SEM-Ether: Semantic Web based Pervasive Computing Framework - Integrating Web, Devices and People

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Abstract

Pervasive computing aims to build an aggregated environment around a user by knitting diverse computing and communicating devices and software services into a single homogeneous unit. Our work is to develop a Pervasive computing framework which harnesses the power of Semantic Web and Web Services, facilitating the development of effective and intelligent Pervasive environments. This paper presents a high level view of the framework and how different Pervasive services can be built on this framework

Introduction

Computers have become part of daily lives of people and are becoming increasingly dependent on traditional computers and other networked computing mobile devices. Though the intention of these devices is to help people in improving the way they do their work, it happens that these devices are more intrusive in terms of increased overheads of managing information distributed across them and the context of interaction with these devices. We need these computing devices to seamlessly integrate into our daily activities by creating a collective environment around a user managing the distributed information a single amassed information and managing the context of interaction across the physical devices. The computing environment around us should proactively tailor and present itself depending upon specific role, location, preferences and similar context parameters for a given individual.

Pervasive Computing is an effort towards achieving the vision of invisible computing fabric around us. The target is to create smart homes, smart offices with intelligent computing devices connected through reliable network that would recognize and adapt accordingly to users and help them to smoothly carry on their tasks without explicit commands.

Current research in Pervasive computing has been much localized, in sense the current Pervasive computing systems [1] [2] have been demonstrated in restricted environment with several assumptions about devices and information representation. Our goal is to remove the barriers of representation and devices communication by using Semantic Web as a mechanism for a generic Pervasive Computing Framework that extends beyond a particular room or organization. Semantic Web provides standardized [3] representation mechanisms that allow automated reasoning and representation of information and services over Web.

The SEM-Ether Approach

Our solution is to use Ontological representations for User profiles, context, preferences and Semantic Web service based wrappers for physical devices and information services. Depending upon the user event, the Pervasive Computing Framework, SEM-Ether, would execute service planner that invokes and composes different services depending upon the event and user profile. With such approach, we can easily envision a global Pervasive Computing framework where different computing devices in different environments or locations would recognize the user and provide appropriate services.

We have developed a prototype for SEM-Ether that demonstrates the intended goals and shows the feasibility for the proposed approach. Integrating some common computing devices such as PDAs, Cell phones and personal computers, we show how the system actually functions and interacts seamlessly with the user. To bring out the effectiveness of the framework, we have implemented the framework for several scenarios. We intend to give a demonstration for the selected scenarios and show how new scenarios can be dynamically added to the framework.

Architectural Description

The major focus in the design of SEM-Ether has been to make it simple and easily implemented to allow wider acceptance and usage. We show a high level architecture diagram for the framework in Fig 1. The Event Handler is a central key component that is responsible for capturing various user-events, such as the "User-In" event when a user enters the environment. Current implementation of Event Handler has been as a Web Service that is invoked by the event generated by the client. The Event Handler invokes the Service Planner which essentially interfaces Semantic Web and has modules for parsing the Semantic User Profile and invoking Semantic Web services. The semantic user profile is annotated information about a user which stores various aspects of the users, like his history,

likes/dislikes, medical information. We foresee that in future, user would 'host' their marked up profiles on 'profile servers' analogous to the user web pages of today's Web.
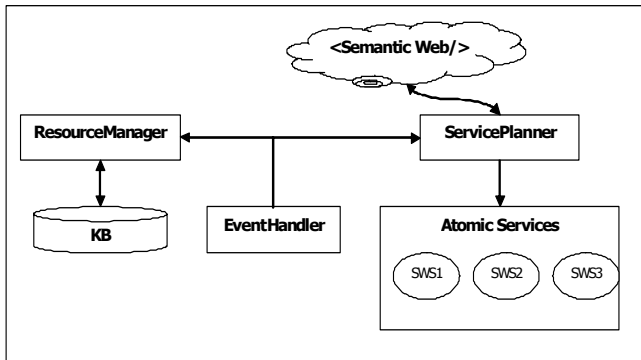

Figure 1. Architecture Diagram

The base of the Pervasive system is a set of Atomic Services that abstract local devices such as a printer or software services like scheduling software. These atomic services are presented as Web Services and are marked up semantically. The Resource Manager stores the information about the resources; hardware or software, part of the given environment in the local KB. The User event is caught by the Event Handler and processed by the Service Planner which fetches the corresponding user context parameters and provides a required service to the user by discovering and composing the available set of local atomic services. The planner also interfaces Semantic Web services over Web. The Service Planner invokes a set of atomic services which takes inputs from user's context and current resource settings and the complete task is accomplished.

Scenarios

We demonstrate the working of the SEM-Ether using several interesting scenarios:

a) **Pervasive Music**: The framework recognizes the user, fetches the user profile from the Web which stores information about user's favorite songs. In this scenario the context is defined by the user's location, user's music preferences and the system policies. The system fetches user's favorite song from the atomic service which provides it or from the external services using Web Service. It then selects the atomic audio service to play the song on the speakers nearest to the user.

b) **Pervasive Buddies**: The system keeps track of the users present in environment. When a new user enters into the environment, the system fetches his/her user profile from Web and checks his/her buddy list (Fig. 2). If any of

his/her buddies is present in the environment then the system alerts the user and his/her buddy. The device used to alert these users depends on the context. The system can send message on user's device like his/her PDA or cell phone or can flash a message on his/her computer.
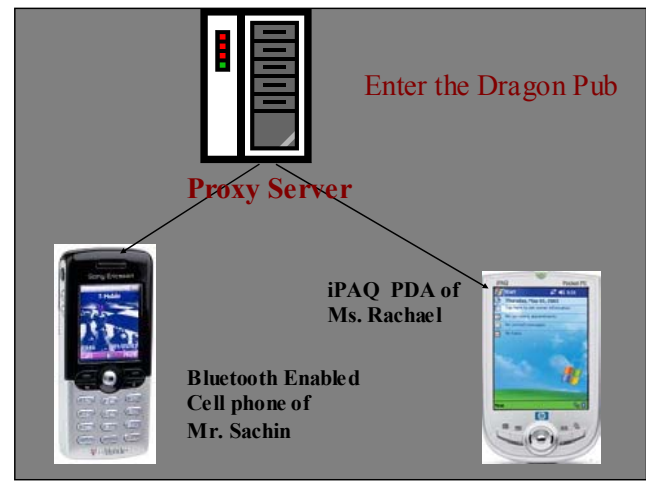

Figure 2. Buddy-Alert: SEM-Ether notifies the presence of buddies on their respective devices.

c) **Pervasive Phone**: The phony service is an intelligent telephone call forwarding service which forwards the telephone call depending on user's current location in the environment. We have also defined policies that govern the call forwarding service. Hence if user is busy with some high priority activity then the system redirects the call to an appropriate person or gives dynamic message to the caller, depending on the context. Since the framework is exposed as Web Service to the external world and user profile is always updated with the user's current location, the system is also capable of handling call forwarding across different Pervasive environments.

d) **Pervasive Scheduling**: User schedule is an integral part of semantic user profile. The system monitors user schedule as long as the user present in the environment. If any task is scheduled in the user's calendar then the system takes an appropriate action to execute related service to that event or informs the user about the event by sending notification to the device which the user is currently using. The user schedules can be updated and referred to irrespective of the environment he/she is currently in.

References

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