Basdekis, I., Karampelas, P., Doulgeraki, V. & Stephanidis, C. (2009). Designing Universally Accessible Networking Services for a Mobile Personal Assistant. Lecture Notes in Computer Science, 5615, pp. 279-288. doi: 10.1007/978-3-642-02710-9_31

Designing Universally Accessible Networking Services for a Mobile Personal Assistant

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Ref as: Basdekis, I., Karampelas, P., Doulgeraki, V. and Stephanidis C. (2009): Designing Universally Accessible Networking Services for a Mobile Personal Assistant. In: C. Stephanidis (ed.) Proceedings of the 13th International Conference on Human-Computer Interaction HCI International 2009 July 19-24, 2009, San Diego, CA, USA. pp. 279-288.

Abstract. At present, a tendency towards smaller computer sizes and at the same time increasingly inaccessible web content can be noted. Despite the worldwide recognized importance of Web accessibility, the lack of accessibility of web services has an increasingly negative impact on all users. In order to address this issue, W3C has released a recommendation on Mobile Web Best Practices, supplementary to the Web Content Accessibility Guidelines. This paper presents the design and prototype development of universally accessible networking services that fully comply with those standards. Validation and expert accessibility evaluation on the XHTML Basic prototypes present 100% compliance. The followed design process is presented in details, outlining general as well as specific issues and related solutions that may be of interest to other designers. The results will be further verified through user tests on implemented services.

Keywords: Web accessibility, mobile accessibility, user interface design, device independence, prototyping.

1 Introduction

Since its creation, the mission of the World Wide Web Consortium (W3C) has been to lead the Web to its full potential. The first goal that specifies this mission[1] is *Web for Everyone* (previously *Universal Access*) while the second is *Web on Everything* (previously *Interoperability*). Ten years ago web users had limited access to software, let alone Web services (eServices) that were designed specifically for desktop computers, as there was no alternative way of accessing the Internet. In parallel, assistive technology solutions were scarce, expensive to purchase, limited to specific age or disability categories, and in most cases incompatible with other hardware and software applications [1].

At present, a tendency towards smaller computer sizes and at the same time increasingly inaccessible web content can be noted. Users have more freedom to choose their preferred hardware-software combination for communication and work through a Web browser (i.e., desktop browser, speech browser, speech synthesizer, Braille display, mobile browser, car browser, etc). Therefore, there is increased demand for web material (i.e., content, digital services) interchangeable and accessible at any time and place. For example, a substantial growth can be observed in mobile Web usage and demand for mobile Web services (mServices). Recent studies indicate that the 27% of European and the 28% of US mobile subscribers who currently do not use mobile data services intend to start using them in the next two years [2].

Following this trend, new and existing eServices are being (re)designed in order to be accessed through mobile devices as well as traditional PCs, and serve the demand for 24/7 web access. However, as studies indicate, web material which is designed basically on visual concepts is largely inaccessible to people with disability [3, 4], raising as a consequence barriers to all mobile device users as well [5]. Therefore, and despite the worldwide recognized importance of eAccessibility, the lack of accessibility of eServices has an increasingly negative impact on all users, and especially those for whom Web access may be one of the main paths to address communication needs and support independent living.

In addition to problems occurring because of inaccessible content, handheld mobile devices (such as PDA's, smart-phones, mobile phones, Blackberries, Notebook PCs, ultra-mobile PCs, and others) can present usability problems as well. The use of a pointing device, touch screen or tiny buttons for input, and a small screen for output, is unsuitable for many users, so these options are not really helpful especially to those who are blind or unable to use a stylus. Additionally, installed browsers on mobile devices may vary in the way they interpret web pages without fully

[1] W3C goals: http://www.w3.org/Consortium/mission

complying with markup standards of W3C (e.g., XHTML Basic, cHTML, CSS and others). Due to platform and hardware differentiations between mobile devices (e.g., sound generation), available assistive technology products are targeted mainly to some well-known device types or major operating systems rather than providing a global solution that works everywhere. Furthermore, mobile operating systems provide minimal or no built-in accessibility support. Inevitably, the rising mobile environment introduces hard constraints to interaction design as the technical characteristics which need to be addressed are much more complicated with respect to accessibility barriers on desktop solutions.

As a consequence of the above, the development of fully accessible and interoperable eServices introduces new challenges to the accessibility provisions that have to be adopted from the early design stages [6]. As in the case of eServices, the accessibility limitations of the mobile Web Services (mServices) can also be addressed with the use of assistive technology products. To this effect, the design process of mServices is even more demanding, since the considerations mentioned previously have to be addressed; nevertheless, mobile accessibility is still feasible. This paper presents the design and prototype development of fully accessible web services, available through mobile devices as well as traditional desktop PCs equipped with assistive technology. The aim of the work presented is to identify the main challenges and propose experience-based practical design guidelines that web developers may follow in order to comply with W3C de facto standards for mobile accessibility.

2 Related Work

As with existing standards and guidelines for web accessibility and usability, many design guidelines for mServices exist since the late 90s' [7, 19]. Nevertheless, mobile web content providers are still not paying specific attention to accessibility, and they are unaware of the benefits of providing accessible solutions. Moreover, currently specialized implementation platforms do not help Web developers in integrating accessibility in Web services. Accessibility of mServices is not supported in existing development suites. In order to address this issue, the W3C's Mobile Web Initiative (MWI) released in July of 2008 the Mobile Web Best Practices (MWBP) version 1.0[2], supplementary to Web Content Accessibility Guidelines (WCAG) versions 1.0[3] and 2.0[4]. The aforementioned document sets out an additional series of recommendations designed to improve the user experience of the Web on mobile devices, without exceptions. Since the delivery of accessible and interoperable eServices should also address legal issues and satisfy the constraints raised from user requirements and devices' technical specifications, the whole design process signifies an exponential design solution space which makes the compliance with W3C standards such as WCAG and MWBP essential (Figure 1).

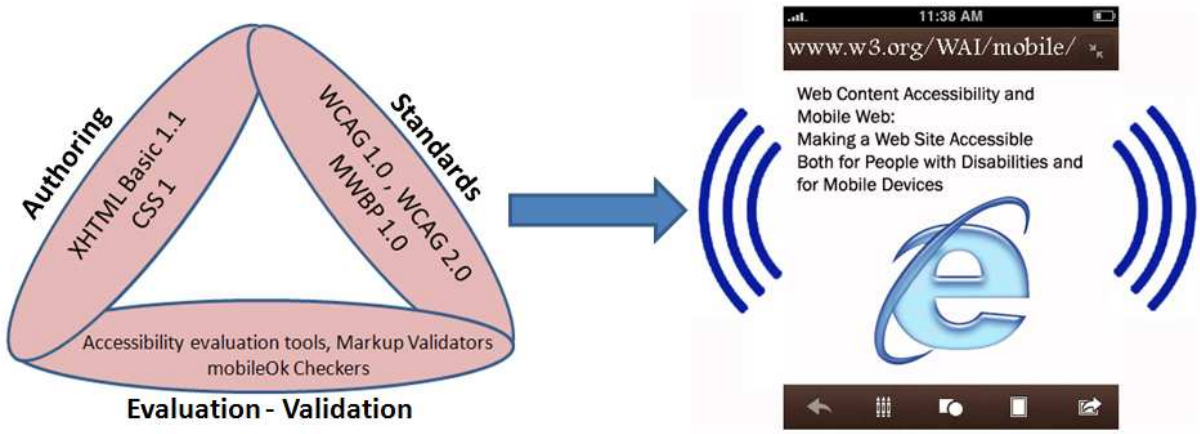

Fig. 1. Rely on Web standards and guidelines for delivering Web content to mobile devices

Functionality targeted to desktop access is often transferred in the design process of mobile services, without considering any special adaptation. On the other hand, providing "text-only" versions of existing websites is a technique largely discredited by people with disability. As a result, it makes little sense developing separate mobile sites for disabled users. After all, content and services delivered through the web are the same, no matter how many different versions may occur as a result of possible adaptations, customisations or different versions to be used for a variety of devices. MWBP, although not a W3C recommendation, presents practical solutions that help deliver a full web experience on mobile devices rather than offering a separate-but-equal treatment. It seems that the philosophy of those practices contradicts other service-oriented standards for mobile usage under development, such as for example the global standard of the International Air Transport Association (IATA) for global mobile phone check-in using two-

[2] W3C- MWI, Mobile Web Best Practices 1.0: http://www.w3.org/TR/mobile-bp/
[3] W3C-WAI, Web Content Accessibility Guidelines 1.0: http://www.w3.org/TR/WCAG10/
[4] W3C-WAI, Web Content Accessibility Guidelines 2.0: http://www.w3.org/TR/WCAG20/

dimensional (2D) bar[5]. For example, it is difficult to imagine displaying a 2D bar code image to a passenger's Braille mobile phone.

Schilit et al. [8] discuss various techniques can be followed to fit desktop content into a small display. Accordingly, the following strategies, ordered by resources needed, can be followed to ensure that an existing eService can be used on a PDA or other browser-equipped mobile device:

1. Keep the same eService (as the desktop design) and perhaps make use of scaling techniques or specific web browsing systems that reduce the size of the working area. The latest fit-to-screen features that are being incorporated in some web browsers allow automatic web page size adjustments (e.g., Mobile Opera[6], Internet Explorer Mobile[7], Handweb[8] , Plamscape, and others[9]). Although such a solution can be handy to experienced users, those with visual disabilities will suffer from reduced readability and face scrolling problems, not to mention that the on-the-fly scaling cannot reorganize in an optimal way designs targeted to bigger displays.

2. Apply automated re-authoring techniques that involve removing all presentation information (i.e., Cascading style sheets, images) and produce raw HTML, or even utilize alternative presentation information (i.e., Cascading style sheets for handheld) by keeping the same markup. Such an automatic process, which is similar to proxy transcoding, may produce user friendly versions for mobile experience in a cost effective way. Examples of such tools and services are Power Browser [9], Mobile Google[10], AvantGo[11], and Skweezer.net. These solutions cannot work effectively though for eServices with broken markup beyond repair (i.e., the web page contains invalid HTML), since the result will look differently in different browsers, and in most cases tend to render well only in basic html markup. In addition, markup resources size is not reduced, so utilization through a mobile device may result in awkward behavior (e.g., scrolling) and increased costs due to mobile transfer fees. As traditional web services are usually developed with desktop computers in mind, their conventional web pages will not be adequately displayed on mobile devices.

3. Perform adaptations in content and/or in interface elements appropriate for enhancing the mobile experience. This process can include transcoding markup to be compatible with device formats, altering or rearranging the structure and the navigation, and introducing a new content structure. This method can be further classified according to the resulting transformed pages provided to the users, e.g., single column, fisheye visualization [10; 11], and overview-detail [12]. Examples of systems delivering such experience are Opera SSR, Fishnet [13], the Document Segmentation and Presentation System (DSPS) [14] and the Stanford Power Browser [15]. However, these solutions cannot be easily generalized.

4. Design and create new mServices from the beginning and constantly evaluate the outcomes against design standards. This process is complex to address for both web designers and developers, as it requires substantial effort, planning, deep knowledge of recent standards and well trained personnel. Although it is possible to reuse some of the principles and practical solutions delivered in the desktop version, design and implementation of these solutions implies the creation of new mobile web templates which is a time consuming procedure. The result of such process provides, in theory, the best experience for mobile users. Nevertheless, maintaining a specific mobile site which does not "look like its big brother" is inconsistent with Device Independence principles.

When dealing with new web services, the optimal solution is obviously to provide universal accessibility at an early stage during the design phase (e.g., by means of evaluation and redesign on early mock-ups and design prototypes against accessibility standards, because accessibility is more expensive if introduced later in the design phase [16].

3 Design Process for embedding accessibility in mobile services

It is argued that web accessibility can be achieved only if accessibility standards are applied from day one of the design. In the case of mobile Web services, the designer should comply with even more strict constraints than for desktop solutions, since the screen size of the mobile device or the interaction style may be totally different from the desktop environment. To this purpose, design and usability guidelines for mobile design can contribute significantly towards ensuring that the final outcome addresses functional limitations such as visual disabilities, hearing impairments, motor disabilities, speech disabilities and some types of cognitive disabilities. From a usability point of view, applicable principles can be derived from guidelines improving mobile web usability [13]. For example, excellent usability

[5] IATA Resolution 792: Bar Coded Boarding Pass (BCBP), version 2: http://www.iata.org/NR/rdonlyres/2BD57802-6D96-4D9A-8501-5349C807C854/0/BarCodedBoardingPassStandardIATAPSCResolution792.pdf
[6] Opera Software: http://www.opera.com/mobile/
[7] Microsoft: http://www.microsoft.com/windowsmobile/en-us/downloads/microsoft/internet-explorer-mobile.mspx
[8] Smartcode Software: http://www.palmblvd.com/software/pc/HandWeb-1999-02-19-palm-pc.html
[9] Wikipedia has a more comprehensive listing: http://en.wikipedia.org/wiki/Microbrowser
[10] http://www.google.com/mobile/
[11] http://www.avantgo.com/frontdoor/index.html

experiments demonstrate that the most effective navigation hierarchy for use with mobile devices is one with only four to eight items on each level [17].

The provision of a universally accessible web service, with mechanisms[12] consistent among all devices in use [20], implies producing the intersection[13] of all relevant standards and guidelines, design according to this larger set of rules, perform tests and at the end re-evaluate and re-visit the designs. In this recurrent process, user feedback is also critical, because it whittles away the design space and so eliminates possible alternatives. Once the design space has been documented, the resulting designs need to be encapsulated into reusable and extensible design components.

The above process has been followed in the context of the Greek nationally funded project “Universally Accessible eServices for Disabled People". The aim of the project is to promote the equal participation of people with disability in e-government services, by the implementation of an accessible portal.

The portal will offer personalized and informative accessible Web services, available through mobile devices as well as traditional desktop PCs equipped with assistive technology. To this purpose and in addition to adhering to aforementioned accessibility standards and generic design principles, the iteration processes involving experts in the field of accessibility as well as end users yielded specific design guidelines. With the stabilization of these guidelines, detailed design mock-ups for all the services were elaborated (Figure 2). Based on the design mockups, markup templates (XHTML Basic 1.1, CSS 1.0) have been implemented to serve as a compass for the implementation team. These templates have been exhaustively tested against aforementioned guidelines and full compliance has been achieved (Figure 3). Refinement based on the actual usage of the mServices is expected in the future and to this purpose user tests have been scheduled.

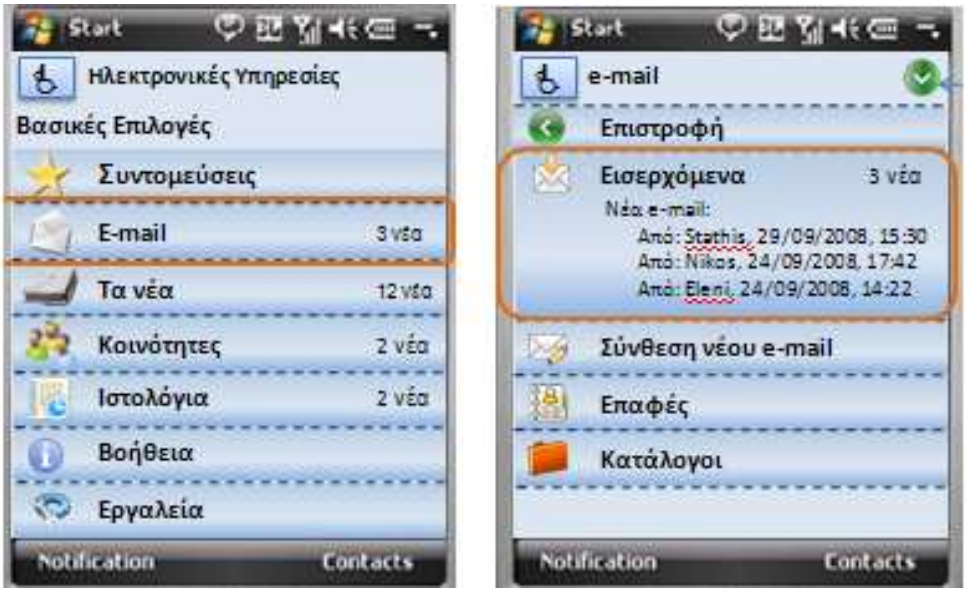

Fig. 2. Design templates for mServices: the main (navigation) page (left) and the first page for email services (right)

[12] WCAG, Guideline 13: Provide clear navigation mechanisms

[13] Set Theory: intersection of the sets A and B, is the set whose members are members of both A and B

Fig. 3. Home page of amea.net (main options translated in English) displayed on a HTC-TYTN II (left) and a Fujitsu Siemens Pocket Loox N500 screen capture (right)

4. Design experience

The practical experience acquired during the design process outlined in Section 3 in the context of the project "Universally Accessible eServices for Disabled People" resulted into the consolidation of the following set of guidelines:

I. Use of standards

- Comply with WCAG 1.0 levels AAA (including subjective 14.1 whenever possible), with the use of valid XHTML. Tools that may be useful are the Bobby software of the Center for Applied Technology[14], the W3C's Markup Validation Service[15], the Colour Contrast Analyser[16], and the WAVE Toolbar[17].
- Comply 100% with MWBP 1.0, consult relationship documents18 and make use of valid XHTML Basic 1.1. Available validation tools include W3C's mobileOK Checker[19] and TAW mobileOK Basic Checker[20].
- Perform manual checks (e.g., rendering without style sheets, test the accuracy of alternative text descriptions, etc).

II. General

- Use only server side actions.
- Do not use javascript at all.
- Avoid scrolling, unless user chooses to enlarge fonts beyond a threshold. To this purpose split the task into a number of sub-tasks.
- Provide single task dialogues (e.g., write a topic then save it).
- Group available options in a single screen.
- Correlate each service with specific color. Reuse faint version as content's background color.
- Use lightweight icons (GIF: size less than 500K), consistent with desktop version for main option categories

III. Navigation

- Stick to George Miller's Golden rule (7±2).
- Use the card sort metaphor [18].
- Always provide screen orientation (Hide/Unhide path).
- After reading – announcing page title, provide high priority/visibility "Return" (back) action.
- Use of icons defined in stylesheets to avoid double announcements of alternative descriptions.
- Avoid relying on color alone, but use the color coding in a consistent manner to help users correlate colors with services (learning disabilities). Comply with the "color opponent process".

[14] Bobby: no longer supported
[15] Markup Validation Service: http://validator.w3.org/
[16] Colour Contrast Analyser: https://addons.mozilla.org/en-US/firefox/addon/7313
[17] WAVE Toolbar: https://addons.mozilla.org/en-US/firefox/addon/6720
[18] W3C, Relationship between Mobile Web Best Practices (MWBP) and Web Content Accessibility Guidelines (WCAG): http://www.w3.org/TR/mwbp-wcag/
[19] W3C mobileOK Checker: http://validator.w3.org/mobile/
[20] TAW mobileOK Basic Checker: http://validadores.tawdis.net/mobileok/en/

- Use graphic icons only for orientation.

IV. Data Form Completion

- Provide error messages at the beginning of the (refreshed) form with links to errors.
- Provide one-click login for unregistered users.
- Auto fill default information.
- Provide simple search as well as advanced search options such as history.

The following table (Table 1) provides a summary of the service-specific guidelines emerged:

Table 1. Examples of additional service-specific guidelines for the design and implementation of mServices.

Service	Guideline
E-mail	Place the most important task first Provide each time just one free-text area on each screen
News	Display the picture list after the content of the article with alternative descriptions Use article pagination to increase readability if necessary
Message board	Flatten message-responses hierarchy for simplicity Place attachments and responses at the end of the message
Chat	Provide access to the list of participants first Refresh the content on user demand
Contacts	Use contacts filtering based on letters Use an index where the letters will be visible only when there are contacts Use multiple pages (cards) with the contact details
Blogs	Focus on the current topic All replies/comments displayed should be associated with the current topic Use archiving mechanism for past topics
User defined shortcuts	Place that option high in the menu Allow the user to define the shortcuts up to a task level
Site map	Use a list of the main tasks of the eservices with explanatory description

4 Discussion/Future work

This paper proposes the adoption of specific guidelines in the context of designing and developing networking mServices mainly targeted to people with disability. By following strict accessibility standards from the beginning of the design process, it is possible to deliver mServices that fully comply with even harder restrictions than for eServices, without compromising functionality. The presented design guidelines emerged as one of the results of an iterative design process involving web accessibility experts as well as users with disability. A conclusion stemming from this experience is that the provision of universally accessible web services in a mobile context requires more intensive efforts with respect to traditional web accessibility. This is mainly due to the fact that practical guidelines have to be derived from both MWBP and WCAG in the context of the specific services being developed. Overall, it is claimed that this experience contribute towards improving the production of cost-effective and qualitative accessible and interoperable Web material by designers with no previous knowledge of accessibility guidelines. Initial tests proves that is possible to develop mServices that fully comply with W3C's accessibility guidelines, however more user tests and heuristic evaluations are require to further validate this process.

In the context of the project "Universally Accessible eServices for Disabled People", user-based tests will follow, targeted to the refinement of the mServices. Users' tests are are necessary for the fine tuning of the final outcome, based on a specific PDA device equipped with a mobile screen reader. To this purpose, HTC-TYTN II and Mobile Speak Pocket have been selected among candidates.

Acknowledgments. This research has been conducted within the Greek nationally funded project "Universally Accessible eServices for Disabled People". The authors would like to thank the Panhellenic Assiociation of the Blind (www.pst.gr), acting as the Project contractor, for their support. The project is funded by the Greek Government under the 3rd Community Support Framework and the accessible and interoperable web services will be available at http://www.ameanet.gr

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