Position paper: Tools for the development of accessible and interoperable services for the Web of Things

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The *"Web of Things is about extending the Internet of Things [Ashton 2009] concept beyond the connection of things and considering issues like heterogeneity, scalability and usability with respect to progressive computing"* [Mayer et al. 2013]. By introducing web technologies, the concept overpasses Machine-to-Machine (M2M) communication and incorporates interaction with users into the landscape. Until now, there is not a lot of research in this domain on developing accessible applications for people with special needs. This position paper presents our initial approach to define and implement a semantic web-based framework for interoperable and accessible services in the Web of Things, which extends previous work of the authors for web 2.0 applications.

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Additional Key Words and Phrases: Human-Computer Interaction, Internet of Things, Web of Things, mobile interfaces, user interface descriptions, model-based user interfaces, web accessibility, user preferences model, device model

1. INTRODUCTION

The seminal papers from Weiser [1991], and Ishii and Ullmer [1997] presented a new paradigm of Human-Computer Interaction where the interfaces surround the user embedded in everyday artifacts. These pioneering works became mainstream at the end of the previous decade with the arrival of smart phones and the so-called Internet of Things [Ashton 2009], extended to the Web of Things (see, e.g., [Mayer et al. 2013] and references therein), enabled by architectural principles based upon the Representational State Transfer (REST) [Fielding 2000; Fielding and Taylor 2002].

These works and many that followed them presented a variety of multimodal user interfaces, which allowed the user to interact with her environment and exchange information with others. However, very few of this research has addressed the requirements of people with special needs (elderly and people with disabilities) for these interfaces. These requirements have a growing importance bearing in mind the population aging worldwide and that these user groups need access to critical services like health (e.g., patient adherence), transport, communications (e.g., social networks) or smart environments (Ambient Assistive Living, AAL), etc.

It could be argued that the generation of accessible interfaces in the Web of Things is covered by the Web Content Accessibility Guidelines 2.0 [WCAG20 2008]. However, as we will see in the following, the accessibility to these services and applications are influenced by other factors like the context of use, interoperability between services and the complexity of interfaces due to a wide variety of data visualization techniques that generate additional barriers.

2. STATE-OF-THE-ART

It is beyond the scope of a position paper to make an in-depth review of all the research work in these area. In the following we will highlight the most relevant approaches from the perspective of designing adaptive and accessible user interfaces for the Web of Things services and applications.

To achieve accessibility, we claim that the following aspects should be considered:

—Interoperability: there is a myriad of Web of Things platforms, which in most cases are incompatible with each other (see, e.g., Blackstock and Lea [2012] and some references therein). If we want to approach universal solutions that enable adaptation of interfaces, the interoperability of the platforms needs to improve. The way to achieve that is via standardization and using semantic technologies.

—Modeling Frameworks: there are different components involved in the operation of services and applications for the Web of Things, which are modeled with different frameworks. These frameworks must go beyond the design of the user interface, and cope with other actors of the system like user preferences, device capabilities, application and context of use (see Ackermann et al. [2012] and Mayer et al. [2014] for detailed reviews in different fields). By combining adequately such models, it may be possible to design adapted interfaces that extend approaches like those described in Boussard et al. [2011], for example.

—Standards: the use of standards like for instance REST [Fielding 2000; Fielding and Taylor 2002], HTML5 and its associated APIs [HTML5 2014] and an appropriate utilization of semantic web technologies that reuse existing vocabularies will facilitate adoption by the community and the developers/implementers of Web of Things services and applications.

3. APPROACH DESCRIPTION

Our approach is based upon a distributed architecture which combines existing toolkits for the Web of Things [Blackstock and Lea 2012; Axeda 2014; DeviceSmart 2014] with our semantic modeling framework [Ackermann et al. 2012] to enable dynamic adaptivity of user interfaces. This modeling framework has been successfully tested to adapt several web 2.0 application prototypes in different domains [i2web 2014].

This modeling framework is based upon the Composite Capability/Preference Profiles (CC/PP) 2.0 [CCPP 2007] RDF framework. CC/PP enables a description of device capabilities and user preferences that can be used to guide the adaptation of content. CC/PP allows to construct user and device profiles as a two level hierarchy: a profile with a number of components, which have a number of attributes. This simple framework allows an efficient processing of profiles without the parsing overhead of semantic models based on OWL, for instance.

Our framework defines a decoupled Web Technology model, which could be used by any other component of our architecture. This approach offers several advantages: (i) it allows the expression of device capabilities for either hardware or software components; (ii) it allows the expression of user preferences; and (iii) it simplifies the expression of matching rules for adaptation with different granularities.

The device model is similar to that of UAProf [UAProf 2006]. However, we have decided not to extend it but to design our own vocabulary, denoting a semantic equivalence or difference where appropriate. This device model refers to the client device of the user and not to the sensor/actuator commonly understood in the Web of Things. This model was developed to reflect the new functionalities of mobile devices and may also be used to identify assistive technology hardware and software. Furthermore, it needs to be further customized to incorporate recent developments in the HTML5 API [HTML5 2014].

We focused the user model on the modeling of the user preferences and not on the modeling of her physiological characteristics. On that way, we could focus on transforming different UI components to enable adaptivity. Our work is based upon the CAMELEON Unified Reference Framework [Calvary et al. 2002; Calvary et al. 2003], which *"... is a framework that serves as a reference for classifying user interfaces supporting multiple targets, or multiple contexts of use in the field of context-aware computing."* Furthermore, following the work of the SERENOA project [Motti 2011], we have newly introduced a semantic container that holds categories of pre-defined transformations, which can be mapped to algorithms similar to those of the library of algorithms for advanced adaptation logic defined by SERENOA. Due to the abstraction level introduced by the Web Technology model, we can avoid redundancies in their classification due to different content-types.

The aforementioned models need to be integrated with the application thus it can be rendered properly. Our initial work has been focused to the usage of the new semantic components of HTML5 [HTML5 2014] or enhancing existing (X)HTML applications with WAI-ARIA annotations [WAI-ARIA 2014]. The authors are exploring the compatibility of this work with those developed exclusively for this domain [Boussard et al. 2011; Mayer et al. 2014], to introduce modifications and improvements.

4. CONCLUSIONS AND FUTURE WORK

We have presented in this document an overview of the work we are carrying out in this area. This is a work in progress as we are experimenting with different prototypes of sensors and devices. We intend to present our results at the workshop.

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