic year. At the beginning the interview focused on their experience with ICT and their diagnosis of dyslexia. A second interview was held in the weeks after the first semester examinations. This interview focused on the possibilities of the AT, the problems and needs the students have faced, usability, and possible improvements. Finally, at the end of the academic year but before the examinations in June, there was an evaluation of the project by the students.

The AT used in the project, Kurzweil3000 and Sprint, both have advantages and disadvantages. Students need to have some basic computer skills to be capable of using this software. There needs to be sufficient training to make full use of all the possibilities this AT offers. Also some preconditions need to be in place to successfully implement this software. These preconditions consist of the availability of digital course material, the possibility or authorization to use ICT during courses and assessments, and sufficient computer skills for the students. Finally university support for many years should be guaranteed in order to maximise the students' motivation to learn and rely on these programs.

As can be concluded from the survey, some participants dropped out of the research due to the lack of digital course material. They found that scanning all their readers and handbooks would take too much time since they are already limited in time due to their disability. The advantage of the AT, i.e. the possibility to read at higher speed didn't compensate for the time they anticipated needing for scanning all material.



### Further implementation of AT and access to digital course material

For the further implementation of AT for dyslexia, K.U.Leuven needed to provide sufficient access to digital course materials. In order to support its students with dyslexia, an on-line form (<http://www.kuleuven.be/digitaletogankelijkheid/dyslexie/formulier>) was created which the students could use to provide all information needed to request alternate text formats of handbooks.

During the previous academic year (2009-2010) students requested alternate text formats through the K.U.Leuven's Disability Team [10]. For this target group, the requests rose to 60; 40 of these requests were positively answered. Due to the, sometimes very detailed, information needed for processing request forms for students with disabilities and the increasing numbers of students applying for AT, it was necessary to improve the work flow of submitting requests.

The above mentioned on-line form contains a broad range of questions several international publishers use in their own on-line request forms [11]. Additionally, a procedure for processing these requests was developed. The alternate file formats of textbooks were then distributed to the individual students, either through Toledo, the Blackboard based electronic learning environment of the K.U.Leuven, or on CD if so requested by the publisher.

### Accessing and managing digital course material

The introduction of this on-line form permitted to streamline the incoming requests for alternate text formats. During the academic year 2010-2011 there were 199 requests made by 44 students. Of these requests, 158 (79%) alternate text formats were provided. Of this material, 121 (77%) was downloaded by the requesting student. This means that about 61% of the requests were granted and reached the student. 39% were not granted by the publisher or downloaded by the student. On average, a student had to wait for 23 days before he or she could access alternate text formats, with a median of 13 days. One student asked for 18 textbooks, on average a student requested 4 textbooks. 30% of the textbooks were requested by multiple students.

Number of requests:	199	
Average waiting period (in days) between request and access to material:	23,68	
Median:	13,5	
Standard deviation:	38,28	
Number of students filing a request:	44	
Highest number of requests by 1 student:	18	
Granted requests:	158	79%
Available but not downloaded:	37	23%
Successful downloads:	121	77%



Downloads ratio - total number of requests:	61%	
Average number of applications per student:	4,52	
Number of unique applications - percentage of double applications:	139	30%

#### Analysis requests academic year 2010-2011

During the academic year 2010-2011, 66 different publishers were contacted. Most books (78) were requested from Acco, which granted 100%. (The cooperative organisation Acco is responsible for the development, production and sales of course material and scientific work. Acco was founded in September 1960 in Leuven as a student cooperative to provide the students of the K.U.Leuven with low-cost course materials.) This was followed by Pearson where 38 book requests were submitted, and 82% were answered positively.

<b>Publishers:</b>			
Number of publishers contacted:	66		
most books requested at:	78	Acco	
most books granted by:	78	Acco	100%
2nd place of requests:	38	Pearson	
2nd place granted:	31	Pearson	82%

#### Analysis Publishers' contacts

For providing the requested course materials, a community in Toledo, the electronic learning environment of the K.U.Leuven, was created. This community is only accessible for students with a disability who are registered within the Disability Team. Via a link in the menu (Documents), the students who are member of the community can click through to the course material that they applied for. Through this link, they are routed to Toledo+, an extension of Toledo that focuses on managing and sharing documents. This tool makes it possible to only give access to these students who requested an alternate text format.

## Conclusion

The average waiting time of 23 days raises questions about a proper follow-up for students. Students need to know when the documents will be available in order to plan properly. If a manual is not available, they should scan textbooks themselves or find another way to study the materials. Both methods require more time for students with dyslexia.

For the next academic year the follow-up of the availability of course materials should be done in a more structured way (e.g. informing the student on a regular basis about the status of his or her applications). But students can also contribute: they should request books as soon as possible.

During the previous academic year it became clear that because of the increased supply of files in Toledo+, the controllability and manageability of the digital course materials would no longer be feasible. A consultation with the University Library Services (Universitaire Bibliotheekdiensten – UBD) was planned to address the problems with storage and access

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of e-sources that are not available on an on-line platform. These are both native digital materials as well as digital files in the form of CD-ROM, PDF, etc. To date there is no actual directive on the procedures and standards to be applied (work-flow) within the K.U.Leuven. Other issues that must be addressed in the near future are copyright laws, digital meta-data and sustainable archiving.

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## 8.5. ICT-Inclusive, A Train-The-Trainer Package To Support Teaching ICT-Skills To Pupils With Intellectual Disabilities

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### Abstract

Professionals working with adults with intellectual disabilities and with pupils in special education become more and more aware of the potential of ICT. However, an optimised use of ICT by people with intellectual disabilities depends strongly on the ICT and pedagogical skills of the coaching professional.

This paper outlines the ICT competencies for coaching professionals. By means of qualitative interviews in two focus groups, an ICT competency profile was established. Furthermore, this paper describes a 9-step plan based on the 4C/ID-model of 'van Merriënboer' to support teaching ICT-skills to adults with intellectual disabilities or to pupils in special education [9].

### Keywords

Intellectual disabilities, ICT competences, ICT skills, train-the-trainer

### Introduction

Making ICT accessible to people with moderate to severe intellectual disabilities is not only about technology but also about informed and trained professionals. More and more, professionals working with adults and pupils with moderate to severe intellectual disabilities become aware of the opportunities and benefits offered by ICT. Although those professionals are willing to embed ICT in their daily activities, they often do not know where and how to start. Teachers in special education and social workers not only need to know which assistive tools, hardware and software are compliant with accessibility and usability requirements but they also should know pedagogical approaches that facilitate learning ICT.

The Flemish Ministry of Education and Training states that ICT in primary education and the first stage of secondary education is not a separate subject. While ICT provides opportunities within all subjects and fields of study, schools are obliged to deploy the ICT-related cross-curricular final objectives as rolled out on September 1, 2007. The key system for acquiring ICT technical and instrumental knowledge and skills is to incorporate them into daily classroom life. The aim is rolling out basic ICT competencies by doing [14, 16]. The same objectives are defined for special education. Based on formal and informal interviews and observations, it appears however that acquiring the basic ICT skills to operate a computer is a major obstacle for many students in special education. Hence, using ICT in special education needs a special approach, which at the moment more relies on the good practice based upon the experience of an individual teacher, rather than on a decent pedagogical model.

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A survey conducted in the scope of a previous project of the ICT-Inclusive research group, showed that adults with limited intellectual capabilities consider the computer as a gateway to today's world of entertainment and social life. Social workers who answered the survey emphasised the urgent need for educational guidelines to train the ICT skills of people with intellectual disabilities [2].

Other research [1, 6, 11, 12] confirms the need of adults with intellectual disabilities to participate in the knowledge society through ICT; but also refers to the need for a customised pedagogical training of persons in the vicinity, such as coaches and family.

In response to the demand for a didactic approach for integrating ICT for teachers in special education, as well as for employees working in facilities caring for adults with special needs, a train-the-trainer package has been developed. The train-the-trainer package consists of an ICT competency profile for the coaching professional (the trainer) and of a 9-step plan to support the trainer pedagogically. In the next section, we shortly explain the ICT competence profile. Thereafter we elaborate upon the 9-step didactical plan. In section 4, we share our experience with some pilot studies. Finally, in section 5, we state our conclusions.

### ICT Competency Profile

In Belgium two studies on the ICT competencies of teaching professionals are relevant: Mictivo and pICTos. Both studies are conducted on demand of The Flemish Ministry of Education and Training.

Mictivo is a monitoring instrument developed by researchers from the Universities of Ghent and Leuven [7]. Among three other indicators Mictivo measures the ICT competences of pupils and teachers. Mictivo aims to provide a general picture of the ICT skills of teachers in Flanders, and therefore is intended for policy assessment, rather than for diagnostic use by the individual teacher.

pICTos (Planning for ICT in Schools) is an online software tool that supports school teams in the development of an ICT-strategy. In addition, pICTos contains a module to visualise and compare the ICT skills of teachers at the same school. This insight is the basis for a team discussion on ICT skills and further professional development needs [13]. In our research, the pICTos competency profile wasn't retained, either. The main argument is that it was not put up with teachers in special education and care takers for people with intellectual disabilities in mind.

While both Flemish ICT competency profiles did not meet the goals of the "ICT-inclusive"-project, the research group worked out an ICT competency profile by means of qualitative interviews in two focus groups: one with more and one with less ICT experienced professionals. For a teacher or social worker, being ICT competent or ICT literate involves more than only being able to demonstrate the necessary technical knowledge. This resulted in a competency profile with five core ICT competencies.

The five core competencies are:

- showing a positive attitude towards ICT
- having sufficient technical ICT skill competence for operating the machine
- preparing ICT activities taking into account the limitations of the target group

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- demonstrating pedagogical knowledge and awareness of how to make the target group ICT competent
- integrating ICT in daily (classroom) activities

Each of the core competencies are concretised in a set of sub-competencies which are given a number between 1 and 4, indicating the level of proficiency. All sub-competencies with number 1 are considered as the base competences. The more 'higher order skills' trainers acquire, the more complex ICT activities they can set up for their pupils. Trainers can go through the competency profile to identify the skills they already possess and those they still need to acquire [4]. Table 1 shows the ICT competency profile.

<b>ICT – competency profile for professionals working with pupils in special education and adults with intellectual disabilities</b>	
<b>1</b>	<b>Showing a positive attitude towards ICT</b>
	<i>I have a positive attitude towards ICT that I send out to the target group, colleagues and the organisation.</i>
1.	I recognise the value of ICT use by people with intellectual disabilities.
2.	I like sharing experiences with ICT among colleagues.
3.	I can inspire and motivate colleagues to use ICT.
4.	I can participate in the development of the long term ICT-strategy of the organisation.
<b>2</b>	<b>Having sufficient technical ICT skills</b>
	<i>I possess the technical skills to operate the computer.</i>
1.	I can work with an operating system like Windows XP, Vista, Windows 7.
1.	I can work with a word processor such as Microsoft Word
1.	I can work with software for data processing such as Microsoft Excel.
2.	I can work with presentation software like Microsoft PowerPoint.
2.	I can look up information on the Internet.
2.	I can work with an email program.
3.	I can copy and paste images from the Internet.
3.	I can prepare the computer so that the necessary programs are ready to use.
3.	I can work on the Internet in a safe and secure way.
4.	I know how to act in case of computer failure.
<b>3</b>	<b>Preparing ICT activities</b>
	<i>I can prepare ICT activities with knowledge of the capabilities and interests of the target group.</i>
1.	I prepare ICT activities taking into account individual differences in interest, level and pace
2.	I know what software suits into the world of the target group.
2.	I know what posture students should adopt when working at the computer
2.	I know the existence of (ergonomic) computer equipment to serve as assistive devices for persons with disabilities
3.	I know which sites fit into the world of the target group
3.	I recognise accessible websites on the Internet.
4.	I can modify (mouse, keyboard, ...) settings to make the computer accessible to an individual with a disability
<b>4</b>	<b>Demonstrating pedagogical knowledge</b>
	<i>I choose the right didactic approach while teaching ICT skills to people with intellectual disabilities.</i>
1.	I can determine the ICT start level of a person with a disability.
1.	I can analyse ICT skills and determine the difficulties for a person with a disability.
1.	I teach ICT skills in a step-by-step learning program.
2.	I use the right software to practise the acquired skills.
3.	I provide tailor-made aids such as a visual step plan, a guide, a customised desktop, ... to





<b>ICT – competency profile for professionals working with pupils in special education and adults with intellectual disabilities</b>	
	promote working independently on the computer.
4.	I make sure that the target group can transfer the acquired skills to other contexts.
4.	I can teach the target group to use the Internet in a safe manner.
<b>5</b>	<b>Integrating ICT in daily (classroom) activities</b>
	<i>I can stimulate ICT integration.</i>
1.	I can work on a project where the target group uses a range of ICT applications.
2.	I can inspire colleagues to fit ICT into the structural activities of the target group.
3.	I make parents and the network of persons with disabilities aware of the possibilities and the danger of ICT.
4.	I encourage the target group to use ICT independently in everyday life.

#### **ICT Competency Profile**

### **9-Step Plan Based On 4c/ld**

For each of the above core competencies it is documented how, and through which organisations, publications or programs, the trainer can broaden his profile.

Focussing on the core competence “Demonstrating pedagogical knowledge” the ICT Inclusive research group has designed a 9-step plan to support teachers and coaches on developing their own tailor-made ICT curriculum for a particular person with intellectual disabilities. The 9-step plan is based on the 4C/ID- model (4-Component Instructional Design) of van Merriënboer [9] and is described in detail in the remainder of this section.

#### **Justification for model selection**

Our choice for the 4C/ID-model was based upon a number of frequently recurring elements in literature and from expert interviews on how people with intellectual disabilities acquire new skills. Examples are given in [3, 8, 10, 18]. In summary, the most important principles are:

- The skills to acquire are meaningful and reflect the interests of the learner
- Complex skills are split up.
- Learning is a cumulative process that builds on existing knowledge structures.
- Learning is an active process: learning by doing embedded in a meaningful context
- Differentiating instruction is necessary to suit different ability levels and learning styles.
- Diminishing support leads to working independently and gradually shifts responsibility to the learners (scaffolding)
- ICT technical and instrumental knowledge and skills are taught separately the moment they are needed in the learning process.

Although the 4C/ID-model combines the necessary concepts, we cannot apply it in its authentic state. Before explaining the adaptations to the original model, we will first shortly clarify the basic principles of the 4C/ID-model.

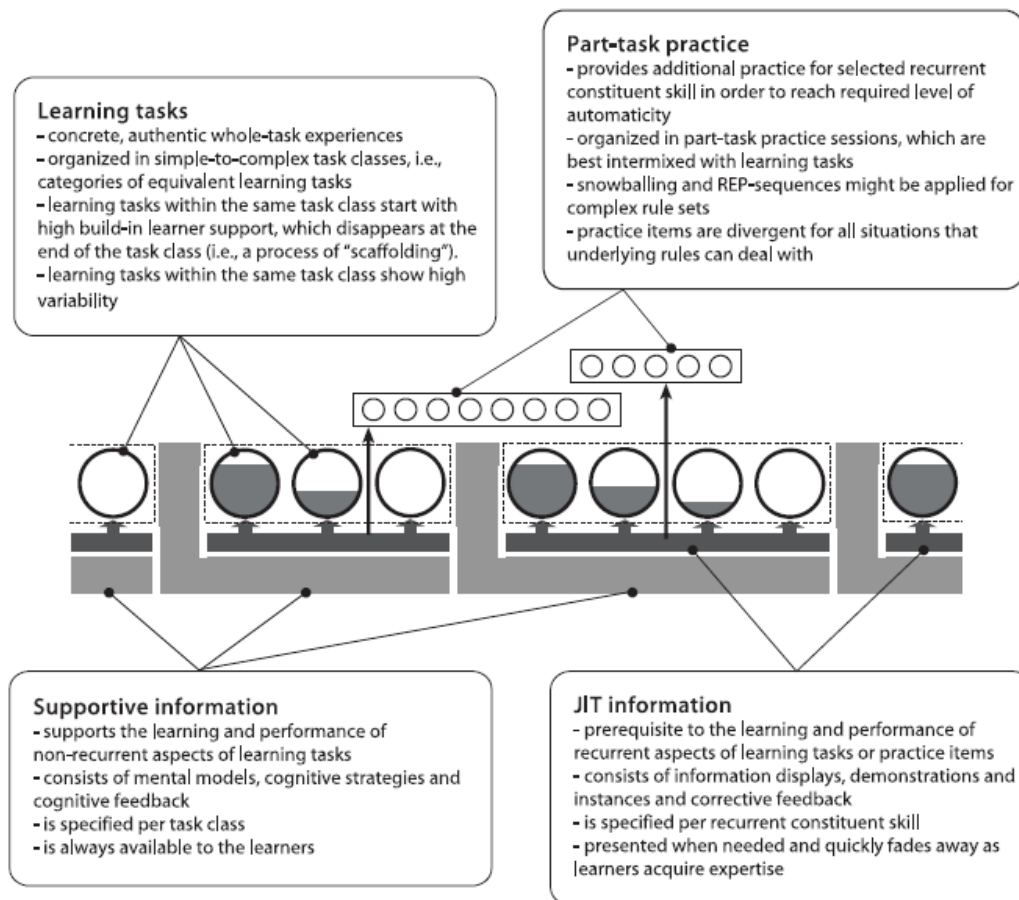
#### **The 4C/ID-model**

The 4C/ID-model is a model for training complex cognitive skills and is characterised by the whole task approach. During the course learners practice simplified versions to more

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complex versions of the whole task while the level of support diminishes as the learner progresses. The four major components of the 4C/ID-model are learning tasks, supportive information, just in time information and part-task practice (fig 1) [17].



**Visualisation of the 4C/ID model [17]**

Learning tasks are concrete, authentic, whole task experiences that are provided to learners in order to promote schema construction for non-recurrent aspects and, to a certain degree, rule automation by compilation for recurrent aspects of the task. Learning tasks are organised in task classes. All the learning tasks factually related in the same task class ensure similar difficulty level.

Supportive information is information that is supportive to the learning and performance of non-recurrent aspects of learning tasks. It provides the bridge between learners' prior knowledge and the learning tasks. This information is always available to the learner.

Just In Time (JIT) information is prerequisite to the learning and performance of recurrent aspects of learning tasks. JIT information is presented when needed and fades away as learners acquire expertise. JIT information is not only relevant to learning tasks, but also to part-task practice.

Part-task practice is provided to learners in order to promote rule automation for selected recurrent aspects of the whole complex skill. Part-task practice sessions are intermixed



within learning tasks, on the moment the learner needs this particular aspect to complete the task.

### The 9-step plan based upon 4C/ID

The 9-step plan is the basis to prepare an individual training program for persons with intellectual disabilities.

1. The first step is to define the complex ICT skill the person with intellectual disabilities wants to acquire. Ideas may be: 'making wishing cards in Paint', 'playing computer games', 'writing a newsletter in PowerPoint', 'looking-up bus schedules on the Internet', ...
2. The second step is to analyse this complex skill. The first goal is to break the complex skill into its constituent skills. The complex skill is more than the sum of its constituent skills, while those constituent skills are interdependent to each other. Training should focus on the whole complex skill, while the decomposition of the complex skill is necessary to define a hierarchy of skills. Learning constituent skills lower in the hierarchy facilitates acquiring skills higher in the hierarchy. Secondly, every constituent skill is labelled as a 'recurrent' or 'non-recurrent' skill. This is an indicator for the type of information that is needed [17]. Typically, for people with intellectual disabilities, an analysis is made for each constituent skill in terms of cognitive, affective and psychomotor behaviour of the learners.  
Taking the complex task 'making cards in Paint' as an example, not all the tools in the toolbox are of equal complexity: when drawing a square in Paint, one uses the rectangle tool in combination with the shift- button. This obviously is a 'higher' skill than drawing with the pencil-tool. Choosing a colour for drawing is a 'lower' skill, but 'making the choice of a colour' is for some people with intellectual disabilities a process that they can't accomplish affectively.
3. The third step consists of delineating the skills that learners are expected to acquire depending on their individual abilities. When for example the learner can't read nor write, it makes no sense to teach how the textbox-tool works in Paint.
4. The next step is to determine the task class sequence for the training. The skills hierarchy, made up in the second step, defines the order in which skills will be trained. Three consecutive task classes are defined: exploring, broadening and deepening. The last task class focuses on transfer of the skills to a context outside the learning environment. Think of pupils who sharpen their skills independently at home.
5. A fifth step is to develop the learning tasks for each task class. Learning tasks are the activities used to learn a particular skill. 4C/ID assumes a whole task approach; this means that in every learning task the entire complex skill is covered. Taking our example, from the first session the learner starts the PC, opens Paint, draws a small picture and saves this picture.
6. While performing the learning tasks the learner may fall back on resources in the form of information displays (JIT information) and cognitive strategies (supporting information). These are developed in step 6.
7. Step 7 consists of the development of part-task practice used to train recurrent aspects of the entire task. E.g. when the learner fails to save a card in Paint, the saving process is trained separately.



8. In step 8 the conditions that affect the performance of the task are described: e.g. the need for an adapted keyboard or an alternative mouse, specific software, low-stimulus area. After this step, the training begins.
9. Every time a course session is completed, last and ninth step is to go through an evaluation process. This review should provide useful feedback enabling the trainer to identify any gaps and to make sure that the learner's needs are fully addressed.

## Pilot Projects

The 9-step plan was tested with pilot projects in five settings: two schools for special education and three caring facilities for adults with intellectual disabilities.

In each setting, participants with individual ICT learning needs were selected. The skills that were identified to teach were: making cards using Paint, building PowerPoint presentations, surfing safely on the Internet, downloading music, emailing, booting games from the Internet and putting data into Excel. The most complex skill taught was learning to spell with Sprint-software in Microsoft Word. Sprint adds speech and language technology to your computer so that people who have problems with reading, writing and spelling (such as dyslexia) can listen to their documents, internet pages and email. Sprint also can read aloud while text is being entered, which helps in detecting spelling mistakes [15].

An initial and final measurement of the basic computer skills was made using the Easy ICT test [5]. After ten weekly training sessions, the outcome measurement of the complex skill was obtained by using the built-in evaluation step (Step 9).

The Sprint-pilot, the Paint-pilot and the game-pilot were completely finished which means that after the training period, the learners fully possessed the complex skills. Although in the other pilots not all the learners had acquired the complex skill as defined in step 1, all those learners had accomplished the learning tasks within the first task class. Main reason is that learners with intellectual disabilities need more time to acquire new skills and need more time to practice than foreseen in the pilot projects. However, in pilot studies, the technical and instrumental ICT skills of the learners had been improved.

## Discussion And Conclusions

Four trainers of the pilot projects evaluated the 9-step plan. There were no differences between the findings in the projects with adults compared to the findings in projects with children.

The conceptual framework from van Merriënboer was found to be difficult, however the translation to the ICT-Inclusive 9-step plan was found to be clear. Analysing the complex skill helps to gain insight in underlying skills needed to execute the complex skill, and to built up the task classes. The division in three task classes is useful. Designing learning tasks based on previous steps is much easier in comparison with not using these steps. One trainer reported difficulties with describing the underpinning information the learner needs, but all trainers found this step useful. Trainers are unanimous that the 9-step plan makes it possible to develop a tailor made program for each pupil.



The ICT-Inclusive train-the-trainer package is developed upon the request of teachers and social workers working with persons with intellectual disabilities. It is based on expert interviews and desk research.

In the train-the-trainer package, the ICT competency profile gives teachers and social workers insight in the ICT competences they possess and in the competences they still can acquire. The fact that they can start to set up a training program for their pupils with the competences of level 1 can encourage them.

The choice of the 4C/ID model is not an obvious one: in its original form, it is a complex and comprehensive model. The translation into a 9-step program to teach ICT skills to the target group remains substantial.

The pilot projects show that, once a coach has experience with the 9-step plan, the development of new ICT-programmes for other pupils is much easier. The most extensive work is step 2, making the analysis. Again, experience plays a role: once supervisors have made an analysis and know how to handle this, they will use these insights for the analysis of new 'complex skills'. Moreover, a technical analysis of a particular skill can be used to set up a program for all pupils that want to learn this particular skill.

ICT-Inclusive offers the technical analyses from the pilot projects to trainers following the train-the-trainer course. Technical analyses and other documents can be shared on KlasCement, a portal for and by teachers (<http://www.klascement.net/>).

In the train-the-trainer course, given in a three hour practical workshop, participants exercise the different steps. They receive a format to set up ICT programs for their pupils.

### Acknowledgement

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## 8.6. Evaluation Of Haptic Ria Maps And Other Navigational Support Systems For People Who Are Blind

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### Abstract

The evaluation of the Haptic RIA Maps web application, as part of the Aegis project, is described. Results found that haptic feedback was unreliable and that the interaction devices used have significant usability issues. Alternative devices will be investigated. A more natural interface with a direct correspondence between user actions and feedback, which is easy to use, is described. Additional information of use to people who are blind, such as position of safe crossings and self-determined reference points, is suggested. Future work, to evaluate the effectiveness of these applications to support the active development of spatial mental models in people who are blind, is proposed.

### Keywords

Allocentric navigational strategies, Haptic RIA Maps, Tactile Maps, Virtual Cane.

### Introduction

Common navigational strategies used by people who are blind take the self (or body) as the main frame of reference, as opposed to an external frame of reference (e.g., see [13]). Other researchers note the variability in the navigational strategies used by people who are blind, with those who perform better in navigational tasks being those who use more map-based strategies [15]; and that training in such strategies greatly improves performance [7, 30]. Martinsen et al [20] note that independent travel by people who are blind seems to be associated with the development of spatial representation in a cognitive map; this gives greater cognitive economy, allowing more attention to be paid to other cues, such as auditory information.

Egocentric mapping relies upon the point of view of the person who is moving in an environment [6]. This kind of sequential mapping is especially useful for orientation when the person moves from the same starting point each time. However, successful navigation is determined by both allocentric and egocentric mapping systems. Allocentric mapping involves identifying location relative to perceptible landmarks (external frames of reference) and encoding vectors between landmarks to provide a flexible system to determine location as the person moves around the environment [5, 10].

External frames of reference and map-based strategies allow more efficient representation which enables flexibility, so that alternative routes can be taken, shortcuts can be made and destinations changed, because they encompass a more complete representation of the environment to enable navigation from a number of perspectives [13, 31]. Planning a route to



a distant goal and maintaining a sense of orientation in large-scale environments would seem to require enduring representations of the locations of objects relative to other objects, i.e., allocentrism [22]. Although there is a noted variability in navigational strategies, the actual mobility training people who are blind receive is generally basic and egocentric in strategy [9].

Technological solutions that support the development of both egocentric and allocentric navigational strategies in people who are blind are of interest. Research into navigating around virtual worlds by people who are blind has shown that interacting with Virtual Environments (VEs) can support and facilitate their construction of spatial mental models [31]. For example, Lahav and Mioduser [17, 18] have demonstrated that, when exploring virtual spaces, people who are blind use more and different strategies than when exploring real physical spaces, and develop relatively accurate spatial representations of them. Replacing the Phantom device used by Lahav and Mioduser with the Nintendo Wii device, the 'Virtual Cane' system allows similar interaction within a VE with auditory and haptic feedback [9]. Results strongly support the potential of the system for facilitating and supporting the use of spatial strategies and the construction of spatial mental models [31]. This is desirable, since, as well as supporting the development of strategies which are more successful for independent travel, such systems may also lessen dependence on travel trainers, who can be in short supply.

Haptic RIA Maps is an application developed through the AEGIS project whereby visually impaired users can explore a representation of a street map using a force feedback device [1, 23]. Haptic RIA Maps is a web application (java applet) that retrieves maps from OpenStreetMap. The user selects a map area to explore. The application calls the OpenStreetMap web service, which returns the description of the selected map area in XML format (OSM). A 3D representation of the selected map is automatically generated. The visually impaired user can then explore the 3D map using a haptic device (e.g. Sensable Phantom [28], Novint Falcon [25]). As well as force feedback there are auditory cues, such as street names, and a sonification mechanism which provides distance information. This system was evaluated in order to explore whether or not it can provide information equivalent to that provided to sighted users by conventional 2D maps.

## Evaluation

The performance testing of Haptic RIA maps was carried out at 4 of the Aegis testing sites: LUND, FONCE/UPM, EPR and NTU. LUND used the PHANTOM OMNI [28]; all others used the Novint Falcon [25].

The test tasks were specified as follows:

- Search for a location; map generated through OpenStreetMap; after a map has loaded, generate 3D representations (i.e., create haptic map)
- Explore the map, feel the haptic feedback, hear the auditory feedback: While moving on the streets, different sounds generated e.g., when standing at an intersection; pitch of sound indicates approximately distance to next intersection; press LCtrl for street; ~ for POI information
- Search for a specific street name





- Move/relocate the map: move around to see more of the map using the arrow keys. Press the spacebar to restore haptics
- Zoom: Zoom the map in and out one step; wait until street info resumes. Space bar restores haptics.

### Participants

LUND tested with 9 people: 1 test leader who also has performed a heuristic evaluation, 2 pilot testers and 6 users. Both the pilot test users were fully sighted but used simulated cataract glasses [19]. The cataract glasses let users see a blurred image of the map, where the blue roads are distinguishable, but not the buildings, text or the cursor. 2 of the end users also used cataract glasses (being fully sighted), 1 user is blind from 6 years of age and the remaining 3 have low vision. The users all had varying degrees of experience with force feedback haptics.

FONCE/UPM tested with 5 blind users, and 3 experts formed the focus group. Users were experienced with Braille maps and GPS but had no experience of haptic devices.

EPR tested with 8 blind/partially sighted users and 10 experts. Users had experience with swell paper and relief usage, but none had ever worked with a Falcon device before.

NTU tested with 2 blind/partially sighted users, 1 tutor and 3 experts (all sighted). All took part in the focus group discussion. Users had some limited experience of tactile maps; both have experience of GPS and some very limited experience with the Falcon.

### Results

Tasks:

- Search: Search stage not accessible by screen reader
- Explore Map: All groups found the haptic feedback to be unstable. Those using the Falcon found it very difficult to use, haptic feedback was erratic and inconsistent, the device was prone to violently lurching and sometimes no haptic feedback could be felt at all
- Search for specific street:

LUND – all users able to do tasks at least partly without help, but found it hard to find street with no guidance

FONCE/UPM – needed to know the area, or have explored Braille map to be able do this task

EPR – most users could not complete this task

NTU – one user completed the task; one user could not complete the task

- Move/relocate the map

LUND – all users able to do tasks at least partly without help

FONCE/UPM – not mentioned

EPR – no users could complete this task

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NTU – if any key press or movement of the falcon while map relocating the system crashed, so didn't do this task

- Zoom

LUND – all users able to do tasks at least partly without help

FONCE/UPM – easier with fewer streets

EPR – users couldn't use this feature

NTU – zoom didn't work when in map mode

The different centres attempted the specified tasks; however, all found that the search stage was not accessible by screen reader, so this part could not be completed by blind users.

NTU could not get zoom to work within the map; in addition, they found moving/relocating the map to be very slow, and if the Falcon was moved, or any keys pressed during this process it caused the system to crash, so this part of the test was also not carried out. Finally, the position of the tilde key in English keyboards made it difficult to use, so this function was rarely activated. One of the blind users was left handed, and found all the key commands awkward.

All the groups using the Novint Falcon as the interaction device found it very difficult to use. Any haptic feedback was erratic and inconsistent, and sometimes the device “jumped” quite violently. Sometimes no haptic feedback was felt at all; the EPR users suggested the “grooves” be deepened so that they might be more noticeable. The users had to go very slowly in order to be able to use it at all, and to try and keep on the streets. It was very easy to “lift off” the streets, in which case the audio feedback stopped. There were no cues to the boundary of the map, so it was difficult to know if one had left the boundary of the map, or lifted the device off the map.

The PHANToM users at LUND also found the haptic feedback to be unstable.

The Spanish users (FONCE/UPM) found the verbal output difficult, because although the Street names were in Spanish the rest was in English, and the pronunciations were difficult to understand. NTU (English) users found the voice difficult to understand. EPR reported the auditory feedback overall as good, but sometimes the CTRL key did not generate any feedback

Lag on TTS and sonification could cause problems; sonification could be difficult to understand, and some found it unpleasant.

### **Overall summary:**

Overall, the verbal feedback could be difficult to understand; sonification was informative but could be improved. The lag on both took some getting used to.

Relocating and zooming functions were unreliable; only LUND users were able to do these, but users didn't like losing their reference points, and having to turn the haptic feedback back on.



All groups reported that an indication of leaving the boundary of the map would be useful.

The PHANToM device appears to give more reliable feedback than the Falcon, but still haptic feedback is reported to be unstable; additionally, the PHANToM is a very expensive device, so that it would be unlikely to be used by many.

Both interaction devices involve a complicated relationship with the map representation (that is, user actions don't have any direct/simple relationship with the map responses).

All groups liked the idea of the application; there were limitations with cues and feedback, but the overriding difficulty was with the haptic feedback, especially for the Falcon.

LUND users were asked to complete a NASA TLX task load rating [24]. The overall mental demand and effort levels were rated quite highly.

## Discussion

While the idea if the Haptic RIA Maps appealed to many, the current unreliability of the haptic feedback means that uptake is unlikely in its present form. In addition, the haptic interaction devices are complicated to use and expensive. While other aspects of the feedback could be improved (e.g., better voice, boundary cues), it is the haptic interaction which is the major stumbling block. More reliable and cheaper devices are sought for investigation; currently, the Microsoft haptic mouse is being considered [21]. However, it would appear that the haptic information could also be improved. Once more reliable haptic feedback was available, the application has potential to be of use for supporting the development of spatial representations of street areas for people who are blind.

An Android app has been developed by the HaptiMap project [14] – Touch Over Maps. Similarly to Haptic RIA Maps, this HaptiMap demonstrator involves adding information to a street map. Users move their fingers over the touchscreen surface of an Android platform; when on a street, the device vibrates, and the name of the street is read out. The zoom level must not be too high. Initial testing has found the app to be simple and easy to learn to use. A blind user was able to quickly explore the screen and find the streets; he found them easy to follow and the voice easy to understand; the edges of the screen were clear demarcations of the map area and simple reference points. He was able to reproduce the layout of the streets by laying pens and pencils out on a sheet of A4 paper with very little effort. A second blind user, who has some residual vision, was not as happy with the application; she could see the layout of the streets, and was frustrated when she found areas of the map where the feedback (both verbal and vibratory) was patchy. She can use Google maps with zoom, and found Touch Over Maps less helpful than Google maps. This application is easy to use and the completely blind user was able to extract useful information from it (the second blind user could see the layout, and so did not need to follow the feedback to get this information). The interface in this case has a direct relationship with the map – users' actions are afforded by the device, and have a natural, direct and reliable relationship with the feedback produced [11, 12, 2, 29]. The haptic mouse could produce similar attributes for interaction with the PC-based Haptic RIA Maps. On a mobile phone, it would not be desirable to add much additional output to the app, as that would detract from the simple ease of use of the map. However, for people who are a blind, additional information from a map is desirable: for example, safe crossings, bus stops, pavements. Additionally, self-determined points of interest and



reference points, and a facility to look up contextual information on demand (such as information about the accessibility of building, c.f., [27]) could be of benefit. Perhaps such additional information could be made available as an option, so that, for example, when studying the map at home on an Android tablet it could be turned on, and could be turned off on the mobile version, which could be used as a guide when on the move.

Further work is planned in a number of areas. Firstly, to see if the haptic mouse can be a suitable interaction device for Haptic RIA Maps. Secondly, to establish if these applications can support effectively the active development of useful, spatial mental models in people who are blind. These cognitive representations could be called upon to support a number of activities of varying complexity. Research is planned to evaluate the information obtained from exploring the map; can users create effective spatial mental models? Can they use this information:

- to know about the layout and content of an area? Possible tasks – recreate map; describe moving from A to B and from C to B
- to find out about an area in which they have known routes (to overcome obstacles, changes, take alternative routes if necessary)? Tasks: explore area around a known route on the map, then try and overcome obstructions
- to extend a known route? Task: attempt to extend a known route
- to create a new route? Tasks: attempt to create a known route and follow it

There are a range of current systems which attempt to support the active development of spatial representations and allocentric strategies in people who are blind in order to support their independent travel: for example, the Virtual Cane [9], the Phantom-based system of Lahav and Mioduser [17, 18], the use of wireless waypoints [8], for indoor orientation and mobility; Point Nav [14]; talking GPS (e.g., [4, 16]; although it should be noted that route guidance can suppress cognitive map development [26]), RouteMate [3] for outside areas. Haptic RIA Maps could prove to be a powerful addition to these tools, which could greatly enhance independence for people who are blind.

## Conclusions

The evaluation of the Haptic RIA Maps web application found that haptic feedback via the Falcon and Phantom devices was unreliable; this is a desirable app but the interaction devices used have significant usability issues and are expensive. Alternative devices are to be investigated, as is possible improvement in the haptic information available. An Android app, Touch Over Maps, was found to be useable; this app involves a natural user interface with a direct correspondence between user actions and the map responses, which is easy to use. Additional information of use to people who are blind, such as position of safe crossings and self-determined reference points, was suggested. Future work, to evaluate the effectiveness of these applications to support the active development of spatial mental models in people who are blind, was proposed.

## Acknowledgement

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## 9. Session 8: Accessibility overall

This session addressed the need of people with disabilities to be able to travel as independently as possible, whether by plane, car, bus, or on foot using auditory multitouch interfaces. Secondly, daily support elements such as support for automated sign language and accessible helpdesk support was also illustrated.

### 9.1. Safe And Secure Trip To And Through The Ideal City For All New Technologies And Challenges For People With Disabilities

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#### Abstract

Some of the JRC projects on accessibility will be illustrated by video clips and pictures presenting the results of the research and their applications in an Ideal City where a blind boy and a deaf girl spend a one-day story. At the airport, electronic gates automatically check their identities. They use a VOICE application either to speak (synthesiser) or to understand (ASR). They walk around the city guided by the SESAMONET system in his blind cane. In a cinema, he gets audio-description from his mobile and she the subtitles from her one. They finally go home safely and securely.

#### Keywords

Identity controls, airports, gate checks, secure path, speech recognition, voice recognition, deafness, subtitling, captioning, disability, usability, accessibility, security, safety, biometrics, assistive technology, mass transportation, transportation systems.

#### Introduction

Research in Assistive Technologies may contribute improving the quality of life of all citizens and their access to the Information Society, by fostering the inclusion and by empowering, from the security standpoint, a portion of the population that is currently partially excluded and that might be exposed to gratuitous security risks. To this purpose the potential for a significant activity of harmonisation of national initiatives, identification of best practices, assessment and demonstration of technologies, and awareness raising, in a complex and multilingual field, is significant.

To this regard, the JRC has carried out several projects in the field of accessibility, particularly the VOICE and SESAMONET Projects and the PRIMA Action, described hereafter, whose first applications and further developments achieved excellent results and demonstrated the feasibility of applications of low-cost and high-performance new technologies for all citizens, in a design for all approach.



The legal framework is there and we will make an overview in particular of the International Convention on the Rights of Persons with Disabilities, which is the institutionally highest form of legislation in the field of disability. Then, another norm in the specific sector of mobility will be described, namely the EU Transport Regulation on the Disabled Air Passengers' Rights. The EC Council Regulation N° 2252/2004 on electronic passports will also be reported. Finally, the possibility of diffusing such programmes everywhere at low cost will be concretely illustrated by means of a best practice in the field of distant teaching and learning.

### Synopsys: video clips

The presentation will illustrate possible solutions and their concrete applications, like the voice and speech recognisers, the electronic blind cane, and so forth, through a series of video-clips illustrating possible applications of available technology, which is able to help a blind boy and a deaf girl to autonomously live in a possible Ideal City. The clips will be introduced and then played. At the end, one of the speakers will talk about one of the abovementioned projects falling in his area of competence. A discussion slot will be dedicated to questions and answers.

A few clips will illustrate the advancement of the VOICE Project, from the first subtitled presentations of the Project in 1998 in Ispra and Vienna, to the 2002 football World Cup's broadcast that a deaf boy watches at home thanks to the subtitles generated by a respeaking companion. Then the conference of the 2003 European Year of People with Disabilities on the harmonisation of television subtitling, and finally the system of films' subtitling starting to be used in several cinemas. Another set of a few clips will present the results of the SESAMONET Project for a guided path for the blind. In the final clips, we will see a few passengers landing at the airport, where electronic gates automatically check their identity.

These clips, completed by pictures and comments will provide an idea of a possible Ideal City where a blind boy can safely meet a deaf girl, talk to her, understand her voice, answer to her numerous general questions and so forth. She can propose an itinerary by typing it on her mobile and let him understand it thanks to a VOICE synthesiser pronouncing it. He can provide her with more details from the tourism on-line database by dictating them to his VOICE speech recogniser. They can have a walk by following the beeps of the SESAMONET System in his blind cane, which can also help them crossing the road, by sending a signal to the traffic light. Then they can go to the cinema, where he can receive the film's audio-description from his mobile and she the subtitles from her one. They can finally go to the hotel and live safely, securely and easily overnight.

## Legislation

### The International Convention on the Rights of Persons with Disabilities

The Convention was agreed by an Ad Hoc Committee of the UN General Assembly in New York on 25 August 2006. The Convention aims at promoting, protecting and ensuring full and equal enjoyment of all human rights and fundamental freedoms by all persons with disabilities, and at promoting respect for their dignity. The Convention will cover 650 millions people in the world, including 50 millions in the EU alone [1].





### The EU Transport Regulation on the Disabled Air Passengers' Rights

The European Union has extensive laws for mobility rights and equal treatment of the disabled passengers. This includes right to boarding, assistance, mobility equipment and accessible information.

On 5 July 2006, the European Union adopted a new Regulation concerning the rights of disabled persons and persons with reduced mobility when travelling by air [2]. The regulation entered into force on 26 July 2008 [3].

The Regulation provides for compulsory assistance to persons with reduced mobility. The overall principle and aim of the Regulation is to protect any passenger with reduced mobility or sensory impairment, intellectual disability or any other cause of disability, age or psychological problems, and whose situation needs appropriate attention and the adaptation to his or her particular needs of the service made available to all passengers.

### EC Council Regulation N° 2252/2004 on electronic passports

Electronic passports were introduced in the European Union with Council Regulation (EC) N° 2252/2004 of 13 December 2004 on standards for security features and biometrics in passports and travel documents issued by Member States which established the characteristics of the new EU passport and were further refined in two subsequent pieces of legislation, namely Commission Decision establishing the technical specifications on the standards for security features and biometrics in passports and travel documents issued by Member States (C(2005) 409 of 28 Feb 2005) and Commission Decision establishing the technical specifications on the standards for security features and biometrics in passports and travel documents issued by Member States (C(2006) 2909 of 28 June 2006).

The first communication established the technical specifications on the standards for security features and biometrics in passports and travel documents issued by EU Member States regarding integration of the facial image on a secure storage medium in the passport. It also started the period for introducing facial images in passports by 28 August 2006 at the latest. The second establishes security standards to protect biometrics in passports (in particular fingerprints) against misuse. It also started the period for including fingerprints in passports as established in Regulation (EC) No 2252/2004. Its provisions officially entered into force last June 2009.

## JRC Projects

### The VOICE Project

The VOICE Project ("Giving a Voice to the Deaf") aimed at the promotion of automatic recognition of speech in conversation, conferences, television broadcasts and telephone calls [4]. It started in 1996 at JRC and developed prototypes of user friendly interfaces allowing an easier use of commercial products in translating the spoken voice into PC screen messages and subtitles. The Project achieved significant results in years 1996-97 and provided a better definition of the requirements of people with special needs. It was then sponsored and funded by the DG-XIII-TIDE (previous to Directorate General Information Society) in years 1998-2000. Through the project, more than one hundred workshops were organized in order to develop an awareness raising process on the potentialities of voice-to-



text recognition systems. The project developed an automatic subtitling prototype and used it for live subtitling the workshops' speeches.

In years 2001 and 2002 the activities addressed the harmonisation of television subtitling, in collaboration with the European Broadcasting Union and the CENELEC Normalisation Committee, with the support of Directorate General Enterprise. The Conference "eAccessibility by Voice", held at Ispra (Varese), Italy, was one of the closing events of the European Year of People with Disabilities 2003. The Conference brought together representatives of European countries, television broadcasters, Associations of people with disabilities and many experts from all over Europe.

### The SESAMONET Project

The SESAMONET Project (SEcure and SAfe MObility NET) is a RFID and GPS based guidance system for visually impaired people. The Project's objective was the development of an integrated electronic system to increase mobility of people with visual disabilities and their personal safety and security.

The system is based on an electronic path made of RFID tags, a custom-designed walking cane, and a smart phone or PDA (Personal Digital Assistant). Each RFID tag provides position signals via a dedicated walking stick to a smart phone containing information about the location, and a recorded voice - via a Bluetooth headset - guides the visually impaired person along the route. The prototype system uses RFID micro-chips embedded in the ground. The microchips can be recycled from the electronic tracking of cattle. The technical aspects have been patented by the EC [5].

In collaboration with the municipal authorities of Laveno (Varese), Italy, on the Major Lake, a full scale pilot project of about two kilometers along the lakeshore has been equipped with microchips. Another path has been equipped at the Parco Prealpi Giulie and the system has been demonstrated at the eInclusion Conference held in Vienna on November 2008. Other new paths are being set up. Collaboration has been established with several associations of the blind, as well as contacts with firms producing tactile paving, which would include an electronic tag in each tile of specific paths.

### The PRIMA Action

After having developed the VOICE and SEAMONET projects, the activities of the JRC moved from the area of people with hearing or visual impairment to address a larger spectrum of problems. The field of applications was further extended considering the difficulties encountered by people with other disabilities, as well as by elderly and disadvantaged people, in view of their Inclusion / Exclusion in the social life. This deals with situations in which a citizen cannot effectively interact with an ICT-mediated environment, and more generally with all citizens, who can some time in their lives have a temporary or a permanent disability.

New initiatives have taken into account aspects of usability and accessibility in the new JRC's Actions on safety and security, as "Border Security" (BORSEC), "Security of Critical Networked Infrastructures" (SCNI) and "Passport, Identity Management and Access Control" (PRIMA). The latter carries out application oriented research in the area of identity management, including but not limited to electronic documents, mobile identification, identification technologies (biometrics and infrastructures) and identification processes, with

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focus on the security of electronic identity documents and their cross-border interoperability. The lessons learned indicate the need to focus it on the aspects of electronic identification (eID) activities [6].

The activities range from assessing the conformity and interoperability of the new travel documents issued by EU member states under the new EU regulations to analysis, testing and assessment of the use of identification enabling techniques such as biometrics when applied to large scale applications such as those related to border security through identity management processes that comprise the complete system for identification of individuals including also digital and mobile identification. The activities pay a lot of attention to testing and standardization. Contribution to the definition of guidelines, best practices and standardization is fundamental to achieve interoperability of identity management systems.

### Other Projects In The Field

Many years have elapsed since the first of the abovementioned projects, the 1996-1998 VOICE project, gave birth to its most important and revolutionising outcome, Voicemeeting, the software programme that allowed live subtitling through Automatic Speech Recognition (ASR) technology. At the time ASR technology was still in its infancy: the transcribed text was not that accurate, subtitles appeared after a quite long delay, and the professional skills required to subtitle a live programme in real time had not been developed yet. On the contrary today technology allows for a speaker-independent automatic transcription. In particular, for a few years, some of the leading companies in the field of ASR in Europe have been working on speaker independent software programmes in order to fulfil the many needs that this technology is expected to do, such as media indexing, rapid text writing, immediate transcription, live subtitling and so forth.

As a follow up of the collaboration with the VOICE Project, the Department of Interdisciplinary Studies in Translation, Languages and Cultures (SITLeC) of the University of Bologna at Forlì, organized a few conferences for raising the broadcasters and professional subtitlers' awareness of the potential of speech-to-text technology in the production of real time subtitles. As a result, interpreters of the University of Bologna at Forlì produced - for the first time in Italy - real time subtitles of several conferences and debates.

From the operational standpoint, this technology produces automated transcriptions from audio signals in multiple steps. First of all, the audio signal is split into acoustically homogeneous regions and segments of the signal containing speech are identified and then grouped according to their acoustic similarity. Next, these speech segments are transcribed after two or more recognition processes, alternated with acoustic normalization and adaptation of acoustic models. By doing so, it is possible to automatically transcribe a signal with unknown content. The result is a transcription of the spoken input and further subdivision and classification of the audio signal into categories such as male or female voice, wide and narrow band speech, speech with background noise or silence. This makes it possible for the machine to automatically generate a series of metadata related to each speaker, such as the gender of the speaker, "named entities" such as company names, addresses, etc., and punctuation. This information can then be used for a number of purposes including automatic indexing, transcription of conferences and meetings, automatic reports, and automated translation of speech.



Technologically speaking, the speech recognition engine uses hidden Markov models of phonemes that are context dependent, n-gram language models with virtually unlimited vocabulary, a decoding algorithm based on the Viterbi algorithm and an adaptation of acoustic models using maximum likelihood linear regression (MLLR). The speech segments are transcribed in two decoding steps that alternate with the adaptation of acoustic models to the segments. The words contained in the first transcription step are then used to supervise the adaptation of the acoustic models. The system can efficiently distribute processing to multiple CPUs. The acoustic front end extracts acoustic features using short-term spectral characteristics in steps of 10ms with a sliding window of 20ms, and adds temporal derivatives. These features can be used directly "as if" or, used in additional downstream processing, depending on the domain and the kind of processing required.

Transcription quality varies widely according to the type of input. For American English, the word error rate (WER), the recognition quality of a transcription system is usually expressed in terms of, is usually around 5 and 10%, depending on the quality of the acoustic input. Quality drops usually occur in case of spontaneous speech, poor acoustic conditions, and non-native speakers. If applied to real time subtitling this technology can be easily applied to respeaking (the subtitler produces subtitles in real time while listening to the audiovisual product to subtitle) interfaced to an editing software programme that makes it possible for an operator to produce subtitles with a WER close to zero even under strict time constraint (2-6 seconds)

### E-Learning Opportunities

Even though the other two projects are still too new to be extensively investigated, the skills to possess in order to operate in the field of interest of the VOICE projects have been so much analyzed that on-line Masters in live subtitling, in particular, are offered by leading Universities in Europe.

More into details, e-learning opportunities have paved the way to many possibilities in the field of teaching and learning the necessary skills required by accessibility operators such as subtitlers. One of the best examples in the field of subtitling for the deaf and the hard-of-hearing is the European on-line Master on Audiovisual Translation (MTAV), a pioneering Postgraduate Diploma which started in Spanish in 2001 at the Autonomous University of Barcelona [7], coupled in 2009 by a copy version in Italian at the University of Parma [8]. The Master is divided into modules, depending on the object of interest, and offers scientifically high-profile courses on Audiovisual Translation (AVT) Theory, Dubbing, Audio-description for the Blind and the Visually-Impaired, Subtitling, Subtitling for the Deaf and the Hard-of-Hearing, Live Subtitling through Respeaking, Voice-Over, Localization of Video Games and of Web Sites. Moreover, it is also possible for the student to spend some time in a company working in the field of AVT so as to put into practice the skills acquired.

The Master is entirely on-line and can be easily accessed through a platform specially designed to meet the goals of distant teaching and learning. Every module is divided into ten units which offer a theoretical insight of and a sound professional training in each of these disciplines by means of both on-line and off-line tools such as extended documents, wikis, on-line and off-line exercises, quizzes, forums, chats, video- and tele-conferences. All this allows students not only to undergo a high-level scientific and professional training, but also



to have the possibility of receiving continuous feedback by their colleagues and teachers and to do all this from a remote workstation wherever and whenever they want.

The possibilities offered by e-learning can be easily applied to all the applications that the abovementioned projects may offer. One concrete example of that is remote instant transcription, that is the method by which a respeaker or a stenographer's workstation is remotely connected to a screen where the text he or she produces appears. This method is more and more diffused all around Europe to subtitle in real time TV programmes and conferences and, more recently, everyday spontaneous speeches and conversations.

While the first two applications are quite common, the last one may require further explanations. In particular, a deaf or hard-of-hearing person connects to the service provider through his or her mobile or notebook and receives the live transcription directly by a respeaker or stenotypist operating in real-time from a remote workstation.

This allows the deaf or hard-of-hearing person to have a real-time transcription of not only what a physician, a banker or a supermarket cashier tells him or her in a monological way, but also what is said in a normal conversation among friends. However, an operator providing such service, though ensuring high quality in terms of accuracy and rapidity of the final product, may be of hindrance to a spontaneous conversation. With a third person listening a conversation, one or all participants to that conversation may indeed feel embarrassed, lose their spontaneity and not talk of what they would really talk, thus thwarting all efforts to make interlocutors intelligible. With the rapid on-going development of the abovementioned speaker-independent technology, it is possible to predict the disappearance of a human interface in this process thus solving also this problem.

## Conclusions

The aim of this paper was to shed light on some of the most advanced technological solutions in the field of disability related to communication, transportation and mobility in general of sensory disabled people and to propose a solution to diffuse all best practices in the easiest and efficient way possible. The paper presented the progress of research in the field from the first prototypes of the VOICE subtitling system to the present use of respawning techniques and the courses that universities and private firms offer; and to the spreading of subtitling in cinemas and theaters and the harmonization in television subtitling. Similar steps forward have been made from the idea of RFID tags in the floor to a guided path for the blind. Significant is also the attention paid to security and usability in the use of automatic identity checks in the airports.

To do so we have first faced the problem of usability challenges in public services and in the daily life of all citizens, including the issues of accessibility, safety and communication. These questions are already addressed even by private companies, which have today released many products on the market which are the natural result of the mentioned projects. Despite these products are used and partially known by many individuals within the population there is still a need to translate such areas into policy proposals, in view of providing the best assistance to elderly people and to people with disabilities by means of existing and new technologies and the application of best practices. The aim is that of eliminating today's barriers and avoiding creating new invisible ones, due to difficulties in the use of incomplete, non-intuitive or complex solutions. Therefore, great attention has to be paid to usability



issues. Care in solving specific difficulties people with disabilities encounter every day is a way to help not only them, but also all citizens, who are or will be all concerned with disability in some way.

These challenges require accessibility norms or standards for services of general interest, and spreading examples of good practices, thus promoting social inclusion and equal opportunities, helping systems' designers to use the potential of new technologies in order to facilitate challenges that users face.

In view of this, since the use of many new systems require technical competence, such systems may indirectly create new classes of technically disabled people, that is those potential users who are unable to properly profit from new technology. This is particularly true in the case of users needing them not that often or in special, unusual situations. That is why easy and large scale training, profiting from the opportunities offered by e-learning is a must.

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## 9.2. 3D Scene Accessibility For The Blind Via Auditory-Multitouch Interfaces

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### Abstract

In this work we describe a computer aid system designed to interact with a user via auditory feedback so as to assist the exploration of the nearby environment. We made use of a Microsoft's Kinect sensor as input peripheral and of an iPad that hosts the multitouch end-user interface which deliver coded data into sound. A computer-vision-based strategy has been implemented to recognize objects present in a real time scene. Afterwards, these objects are associated to sounds of musical instruments and sonified through virtual space sources that create the illusion of sounds originating from their location. Users can hear, explore and understand the scenery composition while finger-triggering the sounds within the iPad surface on which a top-view image of the scene has been mapped. Preliminary experiments using geometrical objects randomly placed on a table, reveal that our system can build very accurately a scene in someone's mind in a satisfactory time, despite the absence of vision.

### Keywords

Visually impaired assistance, sonification, multitouch, computer vision.

### Introduction

Given the increasing number of people in the blind community demanding to be more independent from physical human assistants, the See CoLoR project aims at implementing mobility aids for the visually impaired by encoding colour into instruments sounds [1]. In line with this idea we implemented a new assistive tool to increase independence of the blind. This aid was specifically developed with the intent of enabling users to explore efficiently scenes as well as locate objects and locations of interest.

Despite the fact that general scene understanding remains challenging, solutions exist in Computer Vision for the visual analysis of constrained environments that can benefit aids for the visually impaired [7]. These approaches are mainly focused on automated object recognition. Yet, the possibility of eliciting visual interpretation to the blind goes beyond that. In many cases other sensory pathways, such as touch and audition are recruited to cope with the loss of vision. As a consequence, human vision mechanisms should be efficiently represented in a whole new way. Further than object recognition and location, encoding information is also very demanding. Accordingly, in this work to build a scene in someone's mind we make use of computer vision strategies accompanied by auditory feedback and haptic interaction.



Perhaps, one of the main problems of our approach arises because the amount of information that the vision channel is capable to process has been estimated at 106 bits/s, while audition is about 104 bits/s [4]. In theory therefore, we cannot encode all the visual information through the auditory channel. For the time being, our hypothesis is that given a simple scene (in a controlled environment) composed of a limited variety of unknown objects with uncertain spatial configuration, a computer-assisted audio description can be used to build the scene in someone's mind so accurately that a physical reconstruction can be made. This work presents an experiment in which 10 blindfolded participants have used our aid-system to attempt at identifying and determining the physical location of several simple objects on a table.

## State Of The Art

On the one hand, mobile devices with tangible capabilities are becoming increasingly common nowadays. Despite some advances in touch-screen accessibility for blind people, they still remain inaccessible in many ways. As discussed by McGookin et al. [16], touch-screens pose an especially daunting challenge for blind or visually impaired users. In place of familiar devices like the keyboard, tactile screens generally offer a uniform, featureless surface. The trend of emulating existing GUI's while using the finger as a mouse can translate existing problems into an even more difficult context [2]. On top of this, mobile systems often feature unique or restructured interface layouts. The end result is a confounding environment for accessibility programs [14].

On the other hand, several authors have proposed special devices for visual substitution by the auditory pathway in the context of real time navigation. Some of the most well known works in this area are the K Sonar-Cane [4], TheVIBE [5], The Voice [6], and the prototype proposed by Gonzalez-Mora in [3]. All of them attempt at encoding images or video streaming into audio and use spatialization of sound to represent locations. Nevertheless, works that attempt at encoding depth information are few as yet, so an important visual perceptual property is likely to be missed.

Finally, the problem of specific object detection in images is well established in computer vision. Various techniques including boosted Haar-like wavelets [8], SIFT keypoint matching [9], and random forests for classification [10] all show very good performance on this task [7]. A commonly used approach for object detection involves point descriptors and classification that relies upon statistical training. Hence, machine learning algorithms are very often used in this area [7].

## System Setup

A 3D Kinect sensor positioned in front of the table holding several elements, enables the machine-based object recognition. Afterwards, a top-view of the objects as they are placed on the table is generated and mapped onto the iPad. Thus, the iPad plays the role of a miniature table's surface and objects can be located within it, proportionally as in the table. Each object is associated to a specific sound so as to distinguish from each other. Sounds are triggered as the user touches the corresponding area on the iPad surface. The user experience is like perceiving the scene from above. Further details are listed through the next subsections.

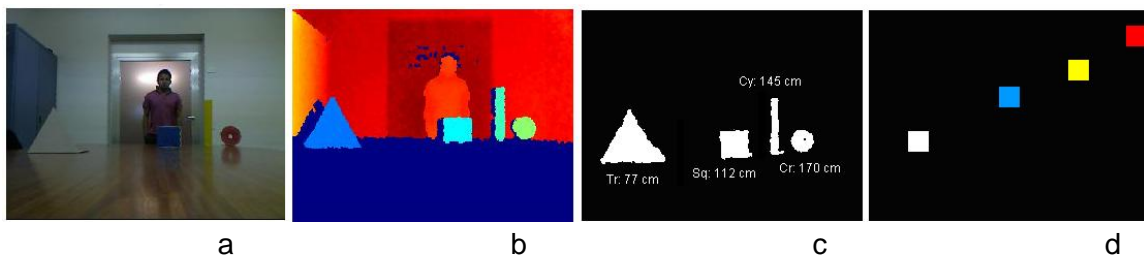




## Computer Vision Engine

In this work we follow a computer-vision-based framework to recognize and locate objects in real time [7]. Below Figure shows the total kinect-provided input to the framework in 1.a and 1.b, whereas the outputs are shown in c and d respectively. This framework comprises first a range-image segmentation algorithm that uses the Kinect-depth information. Next, we apply a classic and adaptable object-recognition strategy based on features classification [11]. Finally, a top-view of the scene is recreated by merging information of the frontal image and the depth map, see below Figure d, a and b respectively. The vertical object positions in the top-view as shown in Figure d are directly extracted from b. The horizontal positions however, are deduced from 1.a after a novel perspective-invariant analysis that relies upon a calibration process. The colour is passed also in a straight line from a to d.

The use of depth captured by the Kinect sensor permits us to know the object distances and enables fast and accurate segmentation, since objects on the table are perceived as isolated entities (see Figure below b). After segmentation, the objects are described by feature-shape descriptors [9]. This enables their classification by a Multi layer Artificial Neural Network (see Figure below c) trained offline with a large set of images [11]. Note that the top-view picture will be mapped onto the iPad and will play the role of the interface, see next section Multitouch Interface.



(a) Colour (b) Depth (c) Automated Recognition (d) Top View.

## Multitouch Interface

The auditory-multitouch-interface presented in this work makes use of finger-triggered sounds to represent the GUI elements that allow the human-machine interaction [14]. In this interface those elements represent the objects on the table as seen in above Figure d. The objects are represented as simple squares because their identification is based on sound and not shape. A corresponding sound is activated and therefore the auditory feedback, when the squares are touched. The fingers coordinates are tracked and sent via IP configuration through the wireless network toward a computer-server that supports all the computational process. Next Figure a shows our iPad as it tracks the fingers and sends this information that finally serves to determine the status of the interaction [6].

## Object Sonification

The core idea behind this work is the association of sounds to objects after an automated recognition. Earcons therefore, will be highly desirable to represent natural objects in the future. In this preliminary experiment however, we only used objects of four classes and each class has a particular colour for all its objects. Given the fact that the strategy of associating colours to instruments sounds for sonification is already well developed in See CoLOr project [1]. For simplicity, we adopted the same strategy and used the already developed module in that work, so that each class has associated an instrument sound depending on its colour. In

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the future however, this association should simply rely on the element itself and not on its colour, besides the use of musical instruments won't be mandatory.

For the time being, the sonification method described in See Color [1] represents the Hue variable by instrument timbre relative to the HSL colour system. The variable S representing the degree of purity of hue is rendered by sound pitch, while luminosity is represented by double bass when it is rather dark and a singing voice when it is relatively bright. Instruments are associated with colours through the following empirical quantization of the hue variable H:

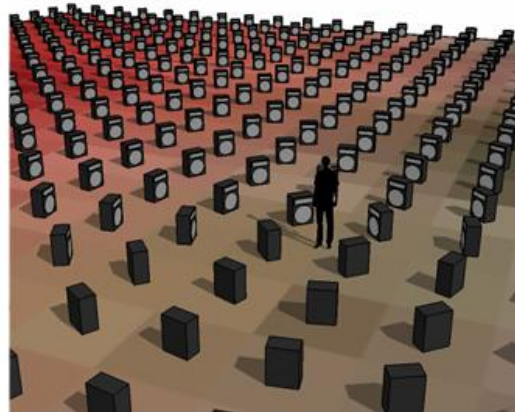
- Oboe for red ( $0 \leq H < 1/12$ )
- Viola for orange ( $1/12 \leq H < 1/6$ )
- Pizzicato violin for yellow ( $1/6 \leq H < 1/3$ )
- Flute for green ( $1/3 \leq H < 1/2$ )
- Trumpet for cyan ( $1/2 \leq H < 2/3$ )
- Piano for blue ( $2/3 \leq H < 5/6$ )
- Saxophone for purple ( $5/6 \leq H \leq 1$ )

### Objects Position Sonification

Spatial audio aims to recreate or synthesize spatial attributes when reproducing audio over loudspeakers or headphones. Such spatial attributes include, for example, locations of perceived sound sources and an auditory sense of space. Therefore, it has been successfully used to aid the blind in navigation [12] or in orientation training [13]. Spatial audio is usually achieved through Head Related Functions (HRTF) [13]. A full sonification of the median plane as shown in below Figure b can be reached through HRTF [16]. For this experiment however, the target of the spatial sound field covers the half median plane in front of the user i.e. objects are never placed behind the user. To meet these needs, we have used spatialization of sound through the azimuth plane i.e. to represent sounds from left to right. Finally, the distance between an object and the user (depth) is represented by the rhythm of the sound i.e. the slower the farther.



a



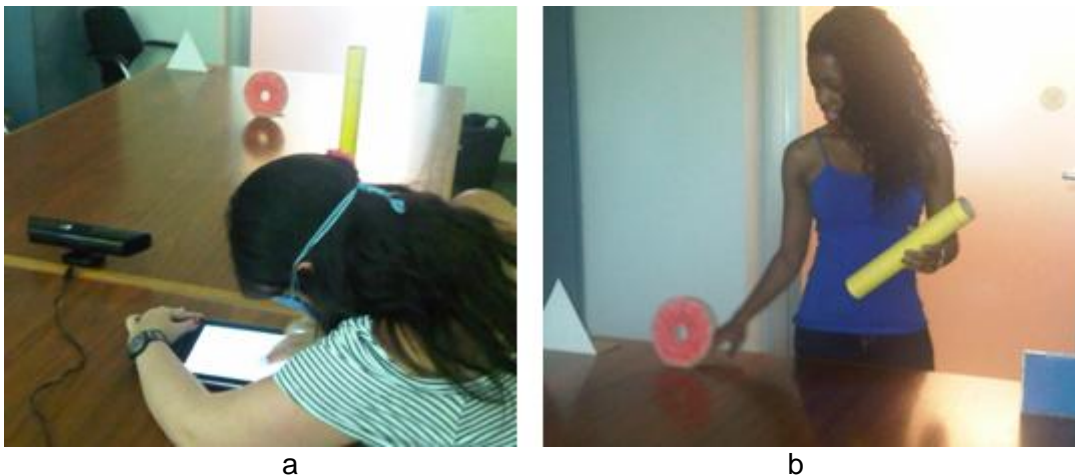
b

(a) iPad (interface) (b) Ideal spatial audio (median plane)



## Experiments

We conducted experiments with 10 blindfolded participants in two parts, in the first step the blindfolded user has to recognise the objects and their corresponding locations on the iPad, see next Figure a and section Scene Exploration. For the second part all the objects are taken out from the table, the user removes her/his blindfold and tries to place the objects back, see next Figure b and section Scene Reconstruction. Each participant was given to explore two scenes with three elements and two more with four. Training before the experiment is highly desirable as participants have no previous experience. Generally, this training aims to make the participant familiar with the system and must last at most 20 minutes. The protocol used for the experiments is described below.



(a) Scene Exploration (b) Scene Reconstruction.

### Learning colour-sound associations

The participant is given up to five minutes to get acquainted with the colour-sound encoding [1] described in section Object Colour Sonification. This process is usually demanding but the use of sounds instead of spelling out names and positions increases the rate of information between the human and the machine. For this experiment we used only four coloured objects so as to reduce efforts on this association process. Within 5 minutes of self-training the participants were able to distinguish objects while listening to their colours. To conclude this stage the user is blindfolded and we perform a quick test to ensure the effectiveness of the training.

### Tangible Localization Training

To get acquainted with the tactile interface, the user is given another five minutes of training with the iPad. The goal of this training is to show her/him the sensibility of the touch screen and the precision needed for reaching the elements in the interface. In addition, during this phase the user can adopt and test strategies for her/his finger-based exploration. Typical strategies to scan the pad are top-bottom zigzag, one finger fixed, spiral, top-bottom strips. The use of one or two fingers is unrestricted and it ought not to make any difference on the interaction as explained in [2].



### **Auditive Localization Training**

For the last training stage, the user is given a practical understanding regarding sound spatialization. Several objects are placed on the table from the left to the right. Afterwards, she/he is allowed to listen to the sounds originating from specific positions while accompanied by visual verification. The rhythm of the repetitions of the sound determined by the elements' nearness i.e. the closer the faster, is also introduced through the same methodology. This is likely the least demanding training, since the representation of the left/right object location using spatialization of sound is natural, and the representation of its depth by rhythm is very intuitive.

### **Scene Exploration**

The participant is blindfolded and the objects are randomly placed on the table. Then, the main part of the experiment is ready to be run; as an example see previous Figure a. Firstly, the user has to find the location of the objects on the iPad by simple tactile inspection. Afterwards, she/he has to identify the objects from the emitted sounds. The participant is expected to perform a mental mapping from the iPad to the real world in parallel. Unless the user claims to have reached an accurate mental representation sooner, this exploration-identification process should last no longer than ten minutes. In any case once the exploration is over, the elapsed time is registered.

### **Scene Reconstruction**

All the elements are taken off of the table and the participant removes her/his blindfold. Next, we ask her/him to put them back trying to replicate the scene as it was perceived during the exploration, see previous Figure b. This task is effortless due to the insight of the scene achieved during the exploration. Time spent in this stage therefore, is too negligible to be measured. No clue is given to the participant who has total freedom to set the new scene.

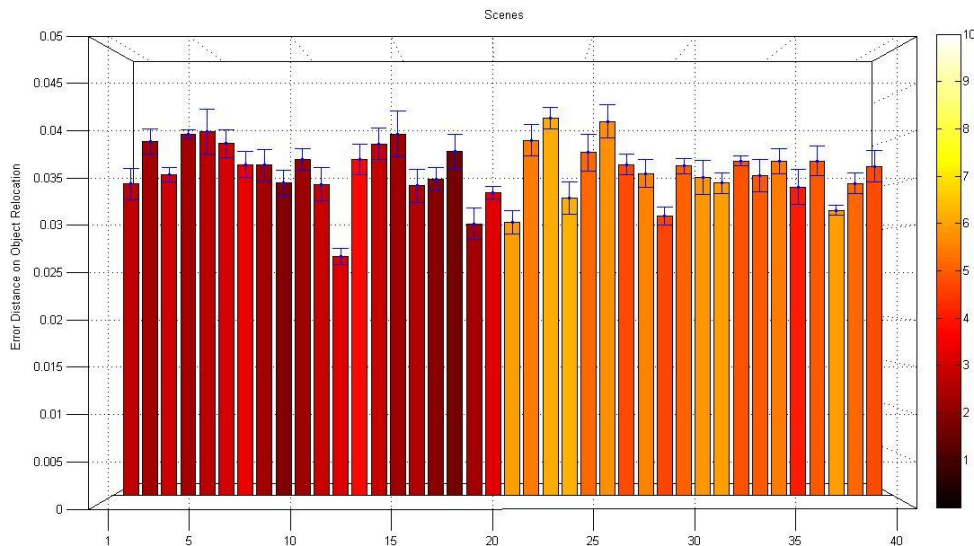
### **Results**

To allow an evaluation of the system, the top-view image (see first Figure d) is saved twice, before scene exploration and after scene reconstruction. To assess the effectiveness of the system at eliciting an insight about the scene in the user's mind, we compare those two pictures. In the ideal case, they should match perfectly to denote a flawless user's scene perception and therefore, reconstruction. In practice this never happens, yet we can estimate how different they are. The Euclidean distance between the objects in the first image (original) and their final location in the second (reconstructed) is used in this paper as a precision estimator of reconstruction. Hence, the assessment of the mental idea of the scene provided by the system can be objectively expressed.

Due to the calibration of the camera, the Euclidean distance between original and final object location in the pictures can be expressed in centimetres. Additionally In this work, this measurement has been normalized in order to express the performance in percentages according to the physical parameters of the experiment. To normalize the distances, we divide them by the largest possible distance between two objects on the table which is the diagonal (260 cm). Hence, the separation of a replaced object with respect to its original position is expressed as a ratio to the largest mistaken possible separation. The results of the experiments are presented in following Figure.

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**Results:** X axis represents 40 different scenes with three objects (1-20) and four objects (21-40). Y axis represents the average of the distances between the original and the final location of the objects. This average distance is already normalized. The colours of the bars (scenes) vary according to their exploration time that goes from 0 to 10 minutes (colormap). Each bar shows on top the standard deviation of its elements' relocation.

## Discussion And Conclusions

The results presented in this paper reveal that the participants were capable of grasping general spatial structure of the sonified environments and accurately estimate scene layouts. The mean error distance on objects' replacement for all the experiments was 3.3% with respect to the diagonal of the table. This is around 8.5 cm of separation between an original object position and its relocation. In both cases i.e. scenes with three and four objects, this distance remained more or less invariant and was understood in this work as an estimator of accuracy. The exploration time instead, varied according the number of elements on the table. In average for a scene composed of three elements, 3.4 minutes were enough to build its layout in mind, whereas for scenes with four elements this time reached 5.4 minutes. This difference was given due to the increase in the number of sound-colours associations to be learned; the results showed no misclassifications of objects though. In general, all trial participants expressed enthusiasm as to the future of the project.

Among others, the considerable amount of freedom of mobility offered in this prototype makes it likely to extend the technology proposed in this work to more general autonomous navigation aids. As a consequence, this possibility mainly urges us to adjust the object recognition engine to general identification tasks. However, the used of an adaptable computer vision framework in this work makes this goal entirely feasible. We also plan to substitute the instruments sounds used in the current prototype by ear cons so as to more intuitively describe natural scenes' objects. Finally, the extension of the HRTF filters toward personalized spatial audio [16] will bring the possibility of representing object locations everywhere (even in elevation) through virtual spatial sound sources.

We presented an aid-system to represent multi-object location and recognition through the auditory pathway. This system aims at providing the visually impaired with a mental occupancy grid of the environment making use of a Microsoft's Kinect sensor, a laptop and a



wireless iPad. For experiments and evaluation, the layout of a scene formed of a table and four geometrical objects was represented on an iPad and encoded into instruments sounds. This encoded information was accessed in real time using the fingers as stylus to trigger the sounds.

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### 9.3. Cognitive Navigation And Object Detection System For Blind People

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#### Abstract

The paper describes a new wearable Cognitive Navigation System for Blind People developed within the '6th Framework Programme (FP6)' of the European Commission in the area of 'Information & Communication Technologies', challenge 'Cognitive Systems and Robotics', within the project: 'Cognitive Aid System for Blind People' (CASBlIP). CASBlIP uses acoustical sounds in order to represent the information of the environment detected by the sensory and stereovision systems. The capture range of the whole system comprises up to 15m in distance and an angle between 32° left and 32° right relative to the human head. With the developed device, blind participants are able to navigate through unknown environments with more confidence and safety.

#### Keywords

Cognitive System, Object Detection System, Navigation System, Blind People

#### Introduction

There are around 285 million people with visual impairment in the whole world. More than 39 million are blind [1, 2]. For a person with loss of vision, the main goal is the navigation through the environment, to know which objects are around, which of them may be dangerous and how to avoid the obstacles. One of the characteristics of the blind people is the maximum use that they make of sound, not only to guess the obstacle presence but also to avoid it safely without any contact.

Taking as a basis this special hearing ability of the blind people, the idea of developing a navigation and object detection device for blind users based on acoustics seems quite logical. Nowadays, the use of sensory and stereovision for capturing environmental information becomes an important goal within the context of the development of the navigation systems for visually impaired people. The idea is to capture the image by cameras and transform it into 3D images.

In the whole world, there are more than 45 electronic devices which help blind people to perceive the environment. Almost all of them are devices based on ultrasounds and sensors [3]. These devices are mainly designed to detect environmental obstacles and represent this information to the blind user through the touch, sounds or vibrations. Through this group of Electronic Travel Aids we can find the Mowat Sonar Sensor, the Sonic Torch or the Sonicguide.

The most modern devices are based on the stereovision acquisition system. These devices have not only the objective of object detection but also to represent the whole environment.



As a good example we can find the Voice system, which informs the user about the environment through acoustic signals.

The last group of devices are the devices based on Global Positioning Systems. These devices are able to guide the user through the environment, selecting a route and memorising them.

Considering the limitations of the existing devices, researchers from the Universidad Politécnica de Valencia in collaboration with six European institutions decided to develop a new cognitive navigation device, which will be able to detect the obstacles from the environment and represent them through acoustical signals CASBlIP (Cognitive Aid System for Blind People).

### System Description

The CASBlIP system is a more complex and wearable system for navigation and orientation using stereovision, sensory system and GPS for extraction of the environmental information, transforming the received information into acoustical signals [4, 5]. The CASBlIP improves the system "Virtual Acoustic Space", developed by Universidad de la Laguna and the Instituto de Astrofísica de Canarias [6]. The innovative aspects of CASBlIP system overcome the limitations (accuracy and precision on environmental data representation, difficult utilization, unclear outputs, non-universality, etc.) of the currently existing devices.

CASBlIP system has been designed and developed separately in two different devices which can work individually or together; the Acoustic Prototype and Real-Time Assistance Prototype (next Figure) [7, 8]. The whole CASBlIP weight is the sum of 139g (weight of the glasses with the laser modules and lenses), plus 688g (weight of the Real-Time Assistance Prototype, which include the cameras lenses and helmet plus the weight of the laptop and FPGA).

The surrounding information, in the Acoustic Prototype, is collected by the sensor, based on a high-speed photosensitive 3D CMOS linear sensor and an infrared pulse illumination using a Time of Flight measurement. 64 infrared impulses (pixels) are emitted by the sensor in a horizontal line in a range between 0,5m and 5m in distance and  $64^{\circ}$  in azimuth. The distance information from the sensor and the detected object is collected and processed in real time for every single pixel. Due to the sensor properties and high perception reliability, the system is able to accurately work both in indoor and outdoor environments.

The acoustical task generates the cognitive load while blind user walks around the environment. An acoustical map is created which attributes one sound to every distance at a particular azimuth.







**Cognitive Aid System for Blind People**



**Object detection using stereovision**

A delta sound of 2048 samples with a sampling rate of 44.1kHz was artificially generated and filtered with the HRTFs for each pixel within an area between 0,5m and 5m in distance and

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60° in azimuth, sounding 64 pixels per image at 3 frames per second in a horizontal plane (at the eyes level). The system emits acoustical sounds whenever an obstacle comes within the detection range [9, 10].

A more complex and optimized device is the Real-Time Assistance Prototype based on artificial vision. Unlike the previous artificial vision, based on navigation systems, the Real-Time Assistance Prototype uses static and dynamic object/obstacle and free path detection (see previous Figure) and acoustical interface. The head mounted system is able to classify the obstacles according to their level of danger for the user, estimating their position, speed and direction of motion. Two FL2-03S2 cameras with auto-iris control and a 6dof inertial sensor were used as main components of the vision system. A small Toshiba laptop was used as an operational system. Acoustically, the system warns the user about the objects within the area of vision in a perimeter better 5 and 15m in distance and 64° in azimuth. The Real-Time Assistance Prototype emits short acoustical signals through headphones at a rate of 64 pixels per image at 7 frames per second. When one or more objects appear in the visual area, the users listen, via headphones, the sound corresponding to the objects position. The auditory output increases as the object is getting near the user. The implemented strategy is expected to generate in the user a visual-like auditory perception. According to the listened sounds, the user is able to take a decision in order to avoid the obstacle appearing in the system area of view. With a minimum practice, the user can easily detect the size of the obstacles. Different acoustical outputs were generated for obstacles and free path.

The integration of both systems into one single unit intends to provide more information about the surrounding environment to the blind user. Using both systems at the same time, the user will be able to detect the obstacles in an area between 0,5 and 15m. The sensory system of the Acoustical Prototype will provide precise information on the nearest obstacles up to 5m, whereas the artificial vision will provide the information of the farther environment up to 15m.

## Results

Thirty blind users tested the system both in indoor and in outdoor environments, in unfamiliar areas. Neurology specialists and mobility trainers from the Deutscher Blinden-und Sehbehindertenverband e.V. (DBSV) from Germany and Instituto dei Ciechi "F. Cavazza" (IFC) from Italy and from Spain evaluated the travel performances. Seven training exercises were performed with the objective of the sound externalization, distance and direction perception. After the training period, blind users participated on the navigation tests in the laboratory and open environment. The laboratory test consisted of the navigation through a 14m labyrinth, where the user should detect the two rows of four pairs of soft columns placed at a distance of 2,5m and pass through them. The open environment consisted of two exercises, the first exercise was based on the navigation through a known environment and the second exercise consisted of the navigation through an unknown street and a shopping mall. During the experiments the main parameters measured were: the absolute walking time, the number of hits and the number of corrections (when the user was leeway from the route).



The users confirmed that with the Acoustical Prototype and Real-Time Assistance Prototype they travelled with more confidence than when they did with only the white cane. This enabled to increase their surrounding perception and walking speed.

## Conclusions

The CASBlIP system was designed to overcome all the limitations of the existing devices, to integrate the object detection with navigation devices in one single unit. The approach of robust real-time of static and dynamic object detection for indoor and outdoor environment and navigation system was achieved. The main goal for the near future is focused on the processing and hardware improvement.

## Acknowledgements

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## 9.4. Language Resources For Computer Assisted Translation From Italian To Italian Sign Language Of Deaf People

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### Abstract

This paper discusses the use of language resources for Computer Assisted Translation (CAT) from Italian Language to Italian Sign Language (LIS) of Deaf People. It gives an overview of a CAT translation system. The pipeline process allows a user to obtain the translation of an Italian Language text as an animation of a virtual avatar signing in LIS. The paper describes the architecture of the translation system and how the language resources are integrated in the platform. It analyzes the features that characterize a dictionary, which links two languages among different features and different communication channels.

### Keywords

Deaf, Sign Language, Assisted Translation, Virtual Avatars, Sign Language Synthesis.

### Introduction

Sign Languages (SLs) are visual languages used by deaf people to convey meaning. SLs rely on signs, as lexical units instead of words used in common languages. Italian deaf people resort to Italian Sign Language (LIS) within their communities and it can be considered as the main source of communication for 60.000 Italian deaf individuals [1].

Inclusion of deaf people in the society aims at providing them access to services in their own language and spreading sign language knowledge among the communities. In this context, the Machine Translation (MT) provides a mechanism to translate the written language into the visual gestural language as one written language is translated to another.

The research on Sign Language Machine translation deals with several issues, generally related to both the translation and the generation of signs.

Most of the translation approaches (e.g., television closed captioning or teletype telephone services) assume that the viewer has strong literacy skills [2]. Then, reading the captioning results to be difficult even if they are fluent in sign language. In these cases, if a live interpreter is not feasible, the translation is avoided to deaf people.

Development of new approach, which takes into account building a system that is able to produce both the translation and the visualization of signs at the same time, is thus very important.

This paper describes a system for the computer-assisted translation from Italian Language to LIS that provides the output of the translation resorting to a virtual avatar. It focuses on the necessary linguistic knowledge and resources required for the development of such system.



Our system is capable to perform both translation and visualization into sign language simultaneously. A platform independent application will be developed. At the moment we have developed the web application which takes Italian text as input and provides the output in Italian sign Language [23].

Section 2 provides the state of the art of the sign language translation. Section 3 describes the approach to the design of a system for a visual language translation. Section 4 goes deeply into the architecture of the ATLAS project [3] and deals with and the interaction between the tool and the language resources. Section 5 gives a set of conclusions and future perspectives.

### State Of The Art

The application of MT to SL is rather recent. Several projects that targeted SL capturing and synthesis were developed and important results have been achieved to improve accessibility of the deaf to the hearing world. The VISICAST translator [2] and the e-SIGN [3] project defined the architecture for sign language processing and the gesture visualization with a virtual character by using motion capture and synthetic generation to create signs. BlueSign [4], Zardoz [5] and SignSmith Studio [6] are additional examples of working systems. BlueSign targets LIS translation without taking into account LIS grammar. Some examples are reported of translation to other sign languages, most of them targeting translation of single words or fingerspelling. Other examples take effort of statistical or example based techniques to perform translation [9], [10]. A MT to LIS system to perform the translation resorting to LIS grammar has never been mentioned in literature.

In [11] authors analyze different statistical translation techniques applied to sign language and conclude that some of them produce reasonably good results. Typical procedures, i.e., scaling factor optimization and selecting the best alignment, work reasonably well but can be improved. More sophisticated algorithms, i.e., syntactic enhancements, fail to improve over the baseline. The general unavailability of language resources for sign language translation is the main issue reported. The available corpora and lexicons are not comparable with the resources used to perform written language translation. The creation and annotation of these corpora (parallel corpora, lexicons, etc...) represents an important resource for testing language hypothesis purposes.

The way the corpora are generated has to be considered because it influences both the quality of annotations and the related information. Recent researches on corpora creation underlined that corpora needs to be representative, well documented and machine-readable [12]. Today several examples of corpora that satisfy those requisites are listed in literature [19]. The DGS Corpus project [15] aimed at creating of a general-purpose corpus of German Sign Language to study lexical variation, semantics, morphology and phonology. The DGS corpus collects data (340-400h scheduled) from dialogues, free conversation, elicited narratives and elicited lexical items. Fluent DGS signers perform the data. Other examples on German Sign Language are provided by the Berlin corpus that collects formal structures of DGS focusing on the interdependency of spoken and signed language based on the collection of natural DGS data. Dialogues and conversation in natural settings are the data. The Deutschschweizerische Gebardensprache (DSGS) corpus [16] collects 18h of group discussions data in Swiss-German Sign Language. An important work on Swiss-German Sing Language is the Multimedia Bilingual Databank that collects 60h of informal groups

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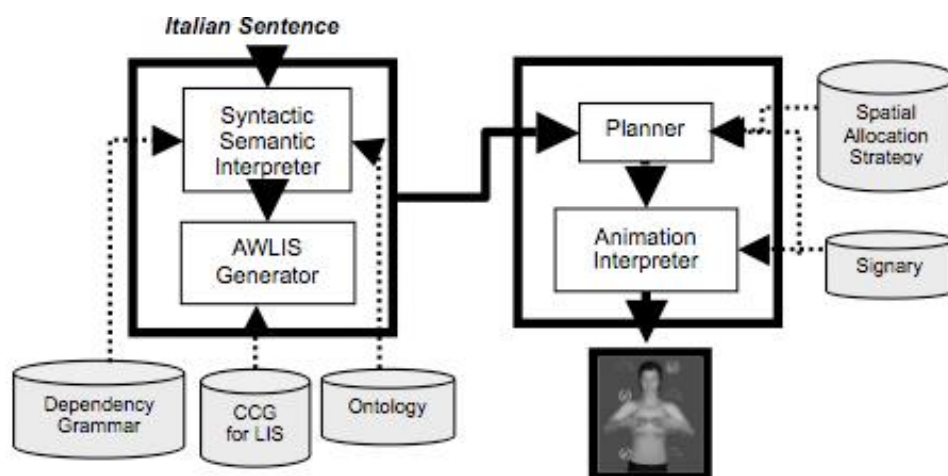


discussions on given arguments (medicine, sport, schooling, etc.). The NGT Corpus [17] for Dutch Sign Language collects 2375 videos (stated at September 2010) for a total of about 72h of data on dialogues and narratives signed by 92 native signers. The corpus is fully transcribed at Gloss level. The ECHO Project [18] constitutes an example of multi lingual sign language corpus: it collects data in Dutch, British and Swedish Sign Languages. It resorts to 30 min of videos per sign language transcribed at gloss level. A rich Sign Language lexical corpus is the SignLex Corpus that includes 5616 videos of elicited lexical items signed by native signers. The domain is focused on technical terms for education purposes.

Statistical approaches are used for Computer Assisted Translation (CAT) [19] as well. In these systems, statistical approaches help the user while performing manual translation. Since a significant intervention by the user is required, these systems are generally more robust than automatic ones. To our knowledge they all miss the final step of translation: the visual adaptation, e.g., by virtual avatars.

### The Atlas Platform

The ATLAS system is designed to get a written text as input and to perform the translation, resorting to two different translators: a statistical one and a rule based one. In next Figure the statistical translation approach is shown [18]. The output of the translator is the set of animated signs performed by virtual character. The statistical translator is based on MOSES [8], an open source statistical translator that automatically trains the translation models for any language pair. The Rule Based translator is based on a traditional rule-based approach. The input sentences are interpreted in terms of an ontology-based logical representation, which acts as input to a linguistic generator that produces the corresponding LIS sentence. The sentence is defined through a formalism called ATLAS Written LIS (AWLIS). A LIS sentence is basically a sequence of annotated glosses carrying a set of additional syntactic information. The semantic-syntactic interpreter resorts to an ontology modeling the weather forecasting domain. The interpreter performs the analysis of the syntactic tree and builds a logical formula by looking at the semantic role of the verbal dependents [22].



Architecture of the ATLAS Systems [18]



This information is collected within the AWLIS formalism, which is sent to the animation module. This module is composed by:

- A Planner: it gets the signs and set them into the signing space, according to relocations strategies.
- An Animation Interpreter (AI): it takes the AWLIS and the sign planning to render the signs by smoothing them together.

The animation engine retrieves a basic form of the sign for each lexical entry specified in the AWLIS from the database. Once the basic shape is generated, it applies a set of modifiers to the shape, e.g., facial expression, automatic relocation, body movements.

The Signary, henceforth referred to as lexicon, is the ATLAS lexical database that collects all the basic forms of the signs, performed by the avatar, in a video format. The resulting video animation is the sign language sign or set of signs.

### Translation Reliability

Sign Language translation is error prone. By increasing the amount of language resources, such as lexicon and training corpora, we expect to achieve a good translation level. There is long way ahead before we can provide a reliable platform translation of text and visualization it into sign language animation. Currently, we are focusing 40 translated weather forecasts in our corpus. To optimize translation quality the user is facilitated to add or modify translation mistakes. The ATLAS Editor for Assisted Translation (ALEAT) is the CAT translation tool developed within the ATLAS project. It translates an Italian text into ATLAS Extended Written LIS (AEWLIS), resorting to a set of manual translation steps. The AEWLIS is an improved version of AWLIS. ALEAT provides access to the parallel corpus in order to retrieve a set of feasible translations. The user selects the most feasible translation and can modify mistakes or remove deficiencies using the user interface. ALEAT gives also access to the lexicon in order to connect each lemma within the AEWLIS with its correspondent entry in the lexicon. This allows the AI directly to play the basic forms of the signs by taking as input the AEWLIS. All the modifiers are specified by means of a tagging window. ALEAT provides a user-friendly interface to perform all operations of the CAT process.

### The Atlas Corpus

A complete description of the ATLAS corpus is out of the scope of this paper. An introduction has been provided in [20], while results on the extraction of sign relocation data from the ATLAS corpus are provided in [22]. The collected corpus consists in the translation from Italian into LIS of 40 weather forecasting news recorded from the national broadcasting network. The corpus has been annotated using the ATLAS Editor for Annotation (ALEA), a web application developed and used within the ATLAS project for the annotation of video content.

The research teams involved in the ATLAS project are performing studies on the ATLAS corpus in order to extract useful data related to LIS linguistic phenomena such as relocation, co-articulation and iconicity. Actually the relocation process has been studied [22] and the results help designing the Planner module.

This corpus has been used to train the ATLAS statistical translator that, along with the Rule Based translator, is involved in the core translation of the ATLAS pipeline.

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The ATLAS corpus includes a lexicon of 3063 signs as high quality videos. Each video is linked with the translation in Italian language. Meaningful fields include definitions and the semantic domains. It contains two sets of signs: general-purpose and weather forecast related. The former includes general-purpose domain signs. Although it contains signs within the Rome area along with some variations used in other regions of Italy, our informants suggested that this set of sign is currently used as a standard lexicon by most of the people in Italy. The flexibility of optimization will help to evolve the new changes and addition of newly developed signs. The system will also help people to learn sign language in order to better communicate with deaf. It solves the problem of variability providing a platform to standardize each sign.

The second set of signs includes:

- 113 New Signs mostly related to the weather forecasts domain
- 73 Variations of signs from the LIS Dictionary
- 214 New Standard LIS signs not present in the LIS Dictionary

### WordNet Integration

The dictionary implementation is the main issue of a translation system. Since each natural language word can be related to a set of synonyms, the relation among words of different languages is not unique. Synonyms can be very useful when the corpus is not fully annotated.

Wordnet [24] is a dictionary that handles the existence of relation among words defining the synset: it models the sense of a single headword. Thus, words sharing the same synset can be defined as synonyms. Including the Wordnet platform as part of the translation process require to store the sysnet data to the lexicon too.

The architecture performs a set of operations to translate an Italian word into a LIS sign (next Figure). The search result includes 3 different scenarios:

1. The input word is not found.
2. The input word has only one correspondence.
3. The input word has multiple correspondences.

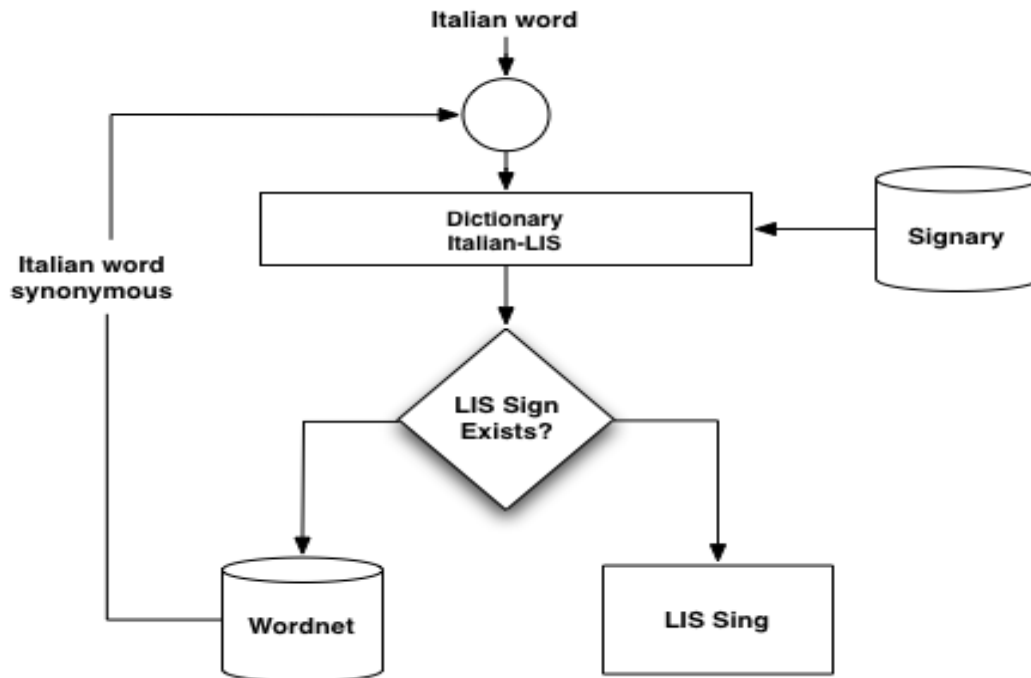
In the first scenario, the synset information associated to the word became the entry for a Wordnet search. If some of the word synonyms already exist in the lexicon cases 2 and 3 can rise.

The second case gives an immediate translation but can be also supervised to check if more than one LIS sign is linked to the original word. In this case, the user is able to manually select the preferred LIS sign.

The third case happens when some disambiguation issue is related to the original word, since some words of the Italian language have multiple meanings (e.g., the Italian word *pesca* may refer to both the peach and the to fish verb). In this case, using the synset data associated to the retrieved results, the user is able to select the right LIS.







The Wordnet Integration Flow

## Conclusion And Future Work

In this paper we proposed the use of lexical resources and corpora in the CAT of Sign Languages. We described the workflow of our CAT tool, ALEAT. Implementing the WordNet infrastructure to support both the limitation of annotated words (using the synonyms) and the disambiguation of word meaning is the main improvement of introduced by the paper.

The tool is currently being integrated within the ATLAS platform. Future work aims at testing the intelligibility of translation produced with ALEAT and at comparing this with the pure automatic translation. Future work includes developing the platform independent ATLAS Italian to Italian Sign language system. Users will have the facility to use mobile and web application. The application will be tested on different subjects to check the validity and efficiency.

## Acknowledgement

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## 9.5. Applications Of Optically Actuated Haptic Elements

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### Abstract

There are missing commercially available large area dynamic tactile displays providing access to high-resolution graphic and Braille for the blind people. This is not solved by currently available displays in the form of a Braille line. The objective of the project NOMS (Nano-Optical Mechanical Systems) is to solve this problem by using optically activated haptic actuators. These will require no hard to assembly moving mechanical parts and have the potential for finer resolution. Recently developed carbon nanotube enriched photoactive polymers provide the basic technology for this purpose. There will be presented integration of those materials into haptic displays.

### Keywords

Braille, Display, Tactile, Haptic, Photo Actuation

### Introduction

Most of the information is presented in visual form which is inaccessible to blind people. To make it accessible the synthetic speech and tactile displays are used. Tactile displays are the most suitable means to present exact written form and layout of a text and perhaps the only possibility to present graphics to blind people. Unfortunately, there are still missing commercially available large area refreshable tactile displays providing access to high-resolution graphic and larger blocks of Braille texts. Blind readers, as well as sighted people, need possibility to backtrack and review Braille text larger than one line and to review information units that takes more than one line like equations or tables. Even more serious problem is access to tactile graphics like maps, plans, diagrams, and schemes in real time. This problem is not solved by currently available displays in the form of a Braille line. Tactile graphics is obviously available in various forms of a relief print, which are not at disposal in real time; production process is complex, long and obviously not automatic. Exceptional special devices presenting graphics part-by-part on small refreshable tactile areas of fingertip size need hard training, excellent manual skills, good imagination and memory and therefore also do not represent satisfactory solution. Finally, more recently there occurred two-dimensional refreshable tactile graphical displays [1, 2] based on the same principle as Braille displays using piezo electric elements. Although working very nice they are still extremely expensive not only for individual users, but even for institutions providing education and other services to the blind people. Thus, the current tactile technology for the blind people significantly limits their access to information, in particular graphics and more complex texts, needed for education, work, and everyday life in rapidly developing information society. Therefore revolutionary technologies are needed to improve the lives of blind people providing better access to information.

The project NOMS - Nano-Optical Mechanical Systems [3] offers one promising solution - the use of actuators that can be activated optically, using materials changing their size by influence of light. These require no bulky moving parts and have the potential for much finer

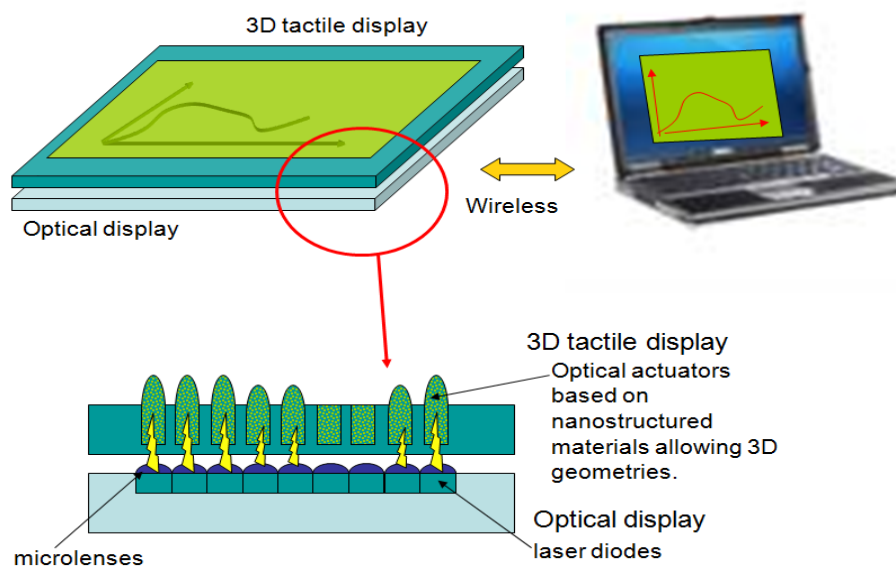


resolution than current technology. The most challenging task of the project is research and development of suitable optically active materials [4, 5, 6]. Recently developed carbon nanotube enriched photoactive polymers provide the basic technology for this purpose. Besides liquid Crystal Elastomers (LCE) also other polymers are examined.

### Noms: Objectives

The main objective of NOMS project is research and development of prototype of photo-actuated large area, high resolution, and fast refreshable, tactile display - tablet - working as follows:

- The original video signal from a computer screen will be transformed into pulses that will trigger the appropriate emitters in the tablet.
- The light emitted by LED/LD-like platform will be focused by microlenses on a polymer NANO-composite film
- The photo-actuation of the film will be tailored to enable tactile graphic representation.
- The final tablet will have the following features:
  - 80x80 blisters tactile display with 1.25 mm mutual distance
  - Full text and graphical capability
  - Tactile distances below human touch resolution enabling more smooth tactile graphics
  - Rapid refresh rate. The estimated actuation speed of one blister is 100 ms, which will yield a maximum reaction delay for changing the whole display contents of a 100x100 mm display of approximately 1 second, assuming sequential actuation.
  - Easy modular integration for larger display capability (A4 format by 6 modules)
  - Fully integrated electronic circuitry
  - Wireless Capability to connect to a PC and other devices
  - Portability



**Schematic of proposed visual-aid NOMS, showing computer wireless interface along with subjacent optical technology**



Photomechanical actuation is preferred to electromechanical transduction also due to following technical and safety reasons:

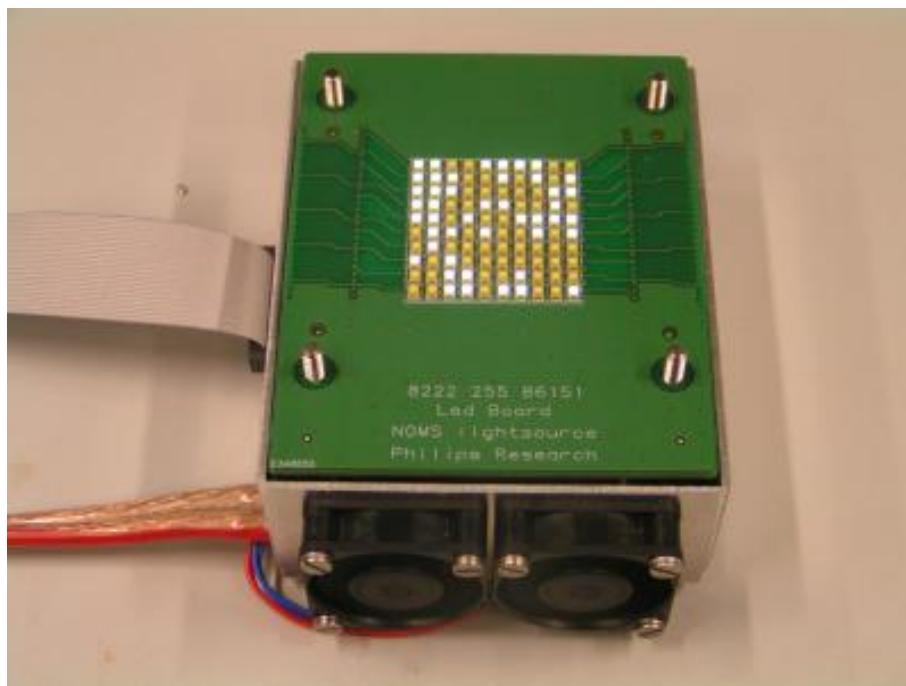
- Wireless actuation
- Electrical-mechanical decoupling
- Low noise
- Easy scaling up/down

### The Work Performed So Far

The work covers the research and production of photoactive NANO-materials, blister and tablet design, communications and control software, optics and microsystem integration, as well as end user evaluation and neuro-cognitive studies.

A very important task has been the research and choice of actuating material [4]. However, only few materials actually exhibit photo-actuation. Initially, we favoured carbon nanotube-polymer composites because of expected decreased manufacturing costs and true photo-actuation. But better results were found for liquid crystals elastomers. Actuation parameters (magnitude of the stroke, needed exerted force in tactile applications, etc.) in liquid crystal elastomer (LCE) materials have outperformed those of carbon nanotube polymer systems. Also, one of the initial disadvantages of the LCE materials, their transparency to visible light, has been overcome by incorporating carbon nanotubes in the elastomer to produce absorption over the complete visible spectrum, allowing successful actuation of LCE-CNT material using a visible LED light source. This observation puts LCE-CNT composites at the forefront of the research in the NOMS project.

As an intermediate deliverable, a prototype of 10x10 tactile tablet has been finalized with a pitch of 2.5 mm to allow standard Braille representation.



**10x10 light emitting layer and driver boards (the LEDs are lit by random data).**

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The interface between the PC and the NOMS tablet has required development of software to perform the visual to tactile transformation, Wireless communication to transmit the tactile image to the display, to control electronics to operate the tablet. A first version of the software has been released and the wireless communication protocol has been chosen.

### Potential Impacts And Use Of Final Results

Knowledge gained by studying photo-active NANO materials during NOMS project development will open new horizons for practical as well as research purposes not only for blind people, but for general public as a means of design for all.

The NOMS graphical display will be for instance suitable for use as a novel research tool for neuropsychologists allowing major progress in this field which has so far been limited by existing tactile technology which is either non-refreshable (e.g. embossed on paper) or just new very expensive devices [1, 2] with lower resolution than proposed by the NOMS project.

Another hopeful application is a single tactile element resembling LED. It might be used for the same signalling purposes as LED, parallel with it or instead of it. This technology could be applied for signalling purposes (power on/off, recording on/off, heating on/off, waiting message etc.) to support or substitute visual perception.

The work proposed here identifies a new direction leading to Implementation of NOMS technology in non-assistive applications which will also be of great interest to the general public judging by the advent of multiple tactile interfaces in PDAs, cell phones, music players and large surface personal computers. Research of photo active NANO-materials will support also development in multiple adjacent fields such as medicine or robotics through artificial muscle technology.

### Conclusion

The proposed device will comprise an invaluable added advantage over current assistive technology by provision of graphic and text information on a large area fast refreshable tactile display. Moreover NOMS is addressing also other specific needs of visually impaired people since that technology is readily adaptable to the latest and most common technical developments like e-books, i-phones and all featuring flat screens without classic keyboards. It could really improve accessibility of electronic information everywhere.

### Acknowledgement

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## 9.6. Digital Barriers: Set Up And Operation Of A National Helpdesk

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### Abstract

The German project “Digital informiert – im Job integriert” (Di-Ji) aims to remove digital barriers in the wide area of the work environment. One of its tasks includes the set up and operation of a helpdesk for people with difficulties using the internet, computer software and public digital terminals.

Barriers cause people to have problems using the services. These problems can be reported to the helpdesk by phone or via the internet. Links to the helpdesk are also available on several other websites notably the German government’s e-Government portal for people with disabilities, their relatives, public authorities and companies “www.einfach-teilhaben.de”.

### Keywords

Accessibility, Work Environment, Digital Barriers, Helpdesk, Design for All

### Introduction

Unobstructed access to digital information and means of communication is fundamental for the integration of people with disabilities in the work environment. However thorough knowledge of current assistive technology, modern web technology and their interaction is required to successfully use the modern World Wide Web. More than half of all employees nowadays work more or less regularly with a computer. But there are still significant barriers for people with disabilities who wish to use web based information and services. Another area with a need for action concerns online documents such as PDF (portable document format) documents. PDF is widely used for contracts, forms, and information brochures etc. and rarely accessible. If a PDF is provided the information is not necessarily available via HTML which could be more accessible. The area of information- and service terminals is growing as personal services are replaced by automated machine based services. In Germany this concerns for instance automated teller machines (ATMs), ticket machines in public transport or the emergence of the so called “Packstation”, an automatic device where parcels can be picked up or sent off replacing the clerk at the post office [1, 2]. It is vital to make all players in this area aware of the special requirements of people with disabilities. Otherwise people with disabilities will be excluded from using these services.

In 2009 the German government ratified the United Nations convention on the rights of people with disabilities. This step can be viewed as significantly extending activities to ensure accessibility which took place on national level in preceding years. This includes the social security code (Sozialgesetzbuch - SGB) IX [3] and the law against discrimination of people with disabilities (Behindertengleichstellungsgesetz - BGG) [4] which included the accessible



information by law (Barrierefreie Informationstechnik-Verordnung – BITV) [5]. As a consequence all government organisations such as ministries down to municipal administrations are required to provide their information in an accessible way.

The German project „Digital informiert – im Job integriert“ (Di-Ji) [6] aims to remove digital barriers in the wide area of school and professional training, employment and the work environment. In order to achieve this goal the project provides information and guidelines on its webpage and is present at trade fairs, workshops and conferences. It also organizes training sessions to train people on aspects of accessibility and electronic media. Di-Ji is also involved in a national working group on the development of a national standard for accessible ATMs.

## Digital barriers

The term “Digital Barriers” refers to all barriers associated with electronic means of communication. This includes online documents (e.g. Adobe PDF and Microsoft Word documents), web sites, software (including operating systems), and public digital terminals (PDT) such as ATMs or ticket machines.

### Barriers on web sites

The majority of complaints received are linked to accessibility problems on web sites. This can be attributed to the fact that the helpdesk was initially set-up in another project which dealt only with web barriers. A recent study on the accessibility of public versus private websites in Germany gave a rate of 41.01% / 23.26% [7].

Even if a web site is initially accessible the level of accessibility decreases over time. This is an issue which has not been addressed. A requirement would be to incorporate sustainability mechanisms in content management systems [8].

The accessibility standard applied to the website is the “Barrierefreie Informationstechnik Verordnung 1.0” (BITV 1.0) which is based on the WAI WCAG I. The following non-exhaustive list contains only the most obvious problems. A lot of problems could also be avoided if web developers would use proper web programming techniques with the appropriate tags, attributes, and techniques.

### Insufficient colour contrast

Colour contrast refers to the contrast between the colour of the text and the background. A light grey text in small print on a dark grey background is difficult to read even for someone who is not affected by low vision. These situations can be found quite often at the bottom of pages where links are given for the imprint, contact etc. There are test tools available to measure the colour contrast. According to the WAI WCAG 1 the colour contrast between fore- and background should be at least 4.5:1.

### Alternative text for non-text content

Non-text content refers in most cases to images. There are several aspects associated with images on a web site. In general a picture is used to support the text which appears on the web site. The picture might be a simple decoration which is not really required to understand what is written. It might also be that the image is used in a link to another web site or that the image is simply there to align certain objects on the web site. It is very important to





distinguish between these different uses of images and to address the particular purpose by using the appropriate attributes. A typical image definition in HTML looks like: ``

The word "img" is the name of the HTML tag and the subsequent words "src", "title", and "alt" are attributes of that image. "src" refers to the source of the image, usually a file stored in the file system where the web site resides. The "title" attribute contains the text which appears when the mouse cursor hovers over the image (tool tip). Finally the "alt" attribute contains the alternative text. This is the text which is displayed when the image cannot be loaded (e.g. if the image's path given is not valid).

Depending on the purpose of the image information can be passed on via the "title" and "alt" attributes. In case the image is used as decoration or to align something on the web page the "title" and "alt" attributes remain empty. If the image is important the "title" attribute contains the image's title and the "alt" attribute contains a descriptive text. If the description of the image exceeds a certain length the "longdesc" attribute could be used. This attribute contains a link to another webpage with a detailed description of the image's content. However this feature is not supported by most web browsers (there is an addon for Firefox). Alternatively a web link could easily be provided to achieve a very similar mechanism. If it's a link the title attribute might be used to indicate whether the link opens in a new window or tab (see below).

#### **Incorrect or missing link between form field and label**

This is a mistake which happens quite a lot in web forms. A form can simply be the input area of a search function on a web page. This input area should consist of a label (e.g. "Search for:"), an input field such as a text-box and a submit button. The link between the label and the input field is usually an ID which is referenced in the label's "for" attribute and the input field's "id" attribute.

#### **No use, incorrect use, or incorrect order of heading tags.**

In HTML heading tags are used to tag headings. It is a general problem that people think that a sentence printed bold is a heading. This is quite a common mistake in word processors which lead to the problem of accessibility of PDF documents. A heading is only a heading if it is defined to be heading. In HTML there are the heading tags `<h1>...<h6>` which can be used to structure a document. A proper ordered structure starts with the top level heading `<h1>` followed by `<h2>`, `<h3>` etc. Sometimes one of the intermediate headings is skipped. This should not happen. In rare cases the headings are in no order whatsoever and are simply used to format parts of the text.

#### **Mouse versus keyboard access**

A general accessibility requirement for a website is the possibility to use the web site exclusively either with the mouse or the keyboard. Using the mouse is usually not a problem but there is a growing tendency that certain areas of a website are not available using only a keyboard. A typical example would be a popup window which appears in front of the main window and implies that it has the input focus but it doesn't. The input elements of the picture in front can only be accessed through the mouse by clicking into this area.



Using a mouse has the added advantage that links are easily recognizable because the mouse cursor usually changes shape while hovering over a link. Using the keyboard the active link is sometimes highlighted by a different text/background colour, by a small rectangular outline, or not at all. People who can only use the keyboard must know where they are.

### Use of Captchas

A captcha is a challenge-response test used in computing as an attempt to ensure that the response is generated by a human being. The test itself has to be easy enough to be solved by all humans and at the same time intrinsically difficult not to be solved by a computer. Captchas are used to protect feedback forms on websites from spamming by automated mechanisms. A typical graphical captcha would be an image of distorted characters (letters and numbers). The characters need to be recognized and typed into an input field. Blind people cannot see the image and the distortion and low colour contrast might make it impossible for people with low vision to pass this test. A captcha which should be solved by all human beings becomes a barrier for some which cannot be circumnavigated.

Alternatives to image based captchas are audible and logical captchas. In an audible captcha a word or an expression is spoken with some background noise and the user has to recognize the text and type it into a textbox. Although this appears to be a good alternative to graphical captchas, it still excludes people in particular those who are hard of hearing and of low vision i.e. the elderly. A logical captcha is simply a question. For instance: "What is two plus two?", "What is the first name of Angela Merkel?", or "Red, blue, green, brown, and yellow. Which of these colours has four letters?"

Captchas are quite a difficult issue to deal with. On one hand there is a reason for having them and on the other hand they are hard barriers which make it impossible for some people to proceed.

### Links opening new windows (or tabs) without warning

The expectation when clicking a link is that the link opens new content in the original frame. However several other things might happen instead. The new content is displayed in a new window, in a new tab or even more pop-up windows open. The danger is that the user loses orientation. This is most likely to happen to blind users or users who are unable to grasp what has happened. In order to avoid confusion the title attribute in the link instruction should be used to inform the user of any deviation from normal behaviour of the link (e.g. "link opens in a new tab").

### Inaccessible online documents

Inaccessibility of online documents is linked to similar issues compared to websites. Rather than using style sheets many people simply use direct formatting techniques to structure their text documents. When printed these documents have the look of properly formatted documents. Conversion of such documents to PDF yields documents which are not accessible. Tags, a structure, and alternative text are missing. Di-Ji aims to educate people by publishing guidelines on how to create accessible PDF documents from different sources such as Microsoft Word, OpenOffice, LibreOffice or Adobe InDesign.



## Software barriers

The area of software barriers applies on one hand to user software (e.g. a spread sheet calculator or word processor) and on the other hand to the subjacent operating system. In the same way a website uses the built in accessibility capabilities of the web browser, the software on a computer can rely on the accessibility features of the operating system. One has to be aware of the fact that although accessibility features are built into an operating system these features such as a magnifier, a virtual keyboard, voice control, or a text to speech synthesizer will be limited. They will not reach the same functionality or level of excellence a commercial product costing at least one to two hundred Euros will.

Nevertheless there is currently a problem of an operating system sold in Germany which has a text to speech capability in English but not in German. This is one of the complaints the helpdesk received from several people and is currently working on.

In general it is quite difficult to receive reports of software which is not accessible. The reason is very simple, if someone cannot use the software, the person is not going to use it. It is the same with cars. If you do not fit into the car because you are too big you will never drive it! The problem is that people, who would be able, sufficiently qualified, and willing to train a particular profession cannot do it because the tool (i.e. the software) is not accessible! Another issue concerns a professional who trained using certain software, has an accident or crippling illness and shall now use the software. Due to his illness or accident this might no longer be possible because the software is not accessible.

Although one could start to examine software using usability testing etc. this is not the scope of the helpdesk. The helpdesk relies on users to report software barriers. The barriers will be similar to web barriers and are likely to lie in the areas of exclusive mouse versus exclusive keyboard access, keyboard shortcuts or colour contrast. The issue of keyboard shortcuts is viewed controversially; on one hand a sufficient number of shortcuts must be available to support accessible operation of the software. On the other hand there are numerous shortcuts which have a universal meaning and should not be used differently (e.g. Ctrl+x, Ctrl+v, Ctrl+c, Ctrl+s). At least some operating systems allow keyboard shortcuts to be entered sequentially rather than at the same time.

## Barriers associated with public digital terminals (PDTs)

An important aspect of independent self-determined living includes the ability to manage one's own affairs. Independent participation requires the ability to use public services. Some of these services are no longer offered as personal over the counter services but as automated services. Typical examples of this development can be found in public transport, banking and postal services.

Large train stations provide passenger information visually and audible. However if you want to buy a ticket things get complicated. "Modern" ticket vending machines provide a touch screen which prohibits blind travellers from using it and people who use a wheelchair will have difficulties to access the controls. In a larger station chances are good to find staff which will assist the traveller. However on a small suburban train station or bus stop people with disabilities will not be able to use the facilities.

Banking is another area where personal services are steadily being replaced by automated services. ATMs have been around for several years now. Nowadays there are not only bank



statement printers but other automated services which allow people to initiate bank transfers and so on. There is not even money in the bank anymore. If you want to withdraw money you can sometimes talk to staff and they initiate the withdrawal process but you are still required to pick up the cash from an ATM using a special bank card. The newest expression in the context of automated services is “Cash Recycling” which means that money can not only be withdrawn but can be deposited. So there are a lot of activities which can be performed 24 hours per day 7 days per week without human interaction. At first glance an ideal situation for the professional working and commuting nine to twelve hours per day. The only drawback is that the machines are not accessible.

A few years back so called “Packstationen” emerged in Germany. The machine looks like those self-service luggage lockers in railway stations. Prior to use the user has to register via the internet and then parcels can be delivered to this machine. Access to one of those lockers is granted by an ID or barcode sent to the user. It is also possible to use the machine to drop off parcels. They are picked up by the postal service and delivered to the recipient. It is a quite nice service for the working population but it is not accessible.

These are some areas where the helpdesk expects complaints to be lodged and where the Di-Ji project is trying to get involved in order to provide solutions. Of course there are a lot more automated services which people are not necessarily aware of because they have been around for decades. For instance vending machines where cigarettes, parking ticket, stamps, condoms, food, and non-alcoholic beverages can be bought or being paid for. New automated services currently emerging in Germany are self-service checkout points in supermarkets and ticket machines where a fine for travelling without ticket can be paid for. It is anticipated that reports of barriers in connection with public digital terminals will increase in the near future.

### Typical use case

Michaela Schmidt (57) [9] is a full time employee. About six years ago Mrs. Schmidt started experiencing difficulties with her central visual field as a consequence of macular degeneration. Michaela uses a text to speech synthesizer when working with a computer. Recently she came across a web page where she experienced some difficulties. The page contained some illustrations with important information which she could not see. As the image did not have an alternative text she could not comprehend what the content of the page was. In order to sort out the problem Mrs. Schmidt tried to contact the owner of the website using a web form. As she could not decipher the captcha she could not send her message to the owner of the web site. As she was unable to get in touch with the owner of the website she decided to get in touch with the national helpdesk for digital barriers. Although she could have called or sent an email message she decided to use a web form to report the barrier to us. The only information she had to provide was the address of the webpage and a brief description of the barrier. However she also included contact details and details regarding her disability and computer set-up. Mrs. Schmidt appreciated that we acknowledged the reception of her report. The helpdesk’s initial activities included a confirmation of the barriers in order to present potential solutions to the owner of the website. The initial letter to the owner of the website briefly introduced the project, states why this letter is sent and requested that the barriers are being removed. The letters sent are neither



threatening nor intimidating. They state the problem, explain why it is a problem, and provide a potential solution all of which is based on current German standards and the German law.

As this was a private website the owner is under no obligation to take any action. If it would have been a government organisation they are obliged to communicate in an accessible way. Of course there is a grey area of private firms developing web sites for government organisations. They are not required to be accessible but the government organisation would be. It is our experience that those companies are usually unaware of the legal accessibility requirements of the government but they are keen learners on accessibility issues.

If it would be a government organisation or a company working for the government we would have gotten an answer by now and Mrs. Schmidt would have received an answer regarding the outcome of her complaint. Companies which are not required to provide accessible web sites tend not to answer at all, might present an excuse, or promise to change the website within a certain timeframe. The information received is given back to Mrs. Schmidt.

## Personas

During the AEGIS project a number of personas were developed [10]. In general anyone would benefit from accessible websites but the following personas were selected to illustrate how their lives would be affected by removing digital barriers.

Gert Van Dijk (42) suffers from partly blurred vision since adolescence. He is a part-time employed and would like to do internet banking. However the banking application is not accessible yet. Therefore his wife Chris has to do all the banking. If Gert would be living in Germany, he could report the barriers of the bank's website to the helpdesk. The helpdesk would then ask the bank to make its website accessible. In fact a target agreement with a group of banks to this effect exists in a part of Germany. This should be extended to the whole of Germany. Additionally Gert does not like websites with ads, captchas or pop-up windows. He finds it difficult to close them. Again, accessible websites do not have these and Gert as well as other people would benefit from accessible websites.

Peter Vandezande (63) who is retired suffers from muscle weakness and spasms in his arms due to Multiple Sclerosis. He experiences difficulties with mouse movements and drag and drop actions are limited and difficult to execute for Peter, which excludes him from using many sites, leaving him frustrated. Peter wishes to be able to use the keyboard more in certain programmes or websites (e.g. the flash site of his favourite football club), to limit the use of the mouse. As mentioned above a prerequisite for an accessible website is the equal support for mouse and keyboard input.

Carolina Combs (45) who is a professor for Ancient History is affected by muscle dystrophy. So she has a similar condition as Peter but she uses voice recognition. Her need is to use voice recognition on her computer and mobile that has a higher success rate of understanding what she says. This is very much linked to the operating system or the voice recognition software already installed. She also experiences problems regarding the consistency of web pages in relation to assistive features, especially social sites.

Tomasa Almaraz (34) is deaf and works as a consultant. She is quite a heavy technology user and wishes that internet videos would be subtitled as it is difficult for her to decide



whether or not the sound is important in a particular video, and what kind of information is given in the sound track.

### Acknowledgement

The project Di-Ji is based on the outcome of the conference “Digitally informed – integrated at work” which was held by the German Alliance for barrier free Information technology (Abl). The project Di-Ji is funded by the German Federal Ministry for Labour and Social Affairs.

### References

- [1] See <http://www.dhl.de/content/de/de/paket/privatkunden/packstation.html>
- [2] See <http://en.wikipedia.org/wiki/Packstation>
- [3] See [http://www.gesetze-im-internet.de/sgb\\_9/index.html](http://www.gesetze-im-internet.de/sgb_9/index.html)
- [4] See <http://www.gesetze-im-internet.de/bgg/BJNR146800002.html>
- [5] See <http://www.gesetze-im-internet.de/bitv/BJNR265400002.html>
- [6] See <http://www.di-ji.de>
- [7] See <http://www.eaccessibility-monitoring.eu/BSC/>
- [8] Thesis presented for the degree of doctor of philosophy, Birgit Scheer, unpublished results
- [9] Mrs. Manuela Schmitz is a persona which is based on Märta Hansson who was created by the Centre of User Experience Research of KU Leuven for the AEGIS project.
- [10] See [http://www.aegis-project.eu/index.php?option=com\\_content&view=article&id=63&Itemid=53](http://www.aegis-project.eu/index.php?option=com_content&view=article&id=63&Itemid=53) and [http://160.40.50.89/Accessible\\_Ontology/Version5.1/AccessibleOntologyOWLDdoc/user.html](http://160.40.50.89/Accessible_Ontology/Version5.1/AccessibleOntologyOWLDdoc/user.html)



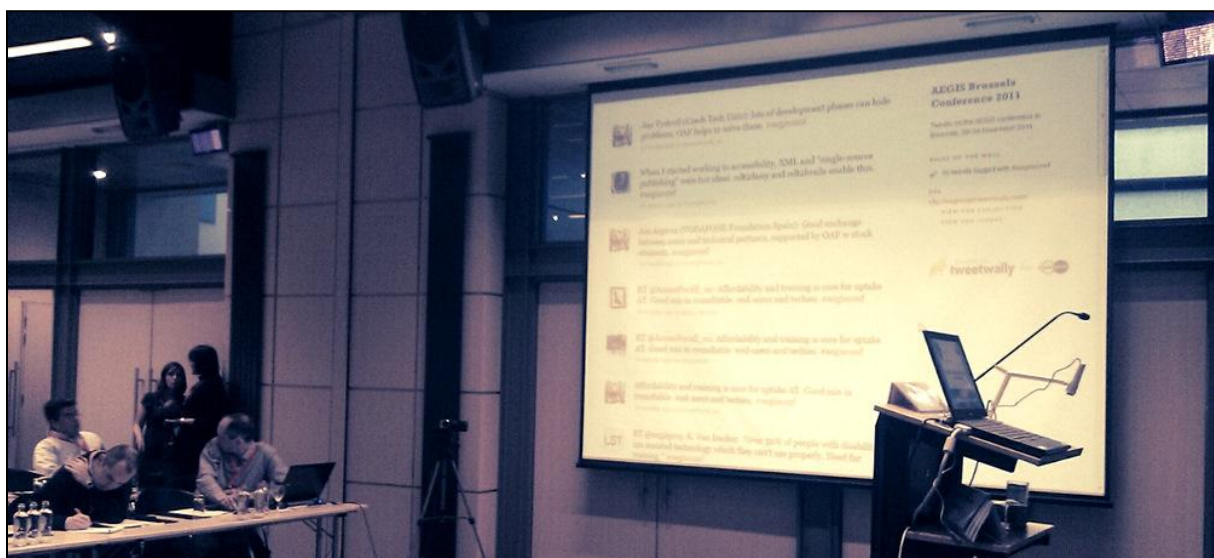
## 10. Pictures

The following sections provide a snapshot of the pictures that were taken at the three days event. All pictures taken during the three days can be viewed and downloaded via the project's Facebook page [www.facebook.com/Aegis.Accessible](http://www.facebook.com/Aegis.Accessible).

### 10.1. Workshop



Speech by Mr. Jan Spooren, EPR Secretary General



Tweetwall in action.

Also available via the conference website [www.aegis-conference.eu](http://www.aegis-conference.eu)





**Opening speech by Dr. Maria Fernanda Cabrera Umpierrez, ETSI Telecomunicacion, Universidad Politecnica de Madrid**



**Attendees to the workshop**

Also available via the conference website [www.aegis-conference.eu](http://www.aegis-conference.eu)







**Mr. Peter Korn moderating the round table**



**Round table participants**

Also available via the conference website [www.aegis-conference.eu](http://www.aegis-conference.eu)





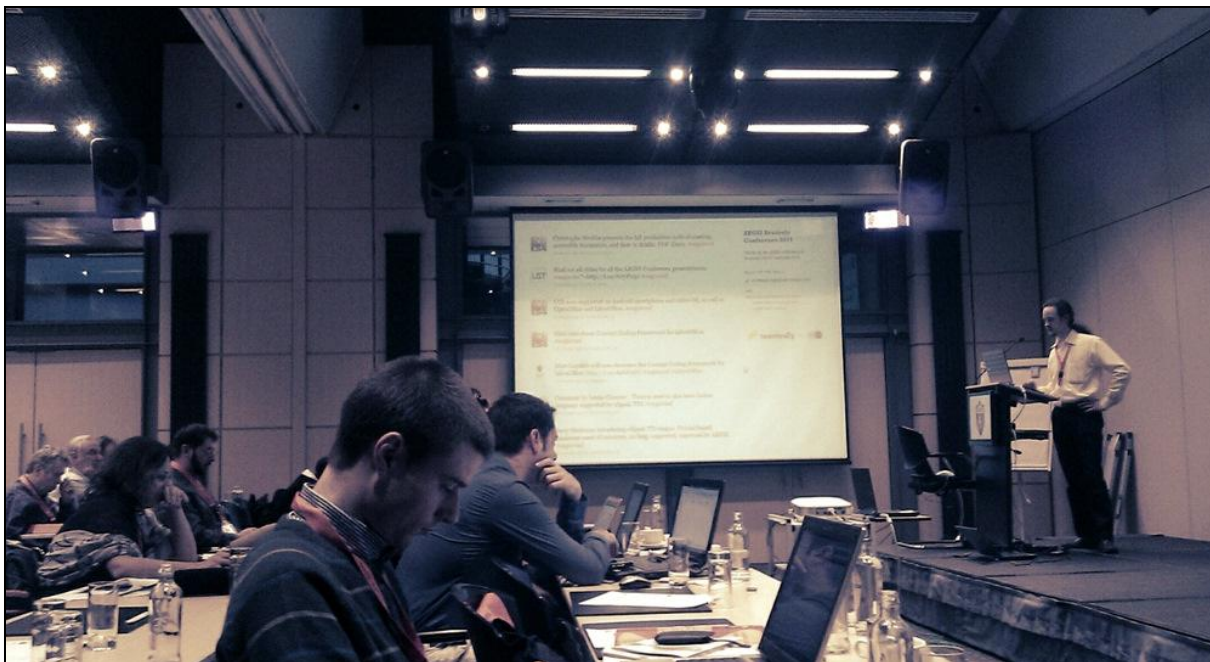
Intervention by attendees during round table



Attendees during round table

Also available via the conference website [www.aegis-conference.eu](http://www.aegis-conference.eu)





Mr. Christophe Strobbe presenting.



Showing of AEGIS project video





Demonstration AEGIS contact manager (for Android)



Mr. Jan Richards presenting Tecla Access.



## 10.2. Conference day 1



**Speech by Mr. Paul Timmers, European Commission, DG INFSO, Director**



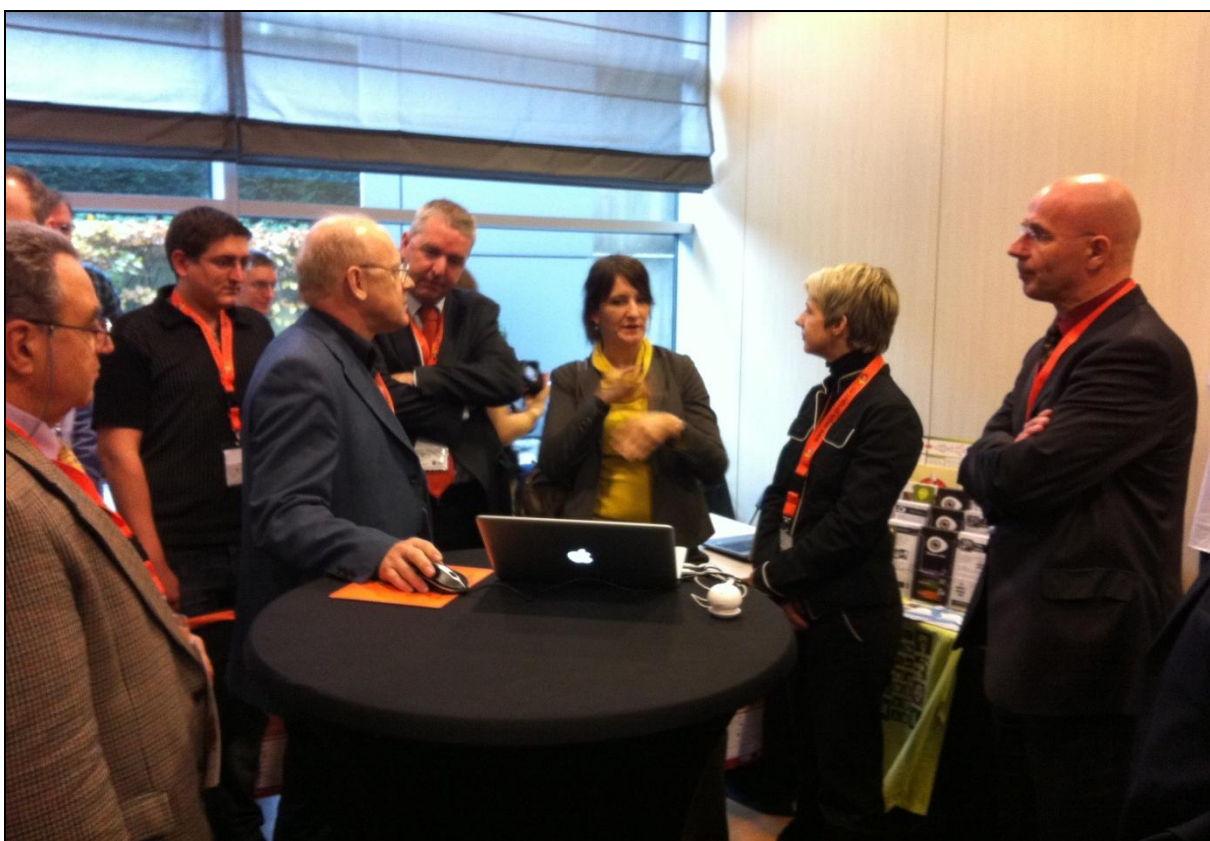
**Speech by Ms. Helga Stevens, Senator and Flemish MP**

Also available via the conference website [www.aegis-conference.eu](http://www.aegis-conference.eu)





**Opening of the exhibition by Ms. Helga Stevens and Mr. Paul Timmers**



**Ms. Helga Stevens and Mr. Paul Timmers visiting the exhibition booths**  
Also available via the conference website [www.aegis-conference.eu](http://www.aegis-conference.eu)





Exhibition hall



Round table with key stakeholders Wim Moeyaert, Gregory Smiley, Gregg Vanderheiden, Clayton H. Lewis, Peter Korn and Jon Azpiroz





**Session 3, Mark Van Assche speaks about local investment in accessibility**



**Session 2, Shadi Abou-Zahra presents in the Accessible Workshop session**







**Session 1, Sign language interpreter**



**Session 2, Jan Vystrcil presents mobile applications accessibility**



### 10.3. Conference day 2



**Speech by Mr. Jan Albers (former EPR president and CEO of Foundation Rehabilitation Limburg, NL)**



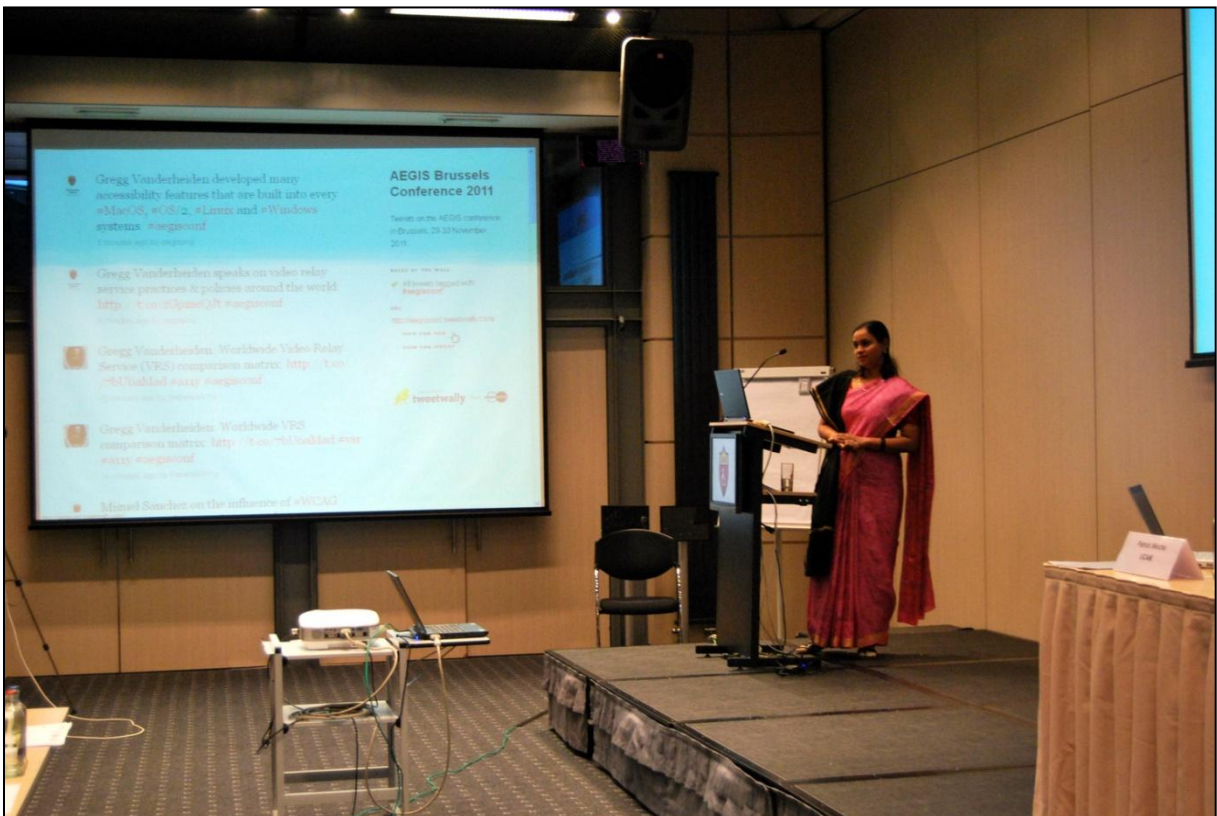
**Session 7, Ms. Carla de Winter presents on open educational resources**

Also available via the conference website [www.aegis-conference.eu](http://www.aegis-conference.eu)





Session 5, Christoph Lange presents on Ontoioip



Session 6, Leena Chourey presents on Orca





Session 5, Miguel Sanchez presents on WCAG rules

Also available via the conference website [www.aegis-conference.eu](http://www.aegis-conference.eu)





Concertation events projects panel



Session 7, Silvia Navarro presents on e-learning resources

Also available via the conference website [www.aegis-conference.eu](http://www.aegis-conference.eu)





Session presentations with interactions by the participants



**Best Paper Award: Shadi Abou-Zahra for "Web Accessibility Guidance, Evaluation Methodologies, and Research Explorations"**





**Best Poster Award: Guillermo Peris Fajarnes for "EYES2021"**



**Best Presentation Award: Edwige Pissaloux for "Vision For Assistive Technologies"**

Also available via the conference website [www.aegis-conference.eu](http://www.aegis-conference.eu)



## Attendance list

#	Family Name	First Name	Organisation	Workshop	Conference Day 1	Conference Day 2
1	Abou-Zahra	Shadi	W3C Web Accessibility Initiative (WAI)		v	v
2	Albers	Jan	EPR			v
3	Al-Mohisen	Abdul-Aziz	Saudi Arabian Airlines		v	v
4	Alves Ortega	Susana	CEADAC (National Brain Injury Rehabilitation Center)		v	v
5	Amza	Claudiu	Bluepoint IT Solutions	v	v	v
6	Åström	Lisa	Omnitor		v	
7	Azpiroz	Jon	Fundación Vodafone España	v	v	v
8	Baldewijns	Jeroen	Blindenzorg Licht en Liefde	v	v	v
9	Baldiris Navarro	Silvia Margarita	University of Girona	v	v	v
10	Bhole	Dhananjay	Pune University	v	v	v
11	Blanchaert	Dries	Flemish Library for Braille and Audiobooks	v		





#	Family Name	First Name	Organisation	Workshop	Conference Day 1	Conference Day 2
12	Bonfiglio	Silvio	FIMI BARCO	v	v	v
13	Breughe	Steven	Blindenzorg Licht en Liefde TReye- IT	v	v	v
14	Brown	David	Nottingham Trent University	v	v	v
15	Buttier	Julie	EPR	v	v	v
16	Buydts	An	Dixit		v	
17	Cabrera Umpierrez	Maria Fernanda	UPM	v	v	v
18	Calu	Johan	Vzw ithaka	v	v	v
19	Carmien	Stefan	TECNALIA	v	v	v
20	Carmona	Iván	Technosite- ONCE Foundation	v	v	v
21	Chalkia	Eleni	CERTH/HIT		v	
22	Chourey	Leena	Centre for Development of Advance Computing	v	v	v
23	Cozette	Bruno	Plextalk	v	v	v



#	Family Name	First Name	Organisation	Workshop	Conference Day 1	Conference Day 2
24	Da Lio	Mauro	University of Trento			
25	Daems	Jo	Katholieke Hogeschool Kempen		v	v
26	De Cecco	Mariolino	University of Trento		v	v
27	De Gnck	Eline	Blindenzorg Licht en Liefde vzw	v	v	v
28	De Letis	Cinzia	EPR	v	v	v
29	De Valck	Dirk	ALS Liga Belgium		v	v
30	De Winter	Carla	AccessCapable	v	v	v
31	Decorte	Ann	vzw Ithaka		v	v
32	Deleyn	Anne-Marie	VAPH	v	v	
33	Delmartino	Mark	European Platform for Rehabilitation - EPR	v	v	v
34	Delolmo	Manuel	Fundación Vodafone España	v	v	v
35	Derbring	Sandra	SU-DART		v	
36	Dimitriou	Jerry	Singular Logic S.A.	v		



#	Family Name	First Name	Organisation	Workshop	Conference Day 1	Conference Day 2
37	Dubost	Marie	EPR	v	v	v
38	Ebert	Andreas	Microsoft Corp	v		v
39	Engelen	Jan	Kath. Univ. Leuven - SCD	v		v
40	Engels	Mia	Progebraille - Helen Keller vzw (PHK)		v	v
41	Engström	Peter	Index Braille (The embosser maker)	v	v	v
42	Evet	Lindsay	Nottingham Trent University	v	v	v
43	Friehoff	Thomas	BAUM Retec AG	v	v	
44	Gemou	Maria	CERTH/ HIT	v	v	v
45	Giudici	Gustavo		v	v	v
46	Gomez	M <sup>a</sup> Visitacion	PA	v	v	
47	Gomez Valencia	Juan Diego	University of Geneva	v	v	v
48	Holmqvist	Eva	SU DART		v	v
49	Ingelmo Sierra	Antonio J.	Fundación ONCE	v	v	v



#	Family Name	First Name	Organisation	Workshop	Conference Day 1	Conference Day 2
50	Jung	Christoph	Fraunhofer IGD			v
51	Kalogirou	Kostas	CERTH - HIT		v	
52	Kant-Schaps	Marianne	Network of European Psychologists in the Educational System N.E.P.E.S.		v	v
53	Kasparova	Lenka	Oracle Czech, s.r.o.	v	v	v
54	Katsigianni	Stella	PA		v	v
55	Katsigianni	Aglaia	Paraplegic Association of Drama		v	v
56	Kawamura	Hiroshi	The DAISY Consortium		v	v
57	Kinisci	Pierre	Vicon			v
58	Knops	Klaus	MS-Liga Vlaanderen	v	v	v
59	Korn	Peter	Oracle America	v	v	v
60	Krid	Laurianne	FIA European Bureau		v	
61	Langdon	Pat	University of Cambridge		v	v



#	Family Name	First Name	Organisation	Workshop	Conference Day 1	Conference Day 2
62	Lange	Christoph	University of Bremen		v	v
63	Lev	Susanne	xml-tekst	v	v	v
64	Lewis	Clayton H.	Coleman Institute for Cognitive Disabilities, University of Colorado	v	v	v
65	Loos	Eugene	University of Amsterdam / ASCoR		v	
66	Lundälv	Mats	SU-DART	v	v	v
67	Magnusson	Charlotte	Lund University Sweden		v	
68	Mahajan	Jayant	Ecole hoteliere lavasa	v	v	v
69	Mamojka	Branislav	Slovak Blind and Partially Sighted Union		v	v
70	Martínez Ramos	Mónica	CEADAC (National brain Injury Rehabilitatiion Centre), Spain		v	v
71	Martinez Usero	Jose Angel	Technosite	v	v	v
72	Mattsson Müller	Ingrid	SU-DART		v	v



#	Family Name	First Name	Organisation	Workshop	Conference Day 1	Conference Day 2
73	Milligan	Michael	Mobile Manufacturers Forum		v	
74	Mitchell	Helena	Georgia Institute of Technology, Ctr of Advanced Communications Policy	v	v	v
75	Moeyaert	Wim	Werkgroep Vorming en Aktie - Open IT	v	v	v
76	Nordberg	Lars	Femtio Procent Data AB	v	v	v
77	Ottosson	Charlotte	Swedish National agency for special needs education and schools		v	v
78	Paramo	Miguel	UPM	v	v	v
79	Pasterny	Hanna	Association Civil Initiatives Development Centre	v	v	v
80	Peisoner	Matthias	Fraunhofer		v	v
81	Peris Fajarnes	Guillermo	Universidad Politecnica de Valencia	v	v	v
82	Perrin	Franck	Accessibility Research Centre		v	v



#	Family Name	First Name	Organisation	Workshop	Conference Day 1	Conference Day 2
83	Pirelli	Giuliano	European Commission Joint Research Centre	v	v	v
84	Pissaloux	Edwige	UPMC (ISIR)			v
85	Radek	Christian	Bundesarbeitsgemeinschaft Selbsthilfe e.V. (BAG SELBSTHILFE)		v	v
86	Rasmussen	Hans	The Danish Association og Disability Organisations in Denmark	v	v	v
87	Reinau	Mitzi	PA	v	v	v
88	Richards	Jan	Inclusive Design Research Centre, OCAD University	v		
89	Rodriguez Castro	Adrián	LST - UPM	v	v	v
90	Roe	Patrick	EPFL-IEL-LEMA		v	v
91	Rottier	Jan	Eureka Die-'s-lekti-kus		v	v
92	Sahasrabudhe	Shrirang	Infosys Technologies Ltd.	v	v	v



#	Family Name	First Name	Organisation	Workshop	Conference Day 1	Conference Day 2
93	Sanchez	Miguel	Polytechnic University of Valencia (UPV)	v	v	v
94	Serrien	Bart	Sclera vzw		v	v
95	Shoaib	Umar	Politecnico di Torino	v	v	v
96	Smiley	Gregory	Nokia	v	v	v
97	Spooren	Jan	EPR	v	v	v
98	Stevens	Helga	Vlaams Parlement		v	
99	Strobbe	Christophe	Katholieke Universiteit Leuven	v	v	v
100	Sturla	Clare	EPR	v	v	v
101	Teplicky	Peter	Slovak Blind and Partially Sighted Union		v	v
102	Thogersen	Niels	xml-tekst	v	v	v
103	Timmers	Paul	European Commission DG Information Society & Media (ICT addressing Societal Challenges)		v	





#	Family Name	First Name	Organisation	Workshop	Conference Day 1	Conference Day 2
104	Tjäder	Claes	Swedish Institute of Assistive Technology	v	v	v
105	Treviranus	Jutta	Inclusive Design Research Centre, OCAD University	v	v	v
106	Turbut	Soring	Bluepoint		v	v
107	Tzovaras	Dimitrios	CERTH-ITI	v		
108	Vallee	Martine	Canadian Radio-television and Telecommunications Commission		v	v
109	Valli	Roberto	Faculty of Engineering, University of Padua	v	v	v
110	Van Assche	Mark		v	v	v
111	Van den Breede	Gerrit	KOC - Kenniscentrum Hulpmiddelen	v		
112	van der Aa	Marc	Plextalk		v	v
113	Van Isacker	Karel	EPR	v	v	v



#	Family Name	First Name	Organisation	Workshop	Conference Day 1	Conference Day 2
114	Van Isacker	Bernard	Phoenixkm	v	v	v
115	van Weele	Niels	BAUM Retec AG		v	v
116	Vandecasteele	Ilse	Centrum Ganspoel		v	v
117	vandenbempt	ingrid	Centrum Ganspoel Dienstt GON		v	v
118	Vander Veken	Katleen			v	
119	Vanderheiden	Gregg	Trace Center - Univ of Wisconsin	v	v	v
120	Vandertogt	Ted				v
121	Vandewalle	Geert	vzw Ithaka		v	v
122	Vanhove	Jean-Marie	Inclusief Consulting		v	v
123	Verhaegh	Jos	Blindenzorg Licht en Liefde, Vlaams Digitaal Oogpunt	v	v	v
124	Votis	Kostas	CERTH/ITI		v	v
125	Vystrčil	Jan	Czech Technical University in Prague	v	v	v



#	Family Name	First Name	Organisation	Workshop	Conference Day 1	Conference Day 2
126	Welche	Patrick	University of Cambridge	v	v	v
127	Zanoletty García	David	Fundación ONCE	v	v	
128	Zelderloo	Luk	EASPD	v	v	



## Consortium



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Supporting Technologies,  
Spain  
[www.lst.tfo.upm.es](http://www.lst.tfo.upm.es)



Fundación Vodafone, Spain  
[fundacion.vodafone.es](http://fundacion.vodafone.es)



ONCE Foundation, Spain  
[www.fundaciononce.es](http://www.fundaciononce.es)



University of Cambridge, UK  
[www.cam.ac.uk/](http://www.cam.ac.uk/)



Blue Point IT Solutions  
S.r.l., Romania  
[www.bluepoint-it.ro/](http://www.bluepoint-it.ro/)



America Online, UK  
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Nottingham Trent  
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[www.ntu.ac.uk/sat/](http://www.ntu.ac.uk/sat/)



Katholieke Universiteit  
Leuven, Belgium  
[www.kuleuven.be/](http://www.kuleuven.be/)



SU-DART, Sweden  
[www.dart-gbg.org](http://www.dart-gbg.org)



Fraunhofer IAIO, Germany  
[www.iao.fraunhofer.de/](http://www.iao.fraunhofer.de/)



FPD, Sweden  
[www.femtioprocent.se](http://www.femtioprocent.se)



Royal National Institute of  
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OCAD University /  
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Research Centre, Canada  
[inclusivedesign.ca/](http://inclusivedesign.ca/)



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