A Roadmap to Advanced Personalization of Mobile Services

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Abstract

Performing complex tasks over the Web has become an integral part of our everyday life. The advent of mobile services will add to the broad range of existing services offered on the Web and provide additional features like location-based information. To take full advantage of complex service offerings, even on limited client devices, and to handle the growing variety of applications, powerful concepts for personalization are needed. Advanced profiling techniques in combination with semantically enriched service descriptions promise to enable automatic discovery, composition and execution of services. Driven by a usage scenario, this paper proposes a roadmap towards personalization of mobile services.

1. Introduction

The Web has become an integral part not only of our business, but also of our private life. Complex tasks like arranging travels, booking flights or online banking can easily be carried out over the Internet. Whereas these services are up to now typically accessed trough the use of personal computers, the recent development of powerful mobile devices, suitable protocols and improved bandwidths promise to take Internet services a step further.

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. In this context, Web Services are recognized as important building blocks of the future Web. In addition, open service standardization initiatives such as the 3GPP/OSA [3GP02] and Parlay [Gro02] standards try to open formerly closed proprietary telecommunication systems and encourage the vision of substantial richness, but also increased complexity for mobile Web services. As a consequence the broad range of applications that already exists on the Web will be enriched by an even larger number of wireless services. Today, we can only grasp a vague impression of how most end-users will soon be confronted with a broad variety of services and ways to combine them. An effective use of these services can only be achieved through adequate personalization and proactive service behavior.

Whereas technical issues for mobile web services are thoroughly investigated, work on service personalization is still in its beginnings [WKB02]. In this paper we present an approach towards advanced personalization of mobile services. From a mobile operator's point of view, we present enabling Web standards and technologies and try to align them with emerging research activities. Research efforts in the area of the Semantic Web are contributing to our vision of personal mobile services. Furthermore, we show how advanced profiling techniques can enable the efficient use of mobile services: user profiles can often be anticipated by the service design, captured by description languages and provided as a standard usage pattern for specific user groups. If a user can be assumed to belong to a specific group, standard usage patterns can be applied during service discovery and execution. In the following we exemplify our ideas by a typical usage scenario that comprises different aspects of mobile Web services.

2. A Usage Scenario

Just imagine how many steps a customer has to perform and what services have to be included to get a business meeting done in a foreign city. Communicating personal requirements and preferences to many sites could easily get tedious. The following scenarios illustrate our vision about personalization of future mobile services: Michael has just arrived from Japan at Boston airport for an international project meeting. He heads straight towards the airport's rental car center, where he picks up his reserved car just by identification and authorization via his mobile phone.

His phone transparently and automatically initiates a discovery of available services. The in-car equipment synchronizes with the PDA and automatically adjusts mirror, seat and heating to Michael's personal preferences. In addition to his convenience-driving settings, his PDA discovers the car's built-in navigation system. Immediately the address for the meeting is transferred and the appropriate maps are loaded by the navigation system. Using a local traffic information service, the navigation system chooses a route and is able to predict the arrival time. Since the in-car system signals that there is enough time before the meeting starts, Michael decides to get some cash in the local currency. He accesses an ATM locator service, which shows the way to the next ATM closest to his current location that is able to charge his credit card at the lowest costs. Since the time slot for this task is well defined, the trade-off between higher costs and the ATM's distance can be intelligently managed and also the route to the project meeting can

be taken into account. Once Michael has selected an ATM the navigation service has to adjust the route and collaborates with another service to find a nearby parking space.

Eventually Michael is guided to the meeting. Having a situation-aware communication environment, his preference of only being disturbed during meetings in the case of emergencies is activated. Arriving at the meeting room, the settings of Michael's communication devices thus are automatically adapted as the session starts. There is no need to explicitly switch to another device profile anymore. Even if there is no internal device profile available that meets the situation requirements, parameters from an external profile are transferred temporarily carefully respecting emergency settings. During the meeting, Michael is able to transfer his video streaming session from his laptop to the built-in screen of the meeting room. In addition to that, other services like a nearby printer and a video transcoder are discovered that support project work.

Since an important partner in the meeting is called off by an emergency, the meeting has to be rescheduled taking the schedules of all meeting parties into account. Meanwhile, Michael might be interested to meet with other researchers from the company. A scheduler service, available through the corporate WLAN, allows for short-term arrangements. It displays the availability of staff and administrative information such as room number or telephone.

3. Roadmap to Personalization

Figure 1 gives an idea of how services are selected according to individual needs of a user. A service is requested according to the user's personal profile which typically includes his individual preferences together with technical constraints of his mobile terminal and his environment. Based on semantically enriched service descriptions a service request management is then performed including a service discovery and execution. Before commenting on this service management and proactive service selection and execution in more detail in section 3.2 we will outline basic prerequisites for personal mobile services in the following.

3.1 Important Standardization Efforts

The past years have shown an enormous increase of efforts in the standardization and development of interoperable Web technologies. A recent trend in the ongoing work in standardization bodies and industry fora is now targeting the vision of truly personal services on the Web. Within this trend, we consider the following standardization efforts to be the key enabler of personal mobile services.

Federated Online Identity

A central concept for personal online access and future Web business is the notion of user identity to enable a single-sign-on to different services. A federated single-sign-on will enable users to sign-on once with a member of an affiliated group of organizations and subsequently use various sites offered by other group members without the need for signing-on again. The establishment of an open standard for federated network identity is part of ongoing standardization activities in industry where the Liberty Alliance Project [Pro02] and Microsoft's efforts around .NET Passport [Mic02] are most likely to be accepted.

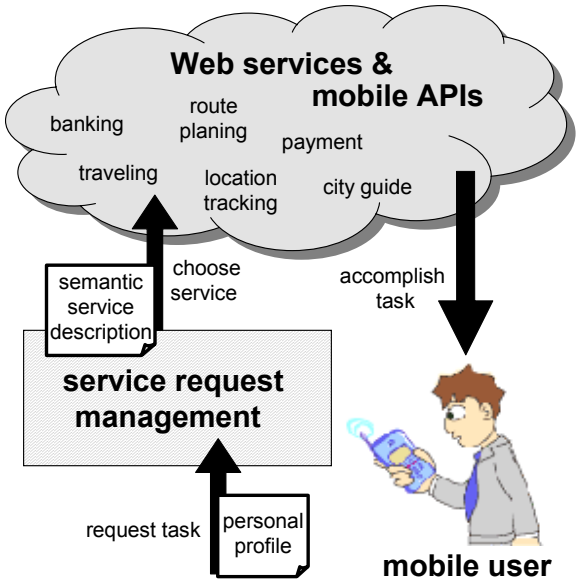

Figure 1: Personalized Choice of Web Services

In the sample usage scenario from above Michael picks up a rental car at the airport. Since he is able to prove his identity through a certified sign-on with his mobile operator and his phone, he can take advantage of the seamless sign-on to the rental agency. Subsequently, the payment of his rental can be processed with minimal effort.

Profiling for Device Independence

Different web-enabled devices have different input, output, hardware, software, and network capabilities. For a Web service to provide optimized content to different clients, a description of the capabilities of the client is required. Recently two new compatible standards have been established for describing delivery context: The Composite Capabilities / Preferences Profile (CC/PP) created by the W3C [Con02a] and the User Agent Profile (UAProf) created by the Open Mobile Alliance [All02] (formerly WAP Forum). They specify an XML and RDF [PF02] based framework to address needs for device independence and provide an interoperable basis for meta data descriptions of profile information.

Since mobile services are typically accessed from different kinds of mobile terminals, device independence and personalization play an important role in universal Web access. This is also true for our sample user Michael: He uses a PDA, a notebook and a mobile phone as his personal mobile terminals. In addition to that, he will use the build-in facilities of his

rental car as well as the in-house equipment of the facility where his meeting takes place.

Although, the main purpose of CC/PP and UAProf is the device independent access to Web resources, these two standards can also be considered the first to enable personal user profiling at the service level. Both highly profit from the use of XML, e.g. XML namespaces allow the association of device capabilities and terminal preferences from multiple vocabularies. However, CC/PP and UAProf are still restricted to profiling for device independence.

Privacy and Security
Clearly some profiling information has to be classified as personal data private to the user. Therefore, privacy-enhancing technologies will become a critical element of the personal Web. The platform for privacy preferences (P3P) [Con02b] is currently the most evolved standard for privacy on the Web. It consists of a framework for describing the privacy policies of a Web site in a format readable by both humans and machines, and enables the user to view privacy policies before accessing a site and disclosing any personal information. As a result, the user can make informed choices regarding disclosure of identifiable personal information at that site.

In our usage scenario the privacy considerations of Michael might be as follows: for the sign-in at the car rental agency the disclosure of his certified identity and his credit card information is sufficient. Other information, e.g. his role as a business traveler or his travel destination, is not exposed according to the privacy policies of his personal profile. In addition to privacy, the reliability and security of user profile information are both critical elements of a trusted personalization framework, e.g. user Michael intends to transfer sensible data in the form of his credit card information, he demands a secure method to sign-in with the rental agency.

The requirement for high security in the context of the WWW has resulted in a large number of research and standardization activities. Equivalent high security standards have to be applied in personalization: no part of a user profile should be compromised, eavesdropped, adulterated or maliciously modified during service execution. Candidates for ensuring integrity and confidentiality of portions of or the whole profile information include XML signatures [IC02] and XML encryption [Con02c].

Open Mobile Network APIs
An unusual, yet significant trend in standardization for mobile services can be noted in the formerly monopolistic telecom market. Here fixed-line and wireless network operators are considering to open up their networks for application development. This means that services and applications will be able to access core network functionality by means of open standardized APIs. Looking at 3rd generation mobile networks, with Parlay [Gro02] and 3GPP/OSA [3GP02], new approaches are in the phase of standardization or already on the market.

Even though most Parlay and OSA implementations are based on distributed programming environments such as CORBA, there is a significant trend towards the support of XML interfaces and Web service integration (cf. the Parlay-X working group [Gro02]). This will allow the Web service developer community the use of integrated services, e.g. offered by the capabilities in telecom networks. A new generation of mobile Web services can be implemented with the aid of open network APIs and combined with existing services. E.g., in the sample scenario from above the location of user Michael might be traceable through a special Web service (again according to his privacy policies). Therefore different location-based services – like a restaurant finder or an enhanced city guide – can be offered to him.

3.2 Personalization Research Issues

The standardization efforts as presented above only provide basic user profiling and personalization of mobile Web services. In this section we will outline research issues to take personalization to a new service level beyond sheer device independence and single service sign-on.

Semantic Service Request Management
At present, dynamic Web service discovery and composition is merely driven by technical properties and requirements: activation signatures, interface types, and quality of service characteristics are utilized to gain initial access to service subscriptions and subsequently allow composing and tailoring service offerings. Research in the area of the Semantic Web seeks a solution to this unsatisfying situation [BLHL01]. Generally speaking, the Semantic Web encompasses efforts to populate the Web with content having formal semantics and rich service descriptions. Recent semantic efforts around UDDI, WSDL and SOAP try to enable automated agents to reason about Web service descriptions and to perform intelligent service discovery, comparison and composition [MSZ01].

For proactive services behavior these semantic service descriptions are especially important. Again, consider user Michael from our example: having just rented his car at the airport he activates the car's navigation system. He expects the system to behave proactively and, if necessary, only wants to state something like "find me the appropriate road maps and show me the best way to get to my business meeting". During service discovery and selection, decisions that have to be made will not necessarily lead to one definitive outcome. Requirements could be met not by just one service or service component, but by a set of them, or none at all, e.g. there might be several maps and routing services as well as several ways to get to the required location.

At respective decision points during service discovery the discovery process can take the user's personal preferences provided with his semantically rich per-

sonal profile into account. Considering other important context information, an optimal selection and execution of a service is ensured. For instance in Michael's case the latest traffic reports of the Boston area together with parking information and all ATMs of his preferred bank can be used to suggest an optimal route like in [BKU03].

Expressiveness of Personal Profiles

Complex meta data about users, services, components and applications will have to be integrated, modeled and expressed by the means of adequate modeling and profiling languages. For user profiling languages there is a lot to be learned from the database and AI worlds where the taxonomy or organization of profile elements is often referred to as schema or ontology. We advocate that the design of future profiling languages for personalization can benefit from the current approaches to the Semantic Web where the layering of content descriptions has a similar quality [PF02]: On top of XML, RDF [LS99] provides a simple yet coherent structure for the expression of basic semantics. The so-called Semantic Web tower then grows more abstract on its next layers towards highly expressive ontology logics, e.g. with the Web ontology language (OWL) [DCvH02] which itself builds upon the DARPA Agent Markup Language and the Ontology Inference Layer (DAML+OIL) [CvHH01].

A similar layering concept is also conceivable for the construction of a personal mobile Web and a first step in this direction was already made with the specification of CC/PP and UAProf which use RDF to encode schemas and profiles of mobile clients and devices. Basic personalization can already be implemented on the basis of this technology: for instance when Michael adjust the settings of his rental car or registers his laptop with the infrastructure of his business meeting facility only basic technical profiles have to be communicated. On the other hand deciding how to best use free time before his meeting and to get to the meeting requires more sophisticated reasoning. While RDF provides a sound basis to state simple user profiles and preferences, higher expressiveness will be vital to enhanced user models and truly personal services. What is more, other fundamental knowledge management problems have to be faced, too. For instance the matching of a rich semantic user description against service parameters will lead to a class of problems known as ontology translation and mapping in the area of knowledge management [Gru93].

Usage Pattern and Default Profiles

Usage pattern and default profiles will play a crucial rule in the personalization of mobile services. Efficiency issues have already affected the standardization of a centralized CC/PP data management and are also important on a semantic level: if a user can be assumed to be of a certain type, i.e. fitting into a certain profile pattern, only a minimal list of attribute overrides have to be transmitted for service execution leading to an efficient use of possibly limited bandwidth. When for instance Michael enters the meeting room at the inviting company the settings of his communication devices are automatically adapted. Since he is assumed to be of user type "meeting participant" incoming calls are automatically redirected to his voice box and all e-mails are silently notified. If necessary, overrides to these default settings can still be specified in his personal profile, e.g. the immediate notification about incoming emergency calls.

In addition to efficiency matters the generalization of user profiles into patterns is also crucial for the automatic service discovery and proactive execution. Because even if a common profiling vocabulary is used for user modeling and service specification, there may be missing parameters in the profiles that have to be added by a sensible default pattern. Conversely, if the service request of a user is too specific, i.e. includes too many or unmatchable attributes, his request can be gradually generalized to match a certain service pattern. Besides, service designers typically have specific ideas in which context the service will be applied, e.g. as an automotive in-car service or a more general location based service, and the types of users that will access the service, e.g. business traveler vs. tourist. These design intentions can best be modeled by adequate patterns related to different user types and contexts.

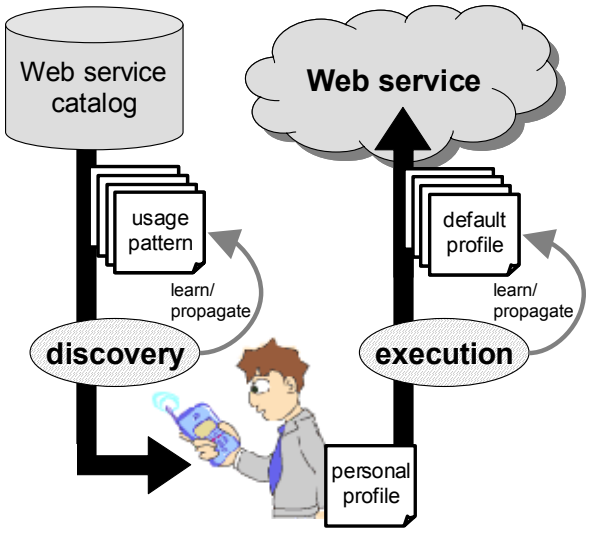

Figure 2: Proactive Service Discovery and Execution

Figure 2 depicts how we envision the use of default profiles and usage patterns. These patterns can be implemented as generalizations of concrete personal user profiles and service description. For a proactive service provisioning the whole personal profile of a user – or only parts of it – can be matched against a set of patterns to complete or generalize the service request. The service discovery and execution themselves then propagate back – in a pattern learning step – to the set of existing patterns to further generalize

the existing patterns or to introduce a new usage pattern or another default profile.

Pattern generalization itself could be achieved by the utilization of meta variables in profiles, the use of generalization policies expressed through additional ontologies, or the definition of generalization rules. Standards methods and commonly used AI algorithms may be adapted and deployed for service and profile pattern mining. Early work on generalization, e.g. [Mit82, Die86] show the applicability of standard methods that can even be extended to conceptual clustering [MCM86].

In a further step it might be conceivable that additional patterns exist to describe the user's intention, situation or context. For instance a simple service task of car rental might be something like "user of type A: rents car, goes from B to C, returns car". Using standard patterns additional information like road maps, hotel or restaurant recommendations can be offered depending on the user's location. However, more situation specific context might be needed. Consider for instance the case of two users renting a car at Boston airport for a weeks time. There might essential differences in the user's needs, for instance depending on whether he wants to stay within the city for business or wants to do a holiday roundtrip through New England before returning to Boston.

4. Summary and Outlook

Mobile services will considerably enlarge the variety of applications accessible on the Web. In this paper we have argued that an effective use of such services can only be achieved through extended service description, adequate personalization, advanced profiling and proactive service discovery and execution. In the future, base technologies such as federated online identity or XML encryption, which are currently in the process of standardization or already on the market, will have to be combined with advanced profiling standards and description languages. Motivated through a concrete usage scenario we established a vision of a personal mobile Web based on existing technologies and emerging research efforts.

We believe that enhanced descriptions of user preferences and profiles, device and service characteristics as well as the option to perform a wide range of service adaptations based on such descriptions is the key for progress in the field and for making the pervasiveness of mobile web services a reality. As the success of i-mode [DoC02] has already shown, operators play a significant role in the provisioning of mobile services. Powerful management of user groups with adequate default service profiles will be needed to ensure the proactive and efficient discovery and use of mobile Web services. Our future work will therefore focus on the deployment of enhanced web services, the use of expressive profiling languages, and the discovery, analysis and utilization of profile patterns.

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5. References

[3GP02] 3GPP. The third generation partnership project. http://www.3gpp.org, 2002.

[All02] The Open Mobile Alliance. User Agent Profiles (UAProf). http://www.openmobilealliance.org, 2002.

[BKU03] W-T. Balke, W. Kießling, and C. Unbehend: A situation-aware mobile traffic information prototype. In *Proc. of 36th Int. Conf. on System Sciences (HICSS-36)*, to appear, Hawaii, IEEE Computer Society Press, 2003.

[BLHL01] T. Berner-Lee, J. Hendler, and O. Lassila. The Semantic Web. *Scientific American*, 284(5):34–43, 2001.

[Con02a] W3C. Composite Capabilities/Preferences Profiles. http://www.w3.org/Mobile/CCPP, 2002.

[Con02b] W3C. Platform for privacy preferences (P3P) project. http://www.w3.org/P3P, 2002.

[Con02c] W3C. XML Encryption. http://www.w3.org/encryption, 2002.

[CvHH01] D. Connolly et al. DAML+OIL Reference Description. W3C Note, December 2001.

[DCvH02] M. Dean et al. OWL Web Ontology Language 1.0 Reference. W3C Working Draft, July 2002.

[DoC02] NTT DoCoMo. i-mode Global Web Site. http://i-mode.nttdocomo.com, 2002.

[Die86] T. G. Dietterich. Learning at the Knowledge Level. *Machine Learning*, 1(3):287–316, 1986.

[Gro02] The Parlay Group. Parlay/OSA APIs. http://www.parlay.org, 2002.

[Gru93] T. R. Gruber. A Translation Approach to Portable Ontology Specification. *Knowledge Acquisition*, 5:1999–220, 1993.

[IC02] IETF and World Wide Web Consortium. XML Signature. http://www.w3.org/Signature, 2002.

[LS99] O. Lassila and R.R. Swick. Resource Description Format: Model and Syntax Specification. W3C Recommendation, 1999.

[MCM86] R. S. Michalski, J. G. Carbonell, and T. M. Mitchell. *Machine Learning: An Artifical Intelligence Approach*, volume 1. Morgan Kaufmann, 1986.

[Mic02] .NET Passport. http://www.passport.com, 2002.

[Mit82] T. M. Mitchell. Generalization as Search. *Artifical Intelligence*, 18(2):203–226, 1982.

[MSZ01] S. McIlraith, T. Son, H. Zeng: Semantic Web Services. In *IEEE Journal on Intelligent Systems*, IEEE, pp. 46-53, 2001.

[PF02] F. Patel-Schneider, D. Fensel: Layering the Semantic Web: Problems and Directions. In *Proc of Int. Semantic Web Conf. (ISWC'02)*, Sardinia, Italy, LNCS 2342, Springer, 2002.

[Pro02] Liberty Alliance. http://www.projectliberty.org.

[WKB02] M. Wagner, W. Kießling, and W.-T. Balke. Progressive Content Delivery for Mobile E-Services. In *Proc. of 3rd Int. Conf. on Advances in Web-Age Information Management (WAIM2002)*, LNCS 2419, pp. 225–235, Beijing, Springer, 2002.