A Personal Agent Manager for Mobile Users*

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Abstract. Service roaming is the current challenge for mobile telecommunication. The concept of Virtual Home Environment (VHE) was introduced into the Universal Mobile Telecommunication System (UMTS) standardization process to focus on this requirement.

In this context, CAMELEON project is experimenting mobile agents and the VHE for mobile users services such as electronic commerce.

GEMPLUS has developed the concept of Personal Agent Manager (PAM) which allows users to manage their agents. From any terminal, roaming users are able to create, launch and retrieve mobile agents.

PAM is built on top of a JavaCard-based application, that provides terminals with the personalization part of users. Once inserted into an anonymous terminal, the smartcard participates in the overall system and application architecture to provide users with a consistent and personalized interface to service agents.

1 Introduction

As an introdution, consider the following futuristic scenario.

While travelling for the next CAMELEON meeting in Ottawa, I received the following mail from my favorite bookstore.

"Next book sales will take place at the market center in Marseille next Friday. For people who cannot be physically there, there will be a virtual market place where users can send shopping agents to buy book items."

"This event is made possible by severals bookstores which will be present there both physically (booth), and virtually on behalf on their respective bookstore agents. The virtual market is hosting at marseille.marketcenter.com on port 6776."

"Users can send their own shopping agent or can use the shopping agent that is provided with a small amount of fee at www.agentprovider.com. However, negotiation and shopping must follow the Standard Shopping Agent protocol (SSA) which is specified at http://www.agent.org. Certification and electronic transaction will be perfomed using the Secure Electronic Transaction protocol (SET) specified at http://www.set.com."

As I could not be in Marseille next Friday, I decide to send my shopping agent to look for new science fiction books. I start my Personal Agent Manager on my UMTS terminal.

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2 UMTS & the VHE

The Universal Mobile Telecommunication System (UMTS) [1] will provide a standardized framework within which services will be created and provided to users. Such an approach should give more flexibility in service development and deployment than in today's Global System for Mobility (GSM) [2], in which services themselves are strongly standardized. Dynamic adaptation of services is the key characteristic for the UMTS.

One important features for mobile users is the ability to access their customized service environment anywhere, regardless serving network (i.e., home network vs. visiting network), terminal device and location. The concept of Virtual Home Environment (VHE) [3] was introduced into the Universal Mobile Telecommunication System standardization process to focus on this requirement.

2.1 The Virtual Home Environment

Basically the Virtual Home Environment allows the support of *service mobility*, also called *service roaming*. The idea behind this is that roaming users will be provided with their own individually customized environment at different terminals within different networks.

Based on works and background experiences of [4], the VHE can be seen as a middleware layer which provide a set of Application Programming Interfaces (API) that isolate mobile users and services from underlaying networks, systems and terminals capabilities.

2.2 The USIM & the VHE

The Subscriber Identity Module (SIM) [5] has been one of the differentiators of the GSM standards towards network operators. While SIM's primary role was in users' identification and authentication, its usage has actually been extended to various operations such as for example hosting users' personal information and preferences, storing off-line applications and driving the handset Man Machine Interface (SIM Toolkit) [6], or securing the access to some specific services such as prepaid Advice Of Charge (AoC) and call control (Fixed Dialed Numbers).

The UMTS has generalized and extended these roles for the User Services Identity Module (USIM) [7]. It has been proposed a VHE model in which the USIM is considered as having the ability to provide networks with service and profile data, service programs and a service execution environment (Fig. 1).

In this model, one possibility to realize the VHE is to store necessary objects (data and programs) in the USIM so that these can be injected into the Home or the Serving Network at any time (i.e., any connection). Hence, the USIM does not only provide network identification and security features but also supply the network with service intelligence such as for example users' personal service profiles.

3 Mobile Agents for Mobile Users

Mobile Agents Technology is an emerging technology that is especially interesting for mobile computing [8]. The ability to transport itself from one system to another allows a mobile agent to move closer to a system that contains an object with which it wants to interact, and therefore, take advantage of being in the same host or network as that object.

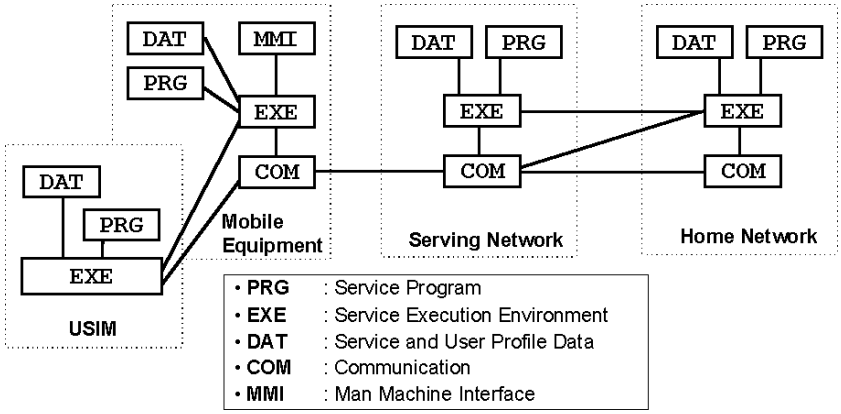

Figure 1: The VHE Architecture Model

Using mobile agents when designing new architectures and services can reduce network traffic, provide effective means of overcoming network latency, and perhaps most importantly, increase asynchronous communications and autonomous operations. This is especially interesting for terminals that do not have a permanent connection to the network and are often disconnected for long periods of time (e.g. wireless terminals, laptops, personal digital assistants, modem-connected home computers).

3.1 Application Areas

Many standardization forums have started activities on mobile agents. Since 1995, the Object Management Group (OMG) is extending its Distributed Object Technology model by specifying MASIF [9], and recently the Foundation of Intelligent Physical Agent (FIPA) [10] has introduced mobility as a candidate technical area.

Roughly mobile agents can be seen as mobile objects, and therefore distributed applications and systems can benefit from using this technology. *Information retrieval* within the Internet can be performed by mobile search agents; In the field of *electronic commerce* mobile agents can locate services or products, compare offers and negotiate with providers on behalf of their owners; Agents can carry out *workflow activities* as representatives of human users or other agents; Finally, in the field of *telecommunication*, mobile agents can be used to enhance the provision and the management of services.

3.2 Naming Services for Mobile Users

Naming services have become essential elements in distributed systems. They often make possible communication, data exchange, co-operation among different distributed objects. A naming server provides objects from a request which has a name as an argument.

Even if many naming servers have already been implemented for a while such as Domain Naming Service (DNS) [11] or CORBA naming service (COS) [12], naming service for mobile agents is also necessary.

Naming and directory services are traditionally supported by network servers and are provided to users as part of their network and service provider subscription. However, as on-line connections and services evolve to become more personalized to users and available at anytime from anywhere, GEMPLUS has developed the concept of Personal

Naming and Directory Service (PNDS) [13], that provide mobile users with the part of naming and directory service that is private and personalized.

PNDS is provided as part of a smartcard component which is integrated in the overall naming and directory network architecture. PNDS supports *referral entries* and *remote attributes* to reference objects and attributes which are located on network servers (Fig. 2).

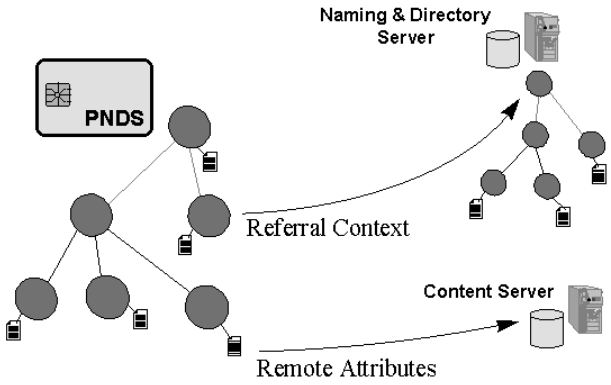

Figure 2: The Personal Naming and Directory Service (PNDS)

4 A Personal Agent Manager for Mobile Users

The Personal Agent Manager (PAM) is an application dedicated to mobile users to manage their mobile agents. From any network terminal equipped with a smartcard reader (e.g., a workstation, a PC with a modem, a cellular phone), roaming users are able to create and launch customized agents, and to retrieve them later on from the network. `PAM` copes with operations such as `create`, `move`, `kill` or `invoke` on agents.

As the terminal may be anonymous (e.g. public phone), it has to be customized prior users can interface and request their personalized service agents. Therefore, `PAM` has to fulfill following tasks:

- **at user connection :** set-up and display the list of active mobile agents acting on behalf of the user who request a connection,
- **at agents invocation :** set-up necessary proxies to agents in order to enable remote invocations,
- **at agent creation :** perzonnalize agents with users' preferences and inputs, and with terminal profile and network characteristics.

In the context of the UMTS, the USIM and the VHE, the PNDS appears to be the best solution to handle users' personalization operations.

4.1 PAM Architecture

The `PAM` is made of two different parts. The first part is anonymous and installed on the terminal. The second part is *personal* and is made of the `PNDS` and the active users' agents.

The architecture is made of following objets (Fig. 3):

- `PAM` itself provides users with an adaptive agent management user interface to service agents. `PAM` is personalized from both the `UserProfile` and service agents.
- `UserProfile` holds the list of users' preferences (e.g., `preferred-colors`), and the list of services for which s/he has subscribed to. Each service from this list can includes a service profile (for example a reference to the service agent factory).
- `AgentProxyFactory` is in charge of building proxy to a mobile agent, based on the agent name and a reference to the naming server where it has been registered.
- `TerminalProfile` consists on the capabilities (i.e., Quality of Service) which are offered by the hosting terminal and network.

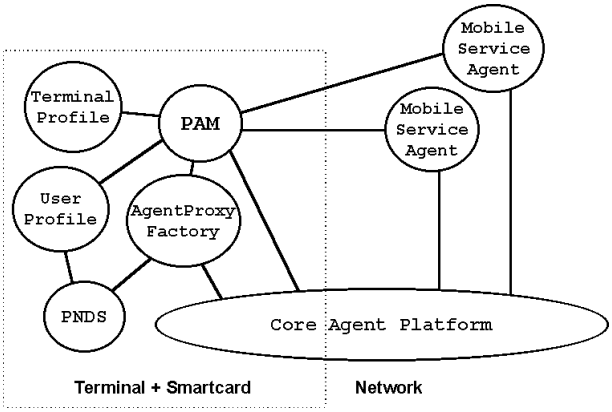

Figure 3: The PAM Architecture

4.2 Scenario

Following is the scenario a user will walk through:

1. A user inserts his/her PNDS smart card into a terminal.
2. `PAM` takes into account the user's, the terminal as well as the network profile, and proposes to the user a list of service agents which are *local* (provided as part of the serving network), and *global* (i.e., *personal*) to the subscribed home network .
3. `PAM` displays the list of active user's agents. These agents have been possibly sent from another terminal and/or from another network. `PAM` gets necessary information from the `AgentProxyFactory`.
4. At this time the user can either select a proposed service and create and launch a new agent, or communicate with one of his/her active agents. In both case the user interact through an adaptive user interface that is supplied by the service agent factory (new agent) or by the mobile agent itself (existing agent).

4.3 Implementation

An implementation of the PAM has been realized on top of the ObjectSpace's Voyager platform. This core agent platform allows mobile agents management (creation, moving, naming registration, etc.), and appears to be adapted for such a prototype. However, the prototype can be easily ported on other agent platforms. A set of Voyager sites simulates a wide network within which mobile agents can move on.

The `UserProfile` and the `AgentProxyFactory` are based on the `PNDS`. `PNDS` is implemented on a GemXpresso JavaCard which is intended to prototype smart card applications. It supplies users with data storage and ensures data confidentiality and personalization of any anonymous terminal and visiting network.

The `PNDS` contains two main directory entries (Fig. 4). The `AgentProxies` consists of a list of agents and proxies information such as the reference of the naming server the agent has been registered, and the agent name. The `UserProfile` contains information on the user and on services s/he has subscribed to. In our case those entries provide a reference to the corresponding service agent factory as well as users' personal preferences.

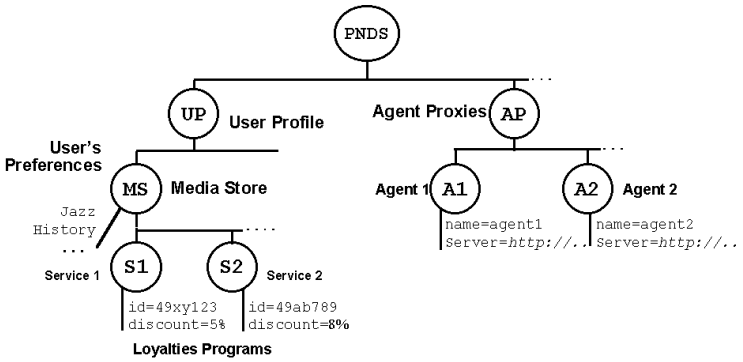

Figure 4: Structure of the PNDS

To demonstrate the Personal Agent Manager, a `MediaStore` application such as described in the introdution scenario (see section 1), has been developed. This application consists of an implementation of a shopping agent, its factory and a bookstore agent. Bookstore agent proposes books with respect to users' preferences. These preferences are set by the agent factory from information delivered by the `PNDS` (Fig. 4), and from inputs possibly entered at the keyboard by the user.

5 Conclusions

The PAM is an application that allows mobile users to manage their own mobile agents. It aims to provide a personal environment. Like a terminal, this application is not personal but is personalized from various information and resources provided by the smartcard itself and by the referenced network resources the smartcard also provided.

Once inserted into a terminal, the smartcard participates in the overall system and application architecture to provide users with a consistent and personalized interface to service agents regardless accessing network, terminal device and location. In this sense PAM and PNDS contribute to the realization of the VHE.

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