Semantic-based Service Discovery on mobile Devices

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Abstract

We demonstrate an early prototype from our work in the field of semantic-based service discovery on mobile terminals. Main contributions are in support for browsing service ontologies and the cooperative discovery of services based on an intuitive preference model. The prototype is based on Semantic Web as well as Web service technology and currently realized as plug-in to Protégé.

1. Motivation

Using Web-based services has already become an integral part of our everyday life. Semantic Web technology and the advent of universal and mobile access to Internet services will only add to the broad range of existing services on the Web and provide additional features like knowledge-based, location- or context-aware information. On the other hand, so far little work has been done to explicitly account for aspects of mobile computing in semantic service frameworks. Whereas much of the work in Semantic Web services discovery and composition concentrated on the functionalities of the services, contextual information, personal preferences and more generally personalization are more pressing challenges in the mobile computing arena. In order to manage an increasing amount of mobile services, it is essential that Semantic Web services standards explicitly support the needs of developers and users, such as the discovery and selection of services they personally need in a given situation or context.

We present MobiOnt – a semantic toolbox to explore mobile user-centered services on the Semantic Web [6]. Our vision is to take full advantage of future complex service offerings on limited client devices and to handle the need for personalized service discovery in mobile environments.

2. A Practical Use Case

We present an extension of the case study published in [6] that addresses a future mobile Internet radio scenario. Internet radio has become increasingly popular in recent years with boosting numbers in Web radio stations and subscribers [4][5]. In this context, personalized access to content is particularly important to accommodate both, varying technical as well as personal user needs and preferences. In our testbed we have modeled Internet radio stations as Web services with varying service characteristics. Radios channels are described using an Internet radio ontology (a fragment of the ontology is shown in Figure) that consists of concepts that describe and classify Web radio services in terms of program format, origin, audio format characteristics and a time-based classification of streamed audio content. This service ontology is then used for preference-based service discovery. Note that our Internet radio scenario is only one of many possible applications for the MobiOnt.

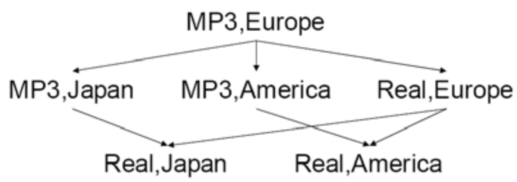

Figure 1: User-defined preference ordering.

3. User Preferences

While browsing the service ontology, service concepts with key relevance to the user can be selected and combined to preferences. In our preference framework [3], these (partially) ordered feature sets are directly handled without the use of any explicit quality or ranking values: user preferences are introduced as a special relation with the semantics of considering some object (or class) A superior to another object (or class) B ("I like Music channels better than News stations"). Preferences indicate constraints that a service should fulfill to best meet its requirements. On the other hand, even if none of the indicated preferences are met, a match can still be possible. To manage multiple user preferences complex preferences can be inductively constructed from a set of base preferences by means of preference constructors [3][6].

Figure 1 shows an example of a combined preference from the radio scenario. Here a user has indicated that she generally prefers radio programs from Europe over those from Japan or America. Still, the latter two choices are her preferred choices over any other available program. Due to the technical capabilities of her player, she also prefers MP3 encoding over Real. Further, she specified that both base preferences are equally important to her.

4. Cooperative Service Discovery

User preferences constructed during preference building define a service request that ultimately needs to be mapped to the underlying service ontology. MobiOnt therefore implements a flexible discovery algorithm that can be extended through different strategies. The goal of service dis-

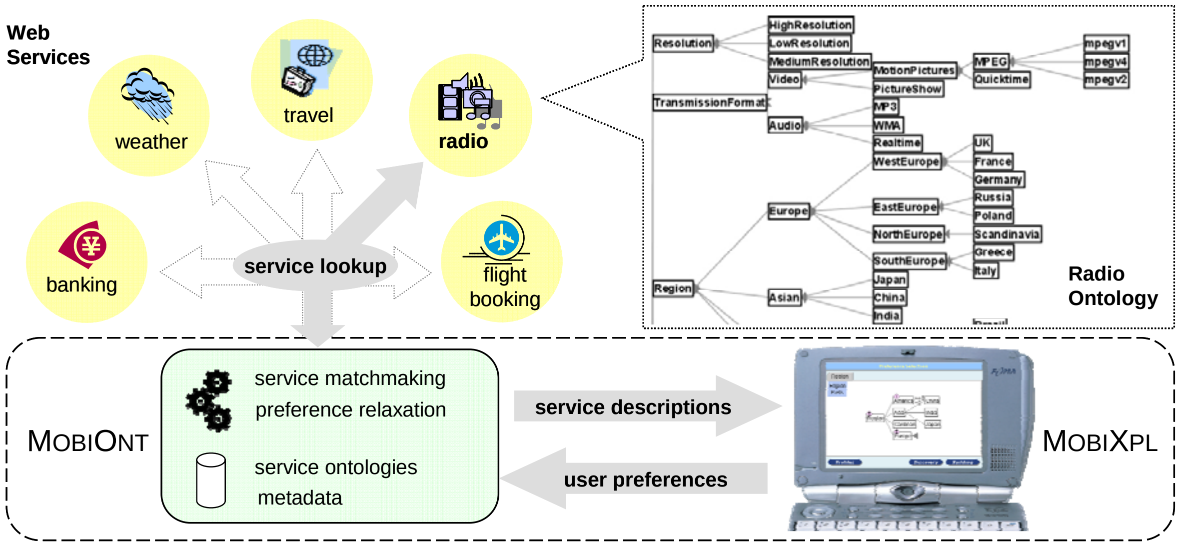

Figure 2: MobiOnt / MobiXpl – A testbed for mobile semantic-based services.

covery is to retrieve those service instances from the ontology that represent the best matches to given preferences.

The proposed and implemented preference-based service matching is performed along the lines of the determined preference order to implement cooperative behavior: if the search for a perfectly matching radio station fails, the initial query is gradually relaxed along the path of the (complex) preferences until a next-best match can be found. Thus, if in our example from above during service discovery no match could be found in European programs in MP3 encoding, the next discovery step consists of trying to match radio stations that broadcast Japanese or American programs in MP3 or European programs in Real. If neither of these two second-best choices is available, any other program is matched. Further implementation and application aspects as well as selective ontology browsing and preference building and mapping are further explored in [1][2].

5. Conclusion

The vision of a mobile Web in which the computing environment will be composed of various devices that are carried by different users as they go through their daily routine might soon become a reality. On the other hand, our experience shows that, to make this vision a reality, we need to combine the service-oriented approaches as put forwards by the Web services community, and methods from the Semantic Web. Only this way it can become possible to provision different services and information in machine understandable and truly intelligent ways. Semantic Web services provide a natural technology to make this vision a reality.

Even though the capabilities of today's Web-based services are still relatively simple, their sophistication and diversification will grow with the improvement of wireless networks, bandwidths, and client device capabilities. Consequently, finding the adequate services will become a more and more demanding problem for the individual user. We advocate that making an informed choice of the right service will essentially include matching the individual user's preferences and dislikes against the services offered in a given situation or context and have introduced the concept of user-centered Web service discovery [1] and selection [2]. Based on this work, basic yet very intuitive user preferences can be defined, accumulated and taken into account during service provisioning.

At this point MobiOnt and MobiXpl are early prototypes that are realized and can be demonstrated as plug-ins to the Protégé knowledge workbench. MobiXpl emulates different commercially available handsets whereas MobiXpl encapsulates central preference-based matchmaking mechanisms. Implementations of MobiOnt as a central network component and MobiXpl as a Java-based client running on an actual phone are currently implemented and will be demonstrated depending on availability.

6. References

[1] W.-T. Balke, M. Wagner. Cooperative Discovery for User-centered Web Service Provisioning. In *Proc. of the 1st Int. Conf. on Web Services (ICWS'03)*, Las Vegas, 2003.

[2] W.-T. Balke, M. Wagner. Through Different Eyes – Assessing Multiple Conceptual Views for Querying Web Services. In *Proc. of 13th Int. WWW Conf. (WWW'04), New York* 2004.

[3] W. Kießling, G. Köstler. Preference SQL - Design, Implementation, Experiences. In *Proc. of the Int. Conf. on Very Large Databases (VLDB'02)*, Hong Kong, 2002.

[4] Radio Locator. http://www.radio-locator.com/.

[5] NullSoft SHOUTcast. http://www.shoutcast.com.

[6] M. Wagner, T. Liebig, O. Noppens, S. Balzer, W. Kellerer. mobiXPL – Semantic-based Service Discovery on Tiny Mobile Devices. In *Proc. of Workshop on Semantic Web Technology for Mobile and Ubiquitous Applications (in conj. with ISWC'04)*, Hiroshima, Japan, 2004.

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Appendix: Demo Explanation

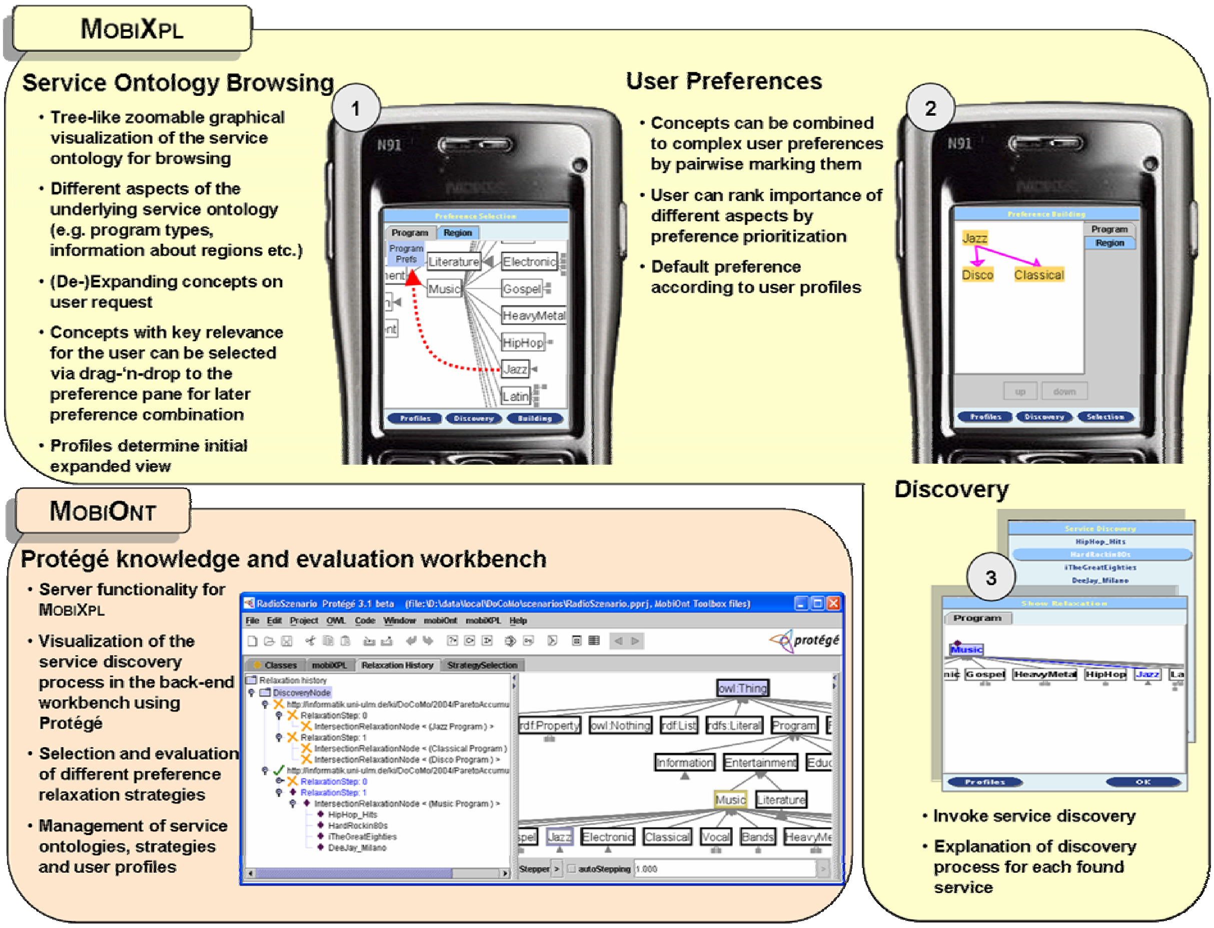

Figure 3: MobiOnt / MobiXpl Demonstration (annotated screenshot of running prototype).

We demonstrate an early prototype from our work in the field of semantic-based service discovery and selection on restricted mobile terminals. Parts of the radio service ontology are carefully exposed to the user through MobiXpl, the graphical front-end to our system. MobiXpl emulates different mobile terminals and consists of a mobile ontology browser with support for individual user views as well as an intuitive interface to user preferences. The idea is to only display selected concepts and sub-ontologies depending on the user's experience level and usage profile. Preference management and matchmaking is performed by MobiOnt, the central component of the prototype. Matchmaking and relaxation paths can be visualized through the MobiOnt Protégé pane.

At this point MobiOnt and MobiXpl are early prototypes that are realized and can be demonstrated as plug-ins to the Protégé knowledge workbench. MobiXpl emulates different commercially available handsets whereas MobiXpl encapsulates central preference-based matchmaking mechanisms. Client implementations of MobiXpl based on Java and Tiny SVG to be run on an actual phone are currently implemented (Figure 3 shows screenshots from software emulator) and will be demonstrated on real phones depending on availability by demonstration date.