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Johan Hjelm EABTGBK		EAB-06:006075 UenEAB-06:006075 Uen		
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Building the Ubiquitious Applications Environment with MobiLife, SPICE, and Ambient Networks

Abstract

The ubiquitous web gets an added dimension when the user is the information provider, and mobile. However, this implies that reasoning and control must be applied to the information; and that the terminals which are providing as well as accessing the information must be able to access the network.

Introduction

The vision of the Ubiquitous Web as outlined in the call for the Ubiquitous Web workshop matches the vision of Ambient Intelligence, which is outlined in the workplan for the 6th Framework of the European Union. Building on this, we can combine the work of three projects which are currently ongoing to fulfill this vision. This paper demonstrates how.

First, the Ubiquitous Web vision makes a number of assumptions, building on the "ubiquity" vision of Mark Wieser. However, in our research, we have found it necessary to take the vision one step further. So, instead of assuming that information which is made available to derive a users context is only available from static information sources, we assume it is available from other users as well. Instead of all information being freely given out at all times, and services always being openly accessible, we assume the user is in control of the information (and this may not be a person, but a programmatic entity such as a charging system, which only gives out information when paid to do so).

Since we have been working with mobile users, our assumption is that the user – and hence the user as an information source – is mobile, which changes the information about him that he provides (and the context information derived from that information). And we assume that the information may be continuously, dynamically changing as the situation of the user (location, network, etc) changes.

Three dimensions of information management

An important assumption in the vision of the ubiquitous web is that information must be accessible, and that methods exist to make sense of it for users. This breaks down into three aspects:

- Availability
- Applicability
- Control

The availability dimension implies that information which will be used to compose services for the user is available. This does not only mean that the user has a right to access it, it also means that both the user and the information source are connected to networks which make the information reachable. This may sound trivial if you assume users and information to be connected through a fixed network, but once you introduce ubiquity, you also introduce mobility, both for the user and the information sources. This means that availability – both in the sense of the user not being able to access the network, and the information source not being accessible on the network – becomes an important factor.

Applicability is a second dimension, where information can be used to derive the requested information service (such requests may be explicit, e.g. when a time table application accesses a server for time table information; or implicit, as when a user clicks on a URI). Information which is explicitly created for a specific purpose can be said to be applicable when requested for that purpose. However, it is not equally applicable when pushed. The users context plays a big role in determining when information should be made available, and which information is relevant at which time (if it is a message that my mother is sick, I will probably be more interested than if it is a message saying that I can buy Viagra without a prescription).

The third dimension is control, and this is really the converse of the applicability. Here, we find both content filtering (e.g. antispam measures) and user privacy (i.e. when the user is an information provider, he does not want to give out all information about himself all the time).

Context is the core

The core of the future information services is context. The notion of allowing your context control the information delivery is almost as old as the “ubiquity” vision, but it goes further and it enables the service delivering information to draw conclusions about what information should be delivered, where, and how. The delivery context, i.e. the configuration of the device, its current settings, etc. is just a subset of this. A true contextual system will take into account the circumstances of the user, the environmental conditions, etc. But it is easy to realize that if you have to look in the wallet, check the sunlight, verify the timezone, and a million other things before providing information, this will be impossible to manage.

Hence, the other face of applicability: Control. By enabling the user to control the information access – both when acting as a context provider, and when acting as a context consumer – the information salience increases.

This brings to light two other notions: The context provider/context consumer interface, and the salience of information. Whereas the Ambient Networks project addresses the availability of information by enabling the user to be “always best connected”, the MobiLife project provides its major innovation through the context provider/context consumer interface, and the SPICE project by developing the notion of policy-based application control (initially exposed, among other projects, in MobiLife) further. In addition, a large part of the MobiLife focus has been on ontologies, which enables the system to conclude the salience of information, and automate contextualization.

Salience of information implies a number of things: You do not have to check all information sources all the time (e.g. if you want to know the weather, you do not need to check your wallet); aggregation (it is not necessary to check the temperature at all the doorways along Broadway to determine the temperature of New York); and which other information sources are relevant to you.

The third aspect is where the group management comes into play. Here, by grouping users, you can determine whether information is relevant depending on whom it comes from. And it can also be used in aggregation. Forming a group with all the thermometers along Broadway, you can know that you are not getting the temperatures off 42nd Street; forming a group with your friends, you can easily determine their positions, and tailor the information services you are receiving – including, if applicable, to their ambience. This filtering can be applied alreacy in accessing the context provider interface, both by the context consumer, and the context provider control as exercised by the MobiLife trust engine.

That the three projects interact in this way should not come as a surprise, since they were designed that way, by virtue of being part of the Wireless World Initiative, a research umbrella under the European Unions 6th Framework project.

User trials

In addition to designing the semantic web, group management, information management, and privacy management technologies, the MobiLife project has also designed and conducted a set of user trials, which deserve to be mentioned before going back to the technologies and their relevance.

The trials had three phases: Scenario phase; Mock-up phase; and User Test phase. This, the third face, is starting during March/April, and will be conducted in two sites, one in Finland and one in Italy. Here, about 50 users in total will be involved in using the MobiLife applications in daily life. These applications have been designed to expose the middleware functions designed in the project, which we believe constitute a complete environment to provide contextualized information services. It builds on the second phase, and includes several features requested by end-users; notable is the strong end-user focus in this project, reflected in the “user-centric design” process.

The second phase closed in September 2005, and enabled us to verify what the user perception of some of the functions were. Here, it is interesting to note the strong user reactions to on one hand automation, on the other privacy. Users were very adverse to allowing machines to draw conclusions for them, and very wary of giving out information about themselves in uncontrolled ways. Users simply felt that they should be in control of information pertaining to themselves (an idea which has support in European legislation).

The first phase ended in March 2005, and consisted of the evaluation of a set of scenarios, which had been composed to enable end-user understanding of the possibilities. Needless to say, they were – as all such scenarios are – quite high-level, but nevertheless, the input given from their evaluation was quite useful, e.g. in the understanding of the end-users reaction to privacy.

Reasoning about information

Given that users are willing and interested to provide information about themselves to certain other individuals and in certain situations, we need a mechanism to enable this. In MobiLife, this takes a twofold approach: First, we use group management to enable users to determine with whom he is communicating (or able to communicate); these groups may be persons, but also devices and services, as long as they can be characterized using a formalized description. Second, the user has the opportunity to set policies which determine how information about himself is given out. For instance, he can set a policy which determines that information can only be given out to specific groups under specific circumstances; or the policy may say that information is to be given out to everyone; or that these conditions apply to certain information items. This mechanism is integrated into the context provider interface, and hence an integral part of all information access in the environment designed by the consortium. This is because we do not want to distract ourselves from the next level: The reasoning on information.

Having obtained a piece of information, say about the users environment, we can start understanding what implications this may have for the service at hand. This reasoning can be done in three layers, where the layering is determining the level of detail you want to provide – as well as the degree of detail in the reasoning.

The lowest level corresponds to information being represented in RDF (or even a format which is mappable to RDF). Here, we foresee information which is used as the basis for inferencing, for instance sensor information, being gathered and managed. It is then used by the reasoning system to conclude the next level, the middle tier which represents a lower resolution but a higher level of representation, being an instantiation of OWL Lite. Finally, we have the highest layer, which is very coarse-grained and is represented in OWL Full. In addition, we have within the project defined a specific OWL enhancement, geared towards mobility.

Ontologies at these different levels will enable us to address services, and resolve how information should be presented, e.g. based on the users calendar. However, it does not allow us to conclude anything about the user – not per definition, but because the user profile is already available in a variety of formats, which do not lend themselves to reasoning (and which, as a matter of fact, are available in a number of locations).

From these results, we have concluded that a number of mechanisms we have created should be brought forward to standardization, and are now actively promoting the semantic translation of personal profiles; the policy control and group management; and the mobile ontologies aspects from MobiLife; and the ubiquitous, context-derived network access from Ambient Networks as standards in various organizations. The W3C is one of our targets, but we have not yet approached it, so the workshop provides us with a good opportunity to spread information about our activities and the result of our projects.