

# TOWARDS MOBILE WEB ACCESSIBILITY EVALUATION

Rogério Bandeira, Rui Lopes and Luís Carriço

LaSIGE, University of Lisbon, Edifício C6 Piso 3  
Campo Grande, 1749 - 016 Lisboa, Portugal  
rbandeira@lasige.di.fc.ul.pt, {rlopes, lmc}@di.fc.ul.pt

**Abstract:** In this paper we present a new approach to mobile Web accessibility evaluation, allowing for Mobile Web adequacy and Web content accessibility evaluation regarding different selectable disability profiles. We define an evaluation approach based on the Web Content Accessibility Guidelines (WCAG), Mobile Web Best Practices (MWBP) and Barrier Walkthrough, with the goal of providing support to Web developers and designers to conduct rapid, yet specialized, accessibility assessments focused on different disability types for Web sites tailored to mobile devices. We also present a mobile Web accessibility evaluation tool that has been developed as a proof-of-concept of our approach. This work was developed on the content of ACCESSIBLE “Accessibility Assessment Simulation Environment for New Applications Design and Development”, a three year STREP Project of the 7th EU Framework Programme for Research and Technological Development (FP7), that aims to define an overall European Assessment Simulation Environment making extensive use of the latest available IT technologies and concepts.

**Keywords:** Evaluation, Methodology, Web accessibility, Mobile Web, Software.

## 1. Introduction

The World Wide Web provides a wealth of information and services and its potential to improve people’s lives and raise their standard of living is enormous. The Web accessibility discipline strives about enabling people with disabilities to use the Web just like the unimpaired, without barriers. Making Web sites accessible for people with disabilities is an integral part of high quality Web sites, a growing market opportunity and, in a growing number of cases a legal requirement (e.g., following Section 508 [12] in the USA).

At the same time, we are being faced with an explosion in mobile devices usage all over the world (including the developing world). Mobile devices are increasingly being used as a terminal to access the Web, its information and services. However, the intrinsic features and limitations of mobile devices are a hinder to Web interaction. Additionally to mobile specific constraints, people with disabilities might also access the web from mobiles devices.

Many Web designers and mobile application developers are not familiar with the peculiarities of these two worlds, and different sets of guidelines to develop accessible Web contents and mobile-friendly Web contents exist. The Web Content Accessibility Guidelines (WCAG) [5] [7] defines a set of rules to make Web sites accessible to people with disabilities, whereas the Mobile Web Best Practices (MWBP) [11] define the rules for making Web sites more usable from a mobile device. Interestingly, there is a recognized partial overlap between them [8] [14].

Nevertheless, the continuous evolution in both areas, whereas by the publication of new guidelines or by the evolution and increasing diversity of mobile devices, complicates the development of applications that follow both directives. Moreover, if we take into account different types of disability and their inherent distinct usage and accessibility constraints, the dimensions of the puzzle become even more intricate. In fact developers may have to consider, evolving accessibility and mobile guidelines and different characteristics of disabled users and of mobile devices. Overall, it is not an easy task.

To overcome all of these aspects, developers need to be assisted during development processes in several steps of their applications development life cycle [1]. Several tools, in particular, are already available for the assessment of Web sites, in terms of their accessibility [9], [17][18], and mobile usage [19]. In general though, they tend to adopt brute force approaches where all the guidelines are applied indifferently of the target users, the target devices or the conjunction of mobile and accessibility constraints. Even if recent work [8] is emerging that addresses some of these nuances, the fact remains that an overall comprehensive approach is still lacking, both in terms of an articulated framework or a full understanding of the intersections of the evolution and differentiation dimensions.

The purpose of this article is to present an approach to mobile Web accessibility evaluation. It allows for Web content accessibility and mobile adequacy evaluation, regarding different selectable disability profiles. This will provide the necessary support to Web developers, designers and assessment experts to conduct rapid, yet specialized, accessibility assessments focused on different disability types for Web sites tailored also to mobile devices. We also describe briefly a prototype that, integrated with the remaining system, will be used as a proof-of-concept of the approach.

## **2. Related Work**

There are different sets of guidelines on making accessible Web content and best practices for mobile-friendly content, such as Section 508 [12], and BITV [2], among others [16]. Two of the most relevant are those that emerge as W3C recommendations: WCAG and MWBP.

WCAG - Web Content Accessibility Guidelines [5] [7] are guides that define a set of guidelines explaining how to make Web content accessible to people with different disabilities. These guidelines do not intend to discourage content developers from using images, video, etc., but rather explain how to make multimedia content more accessible to a wider audience (e.g., people with disabilities, the elderly, etc.). MWBP - Mobile Web Best Practices [11] is a guide to make Web sites that are usable from a mobile device access. It specifies how Web

content should be delivered to mobile devices. The principal objective is to improve the user experience of the Web when accessed from such mobile devices. The overlapping between both recommendations, even if partial, is often viewed as a reinforcing characteristic that should encourage their application as a good practice for Web development.

Regarding the way guidelines and best practices sets are viewed, several evaluation methodologies exist. Conformance testing evaluation methodologies assume that all accessibility guidelines must be met in order to achieve universal accessibility. Still, different groups of users have different requirements. Some of those requirements may conflict with each other and in many occasions for a specific user group the content of some guidelines does not constitute a barrier. Applying those would produce a false positive result that might lead a specific user group, erroneously, to avoid navigation through that page.

Barrier Walkthrough starts addressing this problem by providing a framework where guideline application is related to specific user disability groups, such as blind users using screen readers, low vision users using screen magnifiers, motor-disabled users using a normal keyboard and/or mouse, deaf users, and cognitive disabled users [3]. An additional benefit from the method is the education of evaluators since they become more knowledgeable of accessibility issues with this approach than through the extensive and arid universal checklist evaluation using conformance testing.

An important extension to this work [21] defines Mobile Web Barriers, proposing mobile users as a group that has specific interaction limitations. Although an interesting approach, it fails to characterize the orthogonal nature of people and devices, which are clearly different conceptual and pragmatic entities. Moreover, in practice, precludes the introduction of the device dimensions and thus of its own specific characteristics (e.g. how to define barriers different barriers from a user with a small keyboard based device vs. the same user with a touch based one).

Concerning the application of guidelines and best practices, different development phases and stakeholders can be targeted. Phases can be considered from the design and development to the final and intermediate evaluations [4]. Stakeholders may vary from non-technical or expert evaluators, designers and developers. Either way though, the amount of information and intricacy that may arise from the several abovementioned dimensions, complemented by the demanding cognitive processes that are inherent to design, development and evaluation, urges for support that, as much as possible, automates the application of guidelines and best practices.

However, automation is not straightforward. In fact some of the regulations of WCAG and MWBP are not automatable. Fortunately though, a significant group is. For instance, the mobile OK basic tests recommendation [10] defines a set of tests based on MWBP to ease Mobile Web content authoring. It is a subset of MWBP with those best practices that can be programmatically detected and/or verified in order to allow the development of concrete evaluation tools. A similar subset is defined to other recommendations. Even if the assessments based on those are not as complete, they will surely provide the pragmatic means for designers and developers to create less inaccessible and mobile non adequate web contents. Moreo-

ver they can be easily complemented by manual evaluation of the remainder guidelines, or by formal or informal user participation, performed by significant sets of users from different disability groups and skills.

For the automatable subsets, design and development platforms and tools exist that provide support to Web developers and designers to conduct rapid, yet specialized, accessibility assessments. The Web Accessibility Initiative (WAI) presents a long list of Web accessibility evaluation tools [17]. Most of these check guideline conformance with different sets of guidelines, analyze different kinds of content (HTML, PDF, etc.), or test more specific characteristics, such as color contrast and brightness, etc., as detailed in an analysis by Thatcher [13].

Most widespread accessibility assessment tools include Sheriff Accessibility Module [9] from HiSoftware Compliance Tools, Wave [18] from WebAIM, or Lift Machine [15] from Usable Net allowing compliance for several guideline standards including section 508 and WCAG.

W3C provides a mobile OK checker [19] that follows the publication of the W3C mobile OK Basic Tests 1.0, allowing the application of those tests to a Web site. It has been designed as a tool to cope with the document that provide the basis for making a claim of W3C® mobile OK™ Basic conformance, thus it does not go further into accessibility assessment. Many other mobile devices testing tools provide answers to specific platforms testing, but again do not cope with accessibility issues or to MWBP guidelines.

As far as we know, no testing tools, services or methods provides the means to test web content accessibility and mobile adequacy, considering the necessary flexibility and customization that we aim for. They either fail at coping with accessibility or with mobile access and mobile content adequacy, or specially ignore the specificities of disabilities in that context. To overcome this gap, there is a need for a new approach to evaluation processes, which we identify as Mobile Web Accessibility.

### **3. Mobile Web Accessibility Evaluation**

As part of the ACCESSIBLE project, “Accessibility Assessment Simulation Environment for New Applications Design and Development”, an Accessible Harmonized Methodology (HAM) is being developed. The purpose of HAM [6] is the harmonization of existing knowledge, such as guidelines, standards, etc. in order to be described by ontology-based rules. The resulting framework will allow the implementation of automated assessment systems, enabling, designers, webmasters, programmers, evaluators, disability group users, etc., to conduct specialized accessibility assessments focused on specific disability types, assistive technologies, platforms and/or contextual conditions.

The International Classification of Functioning, Disability and Health, commonly known as ICF [20], are at the core of HAM. ICF provides a concrete classification of body structure impairments which ensures no overlapping. This can be linked to user types (e.g., disability types) in order to link them to ICF body structures and their related impairments. Detailed explanations of the functional limitations that derive from the disabilities and the aspects that should be checked to ensure accessibility for users with those disabilities were produced. This mapping of ICF body structure impairments into interaction limitations facilitates the associa-

tion of existing guidelines and heuristics from the existing literature to specific body structures and therefore to disability user groups, allowing determining which users groups would benefit from each guideline application. Figure 1 shows an example this mapping.

Disability Type		Interaction limitation	
Main Type	Subtype	Function	Checkpoints
Cognitive impairment	Dementia	<p>May have difficulties in language, self-help, independent living etc.</p> <p>They acquire new knowledge at a slower pace than their peers. They have difficulties in understanding instructions. There may be difficulties in fulfilling the every-day duties or organizing one's own work load. These may be difficulty in remembering people's names, a telephone number or important address.</p> <p>In case there are problems in retrieving memories, there may be difficulties in a number of</p>	<ul style="list-style-type: none"> <li>o Generic links</li> <li>o Rich images lacking equivalent text</li> <li>o Video with no captions</li> <li>o Moving content</li> <li>o Generic links</li> <li>o Internal links are missing</li> <li>o Missing icons</li> <li>o Complex of text</li> <li>o Complex of site</li> <li>o Too many links</li> </ul>

Figure 1 – Example of disability type and interaction limitations

The approach of HAM regarding Mobile Web Contents is focused on the dichotomy between the constraints imposed by accessibility and mobile domains. Thus, a primary reflection should be made on how to extend the HAM work on mapping Disability Types to WCAG 1.0, WCAG 2.0 and Section 508 guidelines into the mobile constraints emerging from the MWBP.

The mapping of Web content guidelines, WCAG 1.0, WCAG 2.0 and Section 508 to disability types and interaction limitations result from the design guidance work for Web content performed in HAM and its detailed presentation is outside the scope of this paper (see [6]). However, these guideline correlation between accessibility guidelines and its associated assessment rules and tests are extremely relevant to our work since they have to be also considered when evaluating the mobile usage adequacy of web contents for disabled groups of users. The figure below illustrates that mapping.

Disability Type		Short Description in terms	ICF classification	Interaction limitation		Assistive Tech.	Guideline		
Main Type	Subtype			Function	Checkpoints		WCAG 1.0	WCAG 2.0	Section 508
Vision impairments	Low vision • Loss of central vision (Macular degeneration)	Macular degeneration is a medical condition usually of older adults which results in a loss of vision in the centre of the visual field (the macula) because of damage to the retina.	b210 Seeing functions b2100 Visual acuity functions b21000 Binocular acuity of distant vision b21001 Monocular acuity of distant vision b21002 Binocular acuity of near vision b21003 Monocular acuity of near vision b21008 Visual acuity functions, others	The loss of central vision creates a blur or blind spot, but side (peripheral) vision remains intact. This makes it difficult to read, recognise faces, and distinguish most details in the distance. Mobility, however, is usually unaffected because side vision remains intact.	<ul style="list-style-type: none"> <li>o Rich images that are badly positioned</li> <li>o Rich images included in the background</li> <li>o Colour is necessary</li> <li>o Insufficient visual contrast</li> <li>o Inaccessible frames</li> <li>o Moving content</li> </ul>	Refreshable Braille Display Braille Embosser Portable Closed Circuit TV Reading Machine Closed Circuit TV	1.1 2.1, 2.2 3.4 6.1, 6.3 7.3 8.1 12.1, 12.2 10.1 13.6, 13.8	1.1 1.1.1 1.3 1.3.1, 1.3.2 1.4 1.4.1, 1.4.3, 1.4.4, 1.4.6 2.2 2.2.2 2.4 2.4.1 3.2 3.2.5 3.3.1, 3.3.2	1194.22 (a) 1194.22 (c) 1194.22 (d) 1194.22 (l) 1194.22 (m) 1194.22 (o)

Figure 2 - example of best practice catalogue for Web applications

### **3.1. Mobile Web Accessibility**

MWBP define a set of checkpoints (similar to WCAG) that developers should take into account in order to ensure that their web contents are adequate to be accessed from mobile devices. These checkpoints are aligned into 5 Best Practice Headings, as follows:

- 1) Overall Behavior: general purpose guidelines for any mobile device, independent of its features;
- 2) Navigation and Links: how navigation and hyper linking should be done, in order to ease the task of interacting with Web-based user interfaces with the limited capabilities of mobile devices;
- 3) Page Layout and Content: how Web pages have to be designed, and how content must be created for mobile devices;
- 4) Page Definition: how to potentiate usability by exploiting the features of Web technologies;
- 5) User Input: how to take into account the input methods available on mobile devices.

It is worth mentioning that this alignment is similar to WCAG 2.0 POUR (Perceivable, Operable, Understandable, and Robust) principles. Since the correlation between these 5 headings and POUR are not direct, a potential mapping between MWBP and WCAG has to be defined checkpoint by checkpoint, in order to understand which evaluation procedures have to be defined for Mobile Accessibility Guidelines.

The approach for mobile web guidelines is based on leveraging guidelines from both WCAG and MWBP. We start from the mapping between MWBP and WCAG (both 1.0 and 2.0). We map MWBP guidelines to interaction limitations taking into account the previous mapping results. From this mapping and the work from HAM on disability type mapping to interaction limitations, we get the MWBP guidelines mapping to the different disability types.

The relationship between MWBP and WCAG [8] is documented in a technical report that describes the similarities and differences between the requirements in both guidelines. Compliance with the MWBP helps go towards achieving compliance with some WCAG checkpoints. They also provide a summary of those checkpoints and the three possible levels of effort required, labeled for simplicity with the keywords nothing, something and everything.

There are also aspects important for mobile usage adequacy don't relate to accessibility specific issue or to WCAG checkpoints. Guidelines regarding features such as character encoding use, clarity, content format preferred, content format support, cookies, etc. don't specifically relate to any specific WCAG best practice issue, but rather are critical to general mobile devices interaction. These guidelines must be satisfied by all mobile web content and applications design and development in order to create an accessible web content that is adequate to be used from mobile devices.

In order to provide support to personalized mobile Web accessibility assessment, there is a need to map MWBP to different disabilities. The use of interaction limitations facilitates the mapping of MWBP guidelines to disability types.

Disability Type		Short Description in terms	ICF classification	Interaction limitation		Assistive Tech.	Guideline MWBP
Main Type	Subtype			Function	Checkpoints		
Vision impairments	Low vision • Loss of central vision (Macular degeneration)	Macular degeneration is a medical condition usually of older adults which results in a loss of vision in the centre of the visual field (the macula) because of damage to the retina.	b210 Seeing functions b2100 Visual acuity functions b21000 Binocular acuity of distant vision b21001 Monocular acuity of distant vision b21002 Binocular acuity of near vision b21003 Monocular acuity of near vision b21008 Visual acuity functions, others specified b21009 Visual acuity functions, unspecified b2101 Quality of vision b21023 Visual picture	The loss of central vision creates a blur or blind spot, but side (peripheral) vision remains intact. This makes it difficult to read, recognise faces, and distinguish most details in the distance. Mobility, however, is usually unaffected because side vision remains intact. Individuals with Macular Degeneration have extreme difficulty reading and recognising faces. Shapes or contours of objects may seem distorted, yet enough peripheral vision is retained for good orientation and mobility.	<ul style="list-style-type: none"> <li>o Rich images that are badly positioned</li> <li>o Rich images included in the background</li> <li>o Colour is necessary</li> <li>o Insufficient visual contrast</li> <li>o Inaccessible frames</li> <li>o Moving content</li> <li>o Image maps</li> <li>o Too long toolkits</li> <li>o Internal links are</li> </ul>	Refreshable Braille Display Braille Embosser Portable Closed Circuit TV Reading Machine Closed Circuit TV	ACCESS KEYS AUTO_REFRESH BACKGROUND_IMAGE_READABILITY CLARITY COLOR_CONTRAST FONTS GRAPHICS_FOR_SPACING MEASURES MWBP NON-TEXT ALTERNATIVES OBJECTS_OR_SCRIPT PAGE_SIZE_USABLE POP_UPS REDIRECTION

Figure 3 - example of best practice catalogue for Mobile Web content.

The relation between WCAG guidelines and MWBP was taken in consideration leveraging the work done for Web contents guidelines map to Disability types.

We also take into account the avoidance of false positive test results. Applying tests for guideline conformance, e.g. images size specification, can result in failure results not relevant at all to a blind user accessing the web content from a mobile device using its assistive technology and a browser with the images download option turned off.

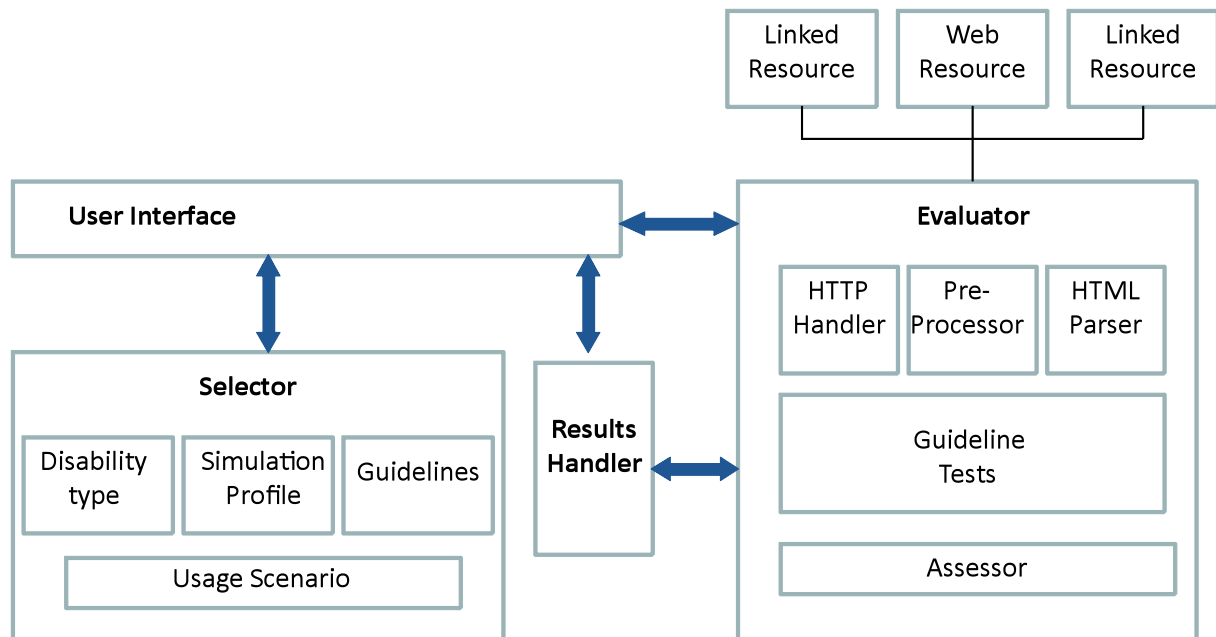
Those specific guidelines whose test for conformance generate false positive situations affecting the accuracy of mobile web accessibility evaluation for specific disability types are also taken into account in the guideline to disability type mapping.

**4 Proof of concept tool**

In order to verify the approach described in the previous section we implemented a proof of concept tool, whose architecture and use cases we present next.

**4.1 Architecture**

The architecture comprehends for main modules: User Interface, Selector, Evaluator and Results Handler (see Figure 4).



**Figure 4 - Proof of concept tool general architecture**

The *User Interface* module may be a graphical user interface, a web services interface or a command line interface. It allows: a) the input of the URL to be accessed; b) the setting of the simulation profile to be defined, a mobile or a desktop access; c) the choice of the disability type; d) the set of generic parameters like proxy server and port and the presentation of results.

The *Selector* module will receive from the user interface the selected simulation profile and the disability type. From these inputs it will send the user interface the set of guidelines that apply to the usage scenario. This will allow a comprehensive user feedback.

The *Evaluator* module receives from the user interface the selected URL to be accessed, what is the selected profile to be simulated and the set of guidelines that were chosen by the Selector. From those inputs the evaluator sets the corresponding http request, and sets the current active list of tests, from all the available in the evaluator that will be applied to the http response received.

The *Evaluator* can be further decomposed. The HTTP handler is responsible for HTTP request and response handling. The HTML parser that balances and parses the HTML documents tree received within the HTTP response. The pre-processor that gathers general analysis data needed to different individual test execution that we only want to gather and analyse once, like CSS style sheet elements and linked resources information. The guidelines tests repository objects that keeps all the tests implemented. The assessor applies each and every one of the tests selected for that usage scenario to the response received from the server.

Finally, the Results Handler module is responsible to gather the test results and provide the detailed evaluation results to the user interface on demand.

#### **4.2 Setting mobile and desktop usage**

Two basic simulation situations may be chosen: mobile and desktop. To that purpose, the “Mobile Access” menu has two menu items “set” and “clear”. Besides obtaining a different set of guidelines from the Selector, the Evaluator will also issue different http requests to the

web server. Choosing the “clear” menu item from the “Mobile Access” menu, will set the tool to perform regular http request to the selected web pages that will simulate the request and will obtain the response that the server would send to a desktop computer browser.

When the tool is set to perform mobile access simulation, by choosing the “Mobile Access” menu “Set” item, the request to the web server is performed with the headers that inform the server that it should deliver content that is compatible with the default delivery context [11]. The default delivery context was defined by W3C Best practices working Group in order to allow content providers to share a consistent view of a default mobile experience. This request results in a response from the web site, when it is prepared to send different representation of the web resource to mobile devices than to desktop computers, as it is the case of the web site in the figure, much smaller and adapted to the mobile devices characteristics than we obtain when we make a regular http request as we would from a desktop computer.

Thus, as consequence of selecting a mobile or desktop profile, not only the set of rules that will be used to assess the web page will be different, but also the web page contents may differ. The Figure below illustrates that. We can see the difference between the HTML sources codes received from the same URL dependent according to the mobile access simulation option selected. The first one corresponds to the mobile access simulation option.

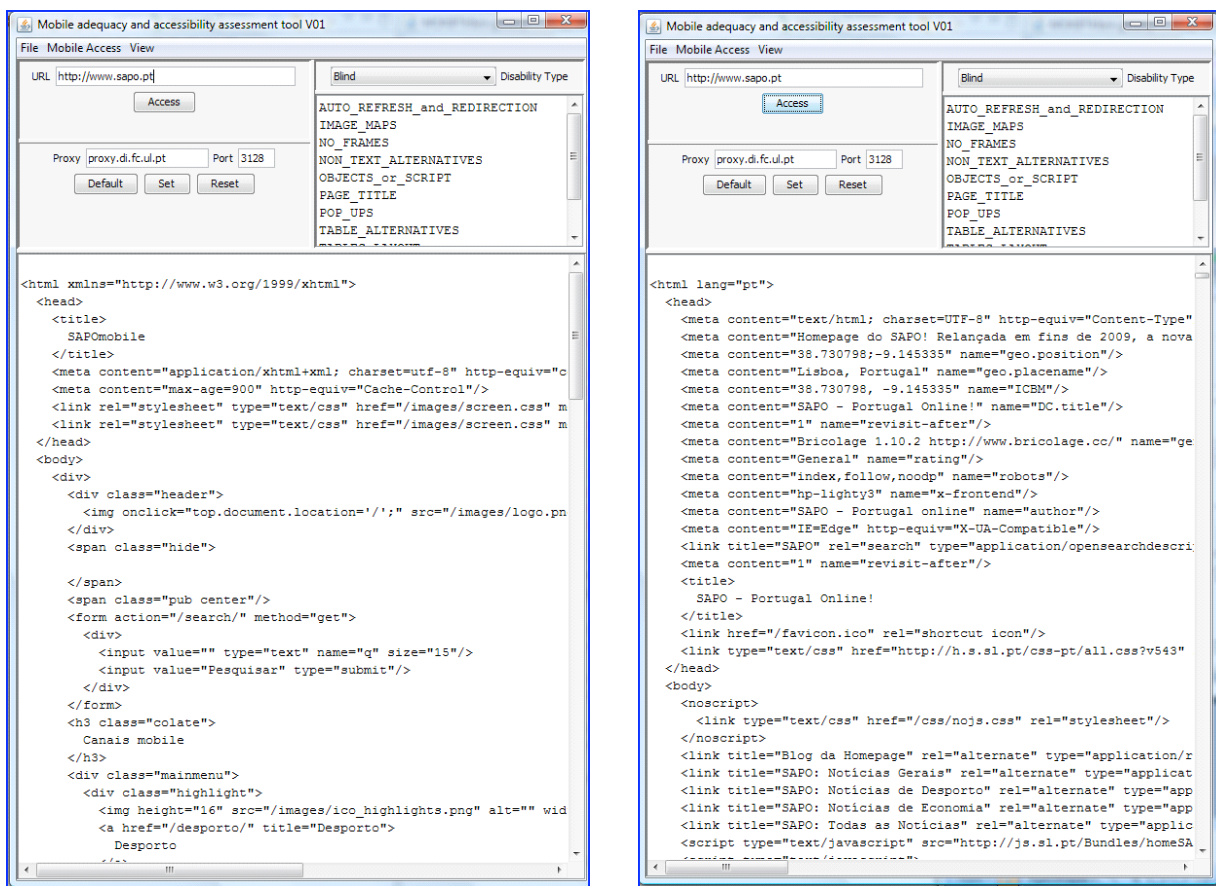


Figure 5 - Different representations received from the same URL

### 4.3 Disability user group selection

In the right upper pane, the “Disability Type” combo box allows the choice of the disability user group to test for. The choice of this user group defines the tests that will be performed on

the web page requested. We support currently for our tests, blind, deaf and motor impaired user groups.

Choosing different user groups will result in a different set of guidelines against which the received response from the selected web site will be assessed. Moreover, these checkpoints for each user group will be different if we choose the mobile Access simulation profile or not. In fact, when the Mobile Access is settled, not only the request will be made simulating a request from a mobile device but also the checkpoints that will be selected which the received response from the selected web site will be assessed, will include a subset of the mobile OK basic tests supported in the proof of concept tool.

This additional set of tests include all the generic tests that are not dependent on specific user capabilities and as a result should be applied to every mobile Web content adequacy tests already mentioned in the previous section. It will also include tests significant to the specific capabilities of the user group, but not all the available tests as if it was a conformance universal test evaluation.

In the figure below we can see in the right upper pane that mobile Web best practices for image resizing and images size specification are selected or not according to the selected blind or deaf disability type. The view menu allows the user to display the results or the intermediate source code obtained from the assessment of the web content received from the last simulation profile. The results from the last evaluation are available until another access is performed and its results for the same URL contents depend on the simulation profile and the selected list derived from the chosen disability type.

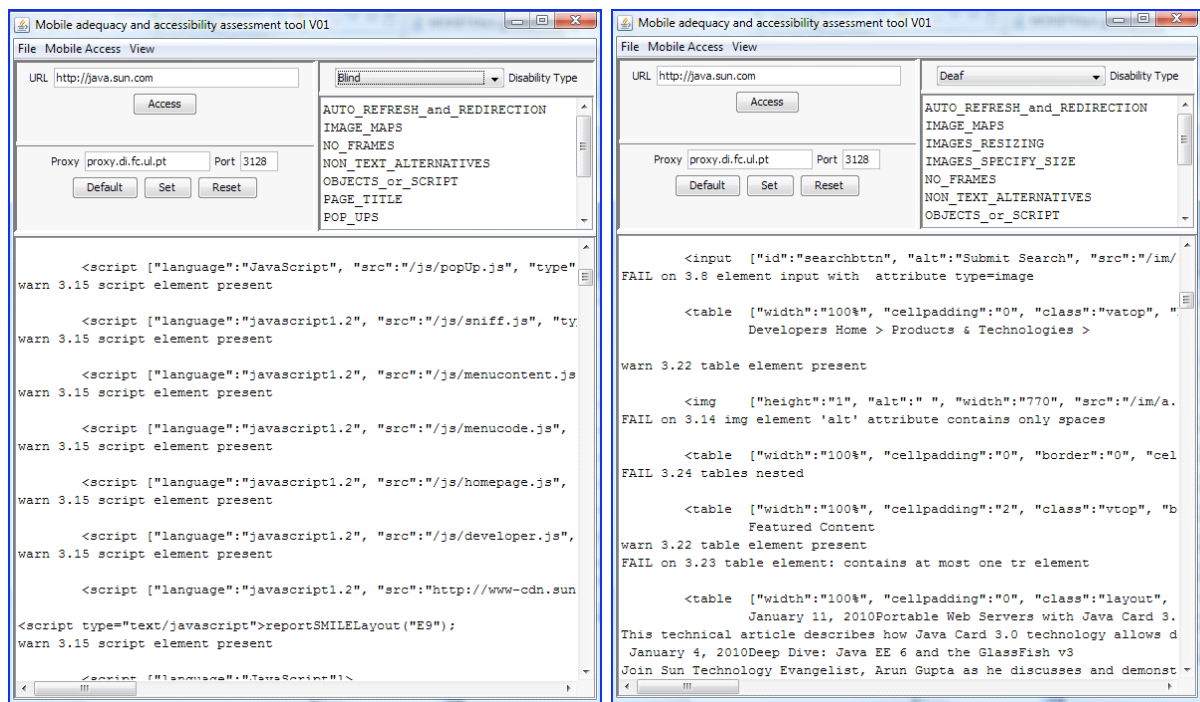


Figure 6 - Different mobile adequacy tests by disability users groups

One benefit we expect from this approach is to present meaningful results to evaluators, being them developers, Web masters, potential Web content users, or even assessment experts, easily interpreted and comprehended than the ones obtained through the extensive and arid universal checklist evaluation derived from conformance testing.

We expect that providing tests environments capable of simulating different access simulation profiles will ease the development of mobile adequate and accessible web contents. Automated tests environments will not substitute users or expert assessments but being easily available integrated in development environments can surely help developers to learn how to and create more accessible and adequate mobile web contents.

#### **4.1 Implementation**

This tool was being developed using Groovy, an agile and dynamic language for the Java Virtual Machine. HTTP requests and responses are being handled with HTTP Builder that extends Apache HTTP Client. The Cyberneko HTML SAX Parser is used to parse the HTML content received from the server.

### **5 Conclusions**

Most Web designers and mobile application developers are not very familiar with the peculiarities of the accessibility and mobile design world. Moreover, diverse and evolving sets of guidelines to make accessible Web content and mobile-friendly content exist and considerations about differentiating assessment for distinct disabilities is of utmost importance. Thus, methods have to be defined. These methods need to be able to take into account the specific capabilities of each type of users and only those capabilities.

We present an approach to assess the accessibility and adequacy of a content to be accessed from mobile devices, by users from different disability users groups and a proof of concept tool. Despite the accuracy of users and expert testing, to spread the adoption of accessible web design and development tools should allow for Web content accessibility and mobile adequacy assessment regarding different selectable disability profiles with the goal of providing support to Web developers, designers and assessment experts to conduct rapid, yet specialized, accessibility assessments focused on different disability types for Web sites tailored also to mobile devices. These assessment capabilities should be available whenever needed, in the absence of experts and disability groups of users that web content developers don't have always by its side.

We developed a proof of concept tool. The efficiency of this method and tool needs to be further explored, through its use in the assessment of sites from different types and geographies, accessed for different usage scenarios of device and disability user group's access. Further research aims at experimentally determining that the method is reliable captures accessibility defects and mobile adequacy defects and is efficient regarding other evaluation approaches.

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