Introducing Accessibility in the Web Services domain

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***Abstract*—The ever increasing diversification of Web services and software applications has poses a real challenge to developers and designers when creating software that has to cope with a myriad of interaction situations, as well as specific directives for ensuring an accessible interaction. Presenting an advanced web services accessibility assessment tool, they can obtain a better understanding of the accessibility constraints for people with disabilities within Web services and software application's user interfaces. The proposed Web services assessment tool will assist them, with a minimal effort, to explore user-centered design and important accessibility issues for their software implementations. In an effort to solve such issues, this paper takes a step forward and introduces the notion of accessibility in the web service domain, in order to enhance web services with accessibility features capable to ensure that HCI through applications utilizing them is accessible.**

Keywords- Human Computer Interaction, Web services, accessibility,assessment, software design, User-centered design

I. INTRODUCTION

The current state of the art in accessibility issues reflects fragmented approaches towards the production of accessible products and services in Europe and worldwide. Thus, accessibility of mainstream Information and Communication Technology products and services has to be extended by combining knowledge and extremely innovative solutions. It is worth mentioning that people with disabilities are not just a tiny minority of the population of the European Union. The lowest estimate, based on the currently defined disablement categories, estimates their total number at around 74 Million persons. However, other estimates that take into account a) people with cognitive difficulties, and b) those people in the so-called hinterland between fully able bodied and the classically termed people with disabilities, should considerably raise those numbers, as highlighted below:

- In the EU 27 countries about 16% of the population are over 65, a number that is estimated to rise rapidly in the coming years
- Up to 15% of the population across the European Union has a disability, such as a visual, hearing, speech, cognitive, or motor impairment
- Around 20% of people over 50 experience severe physical disabilities

Consequently, accessibility is one more aspect that has to be taken into account in the development of software applications, especially in user interfaces. Furthermore, accessibility can be perceived in different angles [4]. What is accessible to one person might not be accessible to another one. The different requirements to access and interact within applications pose a significant challenge on how these should be developed [2]. This task often includes the development of different user interfaces to support a particular user group [3], as well as an augmentation of user interfaces with accessibility concerns that can be interpreted by assistive technologies, such as ARIA [1].

However, the development of accessible software requires a strong effort from developers. With the additional encumbrance of taking into account different kinds of accessibility requirements, guidelines and best practices, and different user interface implementation technologies (which by themselves might pose severe problems of delivering accessible applications), developers are faced with a daunting task. Therefore, the highly specialised skills required for developing accessible software sets aside most developers.

To mitigate these problems, developers should be guided in their development process about accessibility concerns within user interface development. This includes the definition of target users (e.g., their requirements, disabilities, etc.), which aspects should be taken into account to meet users' accessibility expectations, and how it reflects on user interfaces of software applications (thus coping with the particularities of different technologies).

In this context, as the Web plays a major role in everyday life, a large number of research efforts have been conducted towards accessibility in Web applications (e.g. [5][6][7][8][9][10]). Currently, the major steering body for Web Accessibility is the World Wide Web Consortium (W3C) [11] and its Web Accessibility Initiative (WAI). Even though the accessibility of web applications and content delivered through the Internet has drawn much attention from the research community during the past years and moreover, W3C's WCAG is considered to be a well-established and widely adopted standard, accessibility is still an unknown term in the Web Service (WS) domain.

Web services [12] and especially SOAP-based services play a key role for content delivery and service provision through the Web. The utilization of web services has been boosted through standardization efforts which have already been made regarding their proper specification and interoperability [13], [14]. However, standards deployed so far do not take under consideration the fact that the content and functionality derived from web services, delivered through end-user client applications, must also be accessible to people with disabilities.

As a result, Human-Computer Interaction (HCI) with end user applications that provide content or functionality derived through Web Service utilization may become inappropriate for users with special needs. For instance, a visually impaired user of a client application that provides maps delivered from a web service will not be able to use effectively the application, unless the latter provides an alternative way to present the information conveyed through the map images, appropriate for visually impaired users. Moreover, a developer (with no accessibility knowledge) who would like to implement the user interface of this map application though the integration of the adopted web service would like to know what exactly information is being delivered through the web service in order to implement an accessible user interface for this application.

In an effort to solve such issues, this paper takes a step forward and introduces the notion of accessibility in the web service domain, in order to enhance web services with accessibility features capable to ensure that HCI through applications utilizing them is accessible. In the following, the notion of the "accessible web service" is defined, and a web service accessibility assessment framework is proposed, developed within the EU funded project "ACCESSIBLE" [15]. The proposed framework assesses the capability of WSs to provide content accessible to their client application end users (people with disabilities), after ensuring that the WSs are able to interact well with the client applications utilizing their functionality.

II. Web Service Accessibility Assessment Framework Overview

The main idea behind this work is the fact that the interaction between client applications and web services can be enhanced with accessibility features. The intent of these features is to ensure that the Client Application – WS interaction part of the WS utilization chain (Figure 1) allows for accessible HCI at the "End User" - "Client Application" level.

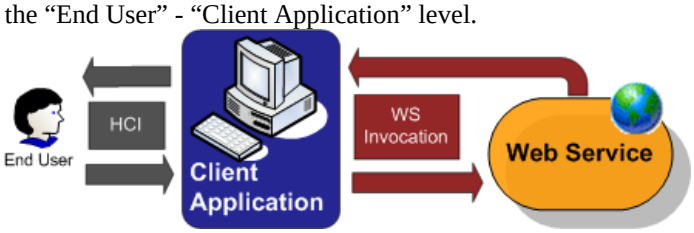

Figure 1. The typical Web Service Utilization chain

For this purpose, a WS Accessibility Assessment framework has been proposed, which aims to assess whether web services are accessible. Within the proposed framework, Web Service Accessibility is defined on the basis of a three-layer-architecture (Figure 2); comprised of the "core functional", "basic accessibility" and "extended accessibility" layers. In order for a service to be considered as fully accessible, it has to:

1. Be well-defined, well-working and easy to integrate within client applications, so that developers of client applications are able to use the service's functionality and/or provided information effectively within their developed application's operational context. This requirement defines the concept of the core functional layer.
2. Have accessibility features that will enable the client applications invoking the service to show the delivered content in an accessible way, in respect to the special needs of impaired user groups. This requirement defines the concept of the basic accessibility layer.
3. Provide data which contains enough information, in order for the content itself to be helpful for impaired users, containing information adapted to their special needs. This requirement defines the concept of the extended accessibility layer.

It is clear that dependencies exist among the above three layers of accessibility. For instance, in order for a service to be able to have "basic accessibility", first it has to have those core functional features that will ensure its proper "core functionality". The concept behind this dependency can be considered to be: "*In order to make a service better in terms of accessibility, it should be working (well enough) first*".

III. Web Service Accessibility Classes and Guidelines

Three service accessibility classes (A, AA and AAA) build upon the three aforementioned accessibility layers (core, basic and extended accessibility respectively), thus providing the means for service categorization based on service accessibility features. As shown in Figure 2, within the proposed framework, a set of guidelines is defined in respect of each accessibility layer. These guidelines, if followed, are able to provide a web service with functional and accessibility features (core, basic and extended) that will enable it to belong to the corresponding accessibility class. Furthermore, for each guideline proposed, a set of specific techniques are defined, which can be used to assess whether an already developed service belongs to a specific accessibility class or not.

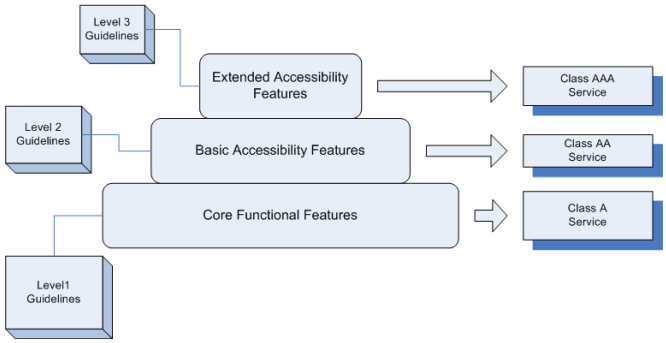

Figure 2: Accessible Web Service Evaluation framework base

Thus, "Class A" accessible services are considered to be accessible for "Typical Use" (thus having the **core functionality**). In this context, "Typical Use" refers to a service's ability to provide, through the exchange of

appropriate messages, functionality and information that can be delivered to users through "basic" User Interfaces of client applications; namely UIs of client applications which not necessarily provide access to user groups with special needs, but provide content to not impaired users in an effective and useful way. The guidelines that should be followed for this class refer to the overall functional - operational characteristics of a service, which ensure the effective and efficient integration of its functionality and information delivered within appropriate "basic" client applications. "Class AA" accessible services are those which are considered to be "accessible for Typical Use" (they have **core functional** features), and also have features that enable client applications to use their functionality and show the retrieved content properly to various user groups with special needs (these services have **basic accessibility** features as well). "Class AAA" Services are those which are "Accessible for Typical Use" (they have **core functional** features) and have **basic accessibility** features as well. Furthermore, the content that they provide contains adequate accessibility information, in order for it to be useful enough to impaired users. These services have **extended accessibility** features which allow them to provide content with information adapted to the special needs of the impaired user groups.

I4.1.1. Alternative text for every image element delivered through the WS SHALL be provided.

WCAG 2.0 corresponding Technique: H37: Using alt attributes on img elements

WCAG 2.0 appropriate Tests for Technique H37

1. Examine each img element in the content
2. Check that each img element which conveys meaning contains an alt attribute.

G.I4.1.1 Accessible WS Test Procedure:

T.I4.1.1.a

Identify all the image elements that are returned from operations defined within the service

T.I4.1.1.b

For all image elements identified from T.I4.1.1.a, identify whether alternative text elements are provided, which correspond to each image respectively.

Figure 3: An example of a web services technique

The proposed framework contains a set of Web service Accessibility Guidelines, formed after thoroughly reviewing W3C's WCAG standardization guidelines regarding the accessibility of Web Content, in an effort to enhance Web Services with the concepts behind the Web Content Accessibility Guidelines proposed by W3C[1]. For instance, such a followed WCAG-based concept is that of alternative text which should accompany any non-text content delivered through the web. Taking this into account, one of the WS accessibility guidelines proposes that a service providing non-text content (e.g. images) upon invocation should also provide a text element that contains all the important information conveyed through the images. The proposed accessibility guidelines are categorized on the basis of three Guideline levels: Level 1, Level 2 and Level 3. These levels correspond to the three accessibility classes, Class A, Class AA and Class AAA respectively. In order for a service to belong to a specific class, it should meet guidelines that belong to the corresponding level and thus have the required, respective functional and accessibility features. A relevant example of a specific technique for the proposed web service assessment guideline is being presented to figure 3, where a short description, a connection of the guideline with WCAG 2.0 techniques and the test procedure that should be followed for the automatic assessment tool. All of the proposed guidelines have been stored in an appropriate WSs ontology in order to be used for the Web services assessment process.

IV. Evaluation Results

The Web Service Assessment module is the one responsible for the evaluation of Web Services through the presented Web services assessment framework. This module communicates with (a) the WSs Ontology in order to get information regarding the Web Services Accessibility Guidelines defined and (b) the EARL-based Reporting tool in order to provide it with all the necessary information for the generation of EARL[2]-based reports regarding the Accessibility of Web Services and present them in users., If the Web services assessment tool considered as a black box, the module can take as input the relevant WSDL file which describes the Service under evaluation and the Web Service Accessibility Guidelines defined within the Accessible Ontology, and produces as output the result of the WS Accessibility Assessment process.

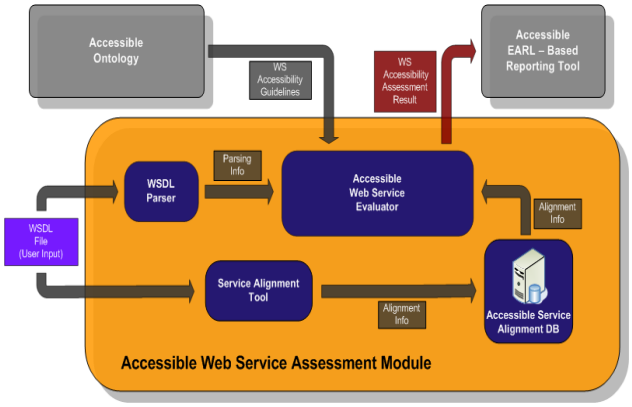

Figure4: Block Diagram of the Accessible Web Service Assessment Module

As depicted in Figure 4 the accessible Web Service Assessment module consists of the following main components:

The Accessible WSDL Parser: This component is responsible for the parsing of "Web Service Description Language" (WSDL) files. It takes as input the WSDL file describing a Web Service and produces as output Java structures that hold information regarding the Web Service, appropriate for further processing and accessibility evaluation. This component's functionality is based on the Apache Axis 1 and Axis 2 W3C SOAP protocol implementations.

[1] http://www.w3.org/TR/WCAG20/

[2] http://www.w3.org/TR/EARL10-Schema/

The Service Alignment Tool: Initially developed for the purposes of the ASK-IT FP6 integrated project[3], this web (PHP) - based tool offers service evaluators the capability to "align" Web Services to the Accessible WS "Ideal Operations" defined within the Accessible Ontology. All the executed alignments can be stored within an appropriate Service Alignment Database.

The Accessible Web Service Evaluator: This component is a Java-based application which takes as input the (a) information derived from the parsing of the WSDL file, (b) the information derived from the alignment of the Service's operations to the concepts defines within the "Ideal" ones, stored within the Accessible Service Alignment Database and (c) the Web Service Accessibility Guidelines defined within the Ontology. The Accessible WS Evaluator combines these three inputs and produces as output the WS Accessibility Assessment result, which is then passed to the Accessible EARL – based reporting tool responsible for the EARL-based Accessibility Report generation. The assessment process supported by the functionalities of the Web Service Assessment module, which is presented to figure 5, consists of the following steps:

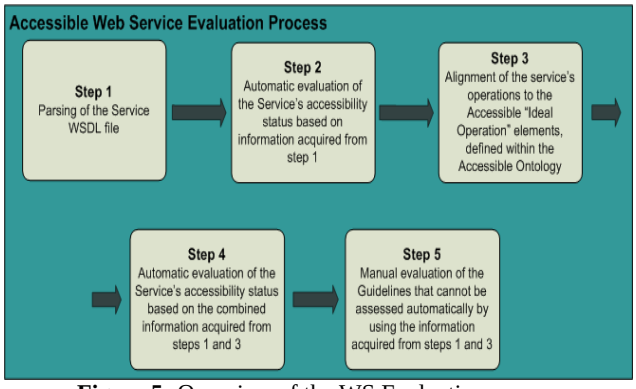

Figure 5: Overview of the WS Evaluation process

1. *Parsing of a Web Service's WSDL file*: During this initial step, the WSDL Parser acquires information regarding the operations defined within the Service under evaluation. During the parsing process, all the information contained in the WSDL file is transferred in Java-based structures, appropriate for further processing and evaluation of the Accessible WS Accessibility Guidelines. The WSDL Parser is able to parse among others the most commonly used "rpc/encoded" and "document/literal" types of WSDL files.

2. *Automatic evaluation of the Service's accessibility status based on information acquired from step 1*: Within this step, all information acquired from step 1 is used from the Web Service Evaluator in order to evaluate a limited set of the Service Accessibility Guidelines. This limited set contains all Accessibility Guidelines that can be automatically checked by using the information acquired so far from step 1.

3. *Alignment of the service's operations to the Accessible "Ideal Operation" elements, defined within the Ontology:* By utilizing the service alignment capabilities offered from the ASK-IT Service Alignment Tool, the Accessible Web Service Assessment Module acquires more information regarding the Service's operations and their input and output structures. Within this process, the service assessment tool is asked to align the operations defined within the Service's WSDL file and their input and output elements to corresponding ones, defined within the "Ideal Operations". The alignments produced are stored inside the ontology, ready to be used from the Accessible WS Evaluator during Step 4.

4. *Automatic evaluation of the Service's accessibility status based on the combined information acquired from steps 1 and 3:* Within this step, all information acquired from steps 1 and 3 is used in order for the Accessible WS Evaluator to evaluate a broader set of Guidelines than the one assessed during step 2.

5. *Manual evaluation of the Guidelines that cannot be assessed automatically by using the information acquired from steps 1 and 3:* During this step, the (user) evaluator of the service manually evaluates the service against the Guidelines not previously checked until step 4. The evaluator, for the purposes of this task, is offered the capability to invoke the Web Service's operations by using the dynamic invocation option provided from the Accessible WSDL Parser, in order to check more accessibility Guidelines.

V. Conclusion and Future Work

Developers and designers often have difficulty understanding the problems users with visual disabilities face when accessing their software applications that are not designed with their needs in mind. The proposed paper presents a work in progress towards the future development of accessible web services. For the first time, the notion of accessibility is introduced in the web services domain. The target is to ensure that the Client Application – WS interaction part of the WS utilization chain allows for accessible HCI at the "End User" - "Client Application" level. For this purpose, this work takes a step forward and proposes a three-layer WS accessibility assessment framework, after defining the notion of the "Accessible Web Service"; a service that is well-defined, well-working and easy to integrate within client applications, provides content which is accessible to impaired users and conveys information that can be actually helpful to them, adapted to their special needs. By this way they can overcome accessibility barriers and improve the overall accessibility of Web applications' user interfaces. Ongoing work is currently being done in several fronts, including: improving the proposed guidelines and implement more ideal operations of Web services that should used for the alignment of the tool, (2) to extend the functionalities of our WS assessment tool, and (3) to improve the alignment tool in order to support an automatic alignment process.

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