Accessibility of Internet Portals in Ambient Intelligent Scenarios: Re-thinking Their Design and Implementation

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Abstract. Internet portals are gateways to the World Wide Web, which offer an amalgamation of services, like search engines, online shopping information, email, news, weather reports, stock quotes, community forums, maps, travel information, etc. Furthermore, with the arrival of the Mobile Web, they are also frequently used in Ambient Intelligence scenarios. This paper will discuss basic design considerations inspired by systems theory fundamental principles, where the portal as a whole and its components (known as *portlets*) are analyzed. This analysis also includes a set of user requirements for people with special needs gathered in previous user studies from the authors.

1 Introduction

Internet portals have become a de-facto standard for acquiring information from the World Wide Web. Initial portal implementations were actually generic taxonomies of Web sites (e.g., Yahoo!, Excite), which through the incorporation of the search functionality became more manageable and user friendly. However, the growth of the Web demanded more personalization of these services, and nowadays is unthinkable an Internet Portal without customized entry points like Google. Despite the maturity of some user modeling systems (see, e.g., [13]; or [19]), these personalized entry points rely only on sophisticated search engines combined with a tightened selection of domains.

There are many definitions for "portal" and many web pages contain in their headings the term portal. Smith ([24]) researched the topic from an academic and industrial standpoint, and established a definition that characterizes portals as "an infrastructure providing secure, customizable, personalizable, integrated access to dynamic content from a variety of sources, in a variety of source formats, wherever it is needed." While portal has been consecrated as a paradigm for more and more applications such as e-commerce, collaborative environments and entertainment hubs, many implementation infrastructures[1] and protocols have been developed. Recently,

[1] See, e.g., Apache Portals: http://portals.apache.org/ as an Open Source set of tools.

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standardizations efforts have taken place aiming at interoperability. The Web Services for Remote Portlets (WSRP) ([20]) and JSR-168 ([1]) specifications are two well-known standards in this are. JSR-168 is a standard Java interface for portlets that builds on the J2EE programming model of servlets. This is an interface between a particular Java type of UI component and its hosting container. On the other hand, WSRP is a platform independent standard messaging interface for interacting with remote compliant UI components. In both specification these UI component are named "portlets". In the context of WSRP, a portlet "is a user-facing, interactive application component that renders markup fragments that can be aggregated and displayed by a portal."

WSRP shows off the emergent Web applications paradigm: developing a Web application as a portlet, makes it pluggable to any portal that conforms to the aforementioned specifications. The blending power of Web Services, combined with the standardization of portlets makes them everywhere available. This implies that portlets UI need to be designed without being aware of the rest of the portal.

Furthermore, scenarios of m-commerce and location-based services make such systems more distributed, introducing new requirements ([22]). Ideally, a Web portal would serve at the same time both desktop and mobile clients. But this also implies that the portal infrastructure would need to be capable of serving portlets from a Universal Design point of view. Having in mind such requirements, this paper proposes a design and implementation path for portal applications from a Universal Sesign standpoint, aiming at enabling seamless access to content and services any-time, any-where and in any fashion.

The following chapters discuss the importance of accessible design of portals, especially in such heterogeneous environments (Ambient Intelligence –AmI– environments) by discussing current portals accessibility status. Then, a "whole/parts" approach for confronting such issues is presented. Finally, conclusions in form of complements and extensions to current specifications context attributes and indicative guidelines are presented.

2 Portals' Accessibility and Ambient Intelligence

The World Wide Web has surpassed its original design goals and, as the ways to access the Internet diversify (along with the range of services offered). In an aging society, it becomes increasingly important to ensure accessibility of these services to everyone, including people with disabilities.

Under the umbrella of W3C's Web Accessibility Initiative (WAI[2]) guidelines and techniques are being continuously developed to cope with accessibility problems merged from the evolution of technologies and user's requirements. In 1999, WAI released the first version of the Web Content Accessibility Guidelines ([10]). The main drawbacks from this version were:

– **Technology focus:** the guidelines were focused on the key (W3C) Web technologies at the time of publication: HTML and CSS. This affects its application to new Web technologies that have appeared since then, and even to non-W3C technologies;

[2] http://www.w3.org/WAI/

- **Usability of the document:** the language of the document might not be appropriate for some of the intended target audiences. There were also ambiguity issues related to clarification on the meaning of specific checkpoints and their priority level;
- **Organization:** there are guidelines focusing on similar issues (e.g. graceful transformation). Grouping them under more generic topics will make the document easier to handle, and the underlying concepts easier to grasp;
- **Conformance and testing:** there are a number of checkpoints that began with the words "until user agents..." which make very difficult to determine when conformance could be claimed; and
- some **errata**.

To face that, WAI is currently working on a new version of this recommendation (WCAG 2.0, [7]), technology independent and organized around four design principles: 1) Content must be perceivable, 2) Interface elements in the content must be operable, 3) Content and controls must be understandable, and 4) Content must be robust enough to work with current and future technologies. In parallel, WAI develops guidelines both for authoring tools and for user agents.

In general, it can be argued that Web accessibility shares methods and techniques with the adaptive hypermedia and the adaptive web (see, e.g., [25]; [3]; [4]; [5]; [11]). Currently, other approaches that propose adaptation of existing non-accessible Web pages have appeared ([14]; [21]; WebAdapt[3]). Some of these are also incorporating semantics in their mechanisms for offering accessibility-related annotations.

2.1 m-Portal Accessibility in Intelligent Environments

On 26th June 2006, the Yankee Group announced the results of its 2006 Transatlantic Wireless Business Survey. According to that, "the percentage of mobile workers in European small businesses continues to rise as mobile investments become a business priority. More than 50% of small business employees are classified as mobile workers, spending more than 20% of their time away from their primary workspace. This figure grew from 48% in 2005." Current generations of mobile phones and infrastructures named 2,5G and 3G are connected to digital communications infrastructures constituting a global network. Such a media can host a wide number of services including electronic commerce, known as m-commerce, pushing the ambient intelligence field.

The "ambient intelligence" term comparing with the preceding "ubiquitous computing," currently mainly implemented by mobile technology, emphasizes that "it does not solely rely on ubiquitous computing (i.e., useful, pleasant and unobtrusive presence of computing devices everywhere) but also on ubiquitous networking (i.e., access to network and computing facilities everywhere) and on intelligent aware interfaces (i.e., perception of the system as intelligent by people who naturally interact with the system that automatically adapts to their preference)." ([15])

In addition, the term mobility is quite broad and may be subdivided into three categories ([23]): "(i) personal mobility that deals with the mobility of people who

[3] http://www.webadapt.org/

may not necessarily carry a device, (ii) computer mobility that deals with the mobility of devices, and (iii) computational mobility that deals with the migration of code over physical nodes."

In case of mobile portals, the following issues arise:

- Personal mobility: a mobile portal need to communicate information to the user in a seamless way, having in mind that the mobile user has limited attention to the application, as in this case the environment might have a strong influence. This case could be somehow compared with a user with cognitive disabilities trying to acquire the same information.
- Computer mobility: the application needs to sense the location of the user and "localize" the information. Here, portals' personalization mechanism could contribute. For instance, a common user profile could be used to serve a number of portlets.
- Computational mobility: the distributed nature of a portal could be expressed in terms of Web Services and WSRP.

Venkatesh et al. [28] strongly suggest that "relevance, structure, and personalization are essential to creating a positive wireless interface experience." Therefore, personalization needs to accompany m-commerce services, to drive them to success. Dholakia & Rask [12] suggests that m-portals need to "focus on personalization, permission and specification of content in order to offer extended mobility and locability for the user." From the implementation point of view, Chen et al. [9] use the term "m-service" that extends the concept of Web Service to the wireless domain. They propose a service oriented architecture of an "m-service portal" giving emphasis to "intelligent m-services", context-aware/semantic-enabled agent-like architectures to improve adaptability and flexibility of the m-service portal.

2.2 Portals Accessibility: Evaluation Results

The accessibility of portals as a distinct type of Web application has not been subject of such wider attention as the accessibility of normal Web sites. Gappa & Nordbrock [16] realized a user study on portal accessibility with 28 users, including older persons and people with disabilities, to analyze particular requirements of portals. The results showed issues similar to those of users of mobile devices, as presented earlier. Further usability investigations will need to be carried out at the prototype level, when applying the proposed design guidelines to Web portals.

3 The Whole/Parts Approach for Portals' Design and Implementation

The whole/parts approach has been inspired from systems thinking basic principles. Systems thinking ([8]) go beyond classical analytical methods and face problems in a non reductive way. The sum of the properties of subsystems/components does not define the properties of the whole system, but is something more. The whole system also has emerging properties that determine its behavior.

Thus, in case of a Web page, the whole page can be inaccessible even though its individual components are fully accessible. Furthermore, this is typically the case with portals that aggregate portlets from different sources. Therefore, an accessible portal implies both portlets accessibility and complete portal accessibility.

Under this prism, this paper proposes a whole/parts perspective that considers portal systems as a whole and the portlets as parts that need to have some attributes, behaviors and organization for accomplishing their purpose. This perspective needs to integrate user needs with device profiles ([27]), which includes information about hardware and user agent capabilities. Of course, the equation for an intelligent environment needs to be closed with context-aware components. Then the problem space might be expressed as:

Accessible Portal Interaction = accessible communication of [accessible aggregation of (accessible portlets + accessible navigation)]

In other words, accessible portlets and navigation are necessary but not enough for composing an accessible portal as the emerging properties would probably result to an inaccessible complete portal. Thus, portlets and navigation should have such properties capable of sensing their aggregated effect on the portal as a whole. Accessible communication of the aggregated content refers to personalization/ adaptation features involving issues such as user/device modeling ([27]) and location/ context of use awareness. The following subsections will briefly discuss portals accessibility issues under such a prism.

3.1 Portal Navigation

For working on the navigation aspect of accessible portal systems, a good test case is made by investigating the case of mobile portal systems ([17]). Mobile devices can be a very good simulation platform for designers of Web portals, because they emulate different access problems due to their limited screen size and input capabilities.

For such portals, navigation is the key to success. The users need to access the information they are looking for without cognitive navigation overhead. Artificial Intelligence techniques have been used ([26]) for reducing click-distances and providing successful navigation. Similarly, in accessible Web portals, users need to interact with portlets in a transparent way and also have at their disposal powerful and useful search engines.

Authors classify portal navigation in: 1) main portal navigation, 2) inter-portlet navigation and 3) intra-portlet navigation. Further we could distinguish two kinds of hyperlinks: (i) user interface links and (ii) semantic links. Semantic links are links that provide additional information on a given topic and may lead to another Web page. User interface links are considered as the repeatable links that are provided in a toolbar paradigm and adds overhead to the actual content.

In general, for a portal page instance to be accessible, it is important to make sure that when the page is serialized by an actor it will produce an acceptable result. I.e., the windowed (portlets windows) version needs to be effectively transformed to a good structured user interface. This implies that portal systems need a mechanism to semantically communicate the portal page structure to the user agents. Consider for

instance PSML[4] or an automatically generated portlet navigation, or even a separation of navigation concerns using Semantic Web technologies.

In other words, navigation should be metadata and not data. Thus a separation of the control of a Web resource from the resource itself is needed. This will allow the actors to semantically extract the navigation information and use it to guide themselves within the Web resource. The metadata can also contain more information about the structure and the content of the Web resource (i.e., pages' descriptions and relations). Furthermore, this approach could offer much towards the Semantic Web. The navigation would then be much more easily being adapted both to the actor, and to the purpose of the content (e.g., learning). Consider for instance the scenarios that aim to be personalized navigation guides.

The proposed abstract navigation language would allow fill such a gap and provide more opportunities. For example, one might consider a portal that can be accessed via speech input-output while driving. Present-day adaptive navigation techniques ([6]) could be used such as link hiding or link generation. This might allow "virtual portals" (aggregation of Web resources in a form of navigation from a set of Web resources sites) and much more.

3.2 Portal Aggregation and Interaction Layers

Portal systems consist of portlet applications that can provide completely different functionalities and serve completely different aims. Portlet applications consist of a number of portlets that have a common aim, but at the same time they are reusable and autonomous components.

In simple terms, aggregation is actually markup that creates the frames for the portlets and puts them in a given resource. Although visually presented in tabular form, the markup should use CSS techniques for layout ([2]), as recommended in accessibility guidelines ([7]).

The aggregation of the content on an interactive environment such as a portal involves an aggregated interaction as well. We can distinguish page interaction and portlet interaction because the first one refers to the interaction that happens on the portal as a whole, and the last one that happens on a specific portlet without affecting the rest of the portal. This can be seen both on a client side and on a server side manner. For instance, a client script might cause change of behavior of another portlet and consequently to the resultant portal page instance. Finally, the AJAX[5] upcoming technology is an interesting case that its accessibility is under investigation.

3.3 Portlets

Portlet interfaces may consist of hypertext and/or media content. To be accessible, these need to follow Web accessibility recommendations. Here, a distinction between portlets and Web pages needs to be made because of the former's fragmented nature.

Already, above mentioned portal specifications define portlets' attributes that affect portal as a whole. An example is the CSS classes including portlets' title. In the

[4] Portal Structure Markup Language: http://portals.apache.org/jetspeed-2/guides/guide-psml.html

[5] http://developer.mozilla.org/en/docs/AJAX:Getting_Started

context of intelligent and distributed environments, context-aware attributes should be introduced for extending portlets capabilities and as a result portals' services and information accessibility.

3.4 Indicative Guidelines

Following the proposed approach, related literature conclusions, best practices (see, e.g., [18]) and authors experience ([27]) some exemplary principles and guidelines for designing and developing accessible portals are suggested. This attempt is by no means an exhaustive investigation of the requirements, but aims to show the need for such a work. The proposed portlet design guidelines, mapped to WCAG 2.0 guidelines ([7]) are:

- Guideline 1.3 (*Ensure that information and structure can be separated from presentation*)
  - Follow a serializable multi-layered layout design approach.
- Guideline 2.1 (*Make all functionality operable via a keyboard interface*)
  - Make portlet controls operable through a keyboard interface. Do it in a non obstructive way.
  - Personalization and customization actions should be operable via keyboard interface.
- Guideline 2.2 (*Allow users to control time limits on their reading or interaction*)
  - Portlets must not refresh the portal page without the confirmation of the user.
- Guideline 2.4 (*Provide mechanisms to help users find content, orient themselves within it, and navigate through it*)
  - Provide a site map.
  - Do not use more than 6 main navigation buttons on a screen.
  - Provide inter-portlet navigation on the top of each page.
  - Provide way to go to inter-portlet-navigation from every portlet.
- Guideline 2.5 (*Help users avoid mistakes and make it easy to correct mistakes that do occur*)
  - Provide to your search engine with the capacity to suggest alternative keywords.
- Guideline 3.1 (*Make text content readable and understandable*)
  - When possible, use alternative modes in terms of modalities (i.e. multimedia) to offer further understandability
  - Provide internationalization
  - Provide metadata for important information to allow content adaptation
- Guideline 3.2 (*Make the placement and functionality of content predictable*)
  - Remain in portal environment and on working portlet. Provide anchors at the beginning of a portlet, so that it can be directly accessed.
  - For all external links provide visual cues and adequate title attributes.
- Guideline 4.1 (*Support compatibility with current and future user agents (including assistive technologies)*)
  - Global page information is not permitted
  - Keep every portlet entity (instance) unique on a page.

4 Conclusions and Further Work

We have proposed an initial set of accessibility guidelines that will support the design of portlets and portals in any type of environment, including AmI scenarios. Further work needs to be carried out in terms of prototyping, usability testing and incorporation of semantic information proceeding from context and device. In this regard, we distinguish between:

- **Context-aware static attributes:** user modeling attributes like those used in the Adaptive Hypermedia field ([4]; i.e., user preferences, knowledge, background, etc.)
- **Context-aware session attributes:** attributes that characterize short term interaction in ubiquitous environments, like device capabilities and context issues ([27]).

Additionally, work in the area of standardization would need to be proposed to ensure industry take-up of any proposed recommendation.

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