Advanced Service Execution and Service Provisioning for Future Telecommunication Networks (UMTS)

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Abstract

Service provisioning and the corresponding signalling load are currently challenging issues to offer future telecommunication services efficiently and at the same time in a flexible and user friendly manner. As a contribution of the CAMELEON project to the VHE (Virtual Home Environment) concept of UMTS (Universal Mobile Telecommunication System) this paper describes and compares advanced approaches for service execution and service provisioning based on agent technology.

Advanced signalling approaches using IN and Service Node Technologies are compared with respect to advanced addressing and intelligent terminating communication services. Agent technology is a promising new approach for Service Provisioning allowing integration of autonomous and intelligent agents as well as automatic feature updates in terminals and network nodes. First implementations of prototype services validating these concepts are presented.

Introduction

3rd generation Universal Mobile Telecommunication Systems (UMTS) are the realisation of a new generation of mobile communications technology for a world in which personal communications services should allow person-to-person calling, independent of location, the terminal used, the means of transmission (wired or wireless) and the choice of technology. Personal communication services should be based on a combination of fixed and wireless/mobile services to form a seamless end-to-end service for the user. Beyond that UMTS will operate in parallel with pre-UMTS technologies (e.g., GSM, DECT).

UMTS will provide a wide range of telecommunication services, provide a single integrated system in which the user can access services in an easy and uniform way in all environments. It will allow device independent services via hand held, portable, vehicular mounted, movable and fixed terminals and also provide the support of roaming users by enabling users to access services provided by their home environment in the same way even when roaming. Ultimately UMTS facilitates the flexible introduction of telecommunication services to allow differentiation between service offerings of various serving networks and home environments. Service Provisioning in UMTS is the overall provision of services to users where a service is defined as a set of functions offered to a user by an organisation. The Serving Network, which is a possibly often changing access network of the user, provides the user with access to the services.

Pre-UMTS systems have largely standardised the complete set of teleservices, applications and supplementary services. As a consequence, re-engineering is often required to enable new services to be provided and this makes it more difficult for operators to differentiate their services. UMTS will standardise service capabilities and not the services themselves.

It is intended that these standardised capabilities should provide a defined platform which will enable the support of speech, multi-media, messaging, data, user applications etc.

The User Interface (UI) from the end user's point of view should be as flexible as possible and capable of being updated so as to meet the requirements of new services which are still to be envisaged. The activation of UMTS services should be as simple as possible with minimum input expected from the user.

The concept of a Virtual Home Environment (VHE) for UMTS was introduced into the standardisation process for the provision and delivery of personalised services across network and terminal boundaries with the *same look and feel*.

The concept of the VHE is such that users are consistently presented with the same personalised features, user interface customisation and services in whatever network, with whatever terminal (within the capabilities of the terminal), wherever the user may be located.

The ability to provide such flexible service provisioning has many implications for the network in terms of management, control of services, signalling and also implications to future advanced addressing. The name or number is used to uniquely label the users and addresses are used for routing. The user perspective will be that the name/number will be the way to reach another user but from the network point of view the name/number may not be directly used to reach the called user. A user request for an unknown service will require some means to locate where that service request can be handled or where information can be found on how to handle the service request itself. This may imply that service control is distributed in the system giving rise to complicated network management protocols and stringent security requirements.

Current developments in GSM such as CAMEL, MExE and SAT (SIM Application Toolkit) are going some way towards fulfilling the requirements of the VHE and they will also be adopted for UMTS. However, there is scope for other techniques to be employed to meet all the requirements of the VHE. Agent technology is a possible solution to the problem of service portability in heterogeneous networks. Agents offer the potential to distribute service related processing, a means to make new services backward compatible with existing terminal equipment and a mechanism for nodes in different networks to co-operate in order to provide a service to a user. However, this technology is relatively new and its suitability for solving telecommunications problems needs to be proven in implementations. This paper provides a description of some possible service architectures for personalised service portability in UMTS based on the use of agent technology.

In the context of this project an *agent* is defined as a piece of software that is able to perform a task autonomously on behalf of a user or application, using its intelligence to access distributed resources. A *place* is an execution environment for agents at a specific location. Two types of agents are distinguished: Provider Agents (PA) and Service Agents (SA). A provider agent is permanently available at a fixed location and offers access to local resources. More than one provider agent can exist at a place. The agent that has been given a certain mission and will be using the services of a provider agent is called the *service agent*. The mission of the service agent is a user-defined abstract set of rules in which the agent should act. A service agent can either be generated at a place locally (possibly out of a pool of available objects) or can be a visitor that has been created elsewhere and was moved to the place, carrying with it the previous state of execution. Other service agents that have been defined in the context of this project are, e.g., the Terminal Agent (TA), describing the basic capabilities of the terminal and a basic user interface for authentication, and the User Interface Agent (UIA), which provides, e.g., a GUI depending on the terminal. Interworking between different services will also be solved by special agents called the Inter Service Communication Agents.

This paper describes an alternative approach for future network signalling. Advanced addressing and intelligent communication management were chosen as examples. The first part surveys possible advanced addressing mechanisms. The second part details the message flows separately for the originating party and the terminating party. The last part describes the management of the different involved entities based on agent technology in the context of some of the services prototyped in the CAMELEON project.

1 Advanced Addressing

As stated in the introduction the flexible service provisioning has implications also to future advanced addressing. Traditionally, parties have been called by means of an E.164 telephone number, by a short number (on a PABX), by an X.121 number on packet data networks or by an X.400 or Internet name for electronic mail. UMTS is intended to be universal, so although it may support all these existing mechanisms, it should also support a more integrated approach, where calls can be set up without having to use all these mechanisms together.

In today's numbering plans there is a mixture of names and addresses in one scheme. The E.164 numbering plan, for example, is used for user, personal, terminal and node addressing. For personal addressing the 0700 numbers are recommended by the ITU-T. These numbers are portable and do not indicate the home environment. On the other side, mobile station roaming numbers (MSRN), numbers that are temporarily assigned for roaming GSM subscribers are used from the same numbering space as the mobile station ISDN numbers (MSISDN). On routing level these numbers cannot be distinguished and this leads to serious administrative problems.

For future telecommunication systems there should be a clear difference between different types of addresses or numbers. These should be Names, Service Numbers, and Routing Numbers. The terminology is under discussion for the moment, however, a three layer approach seems to be accepted by ITU-T.

1.1 Names

To make future telecommunication services more user friendly, the user will be able to initiate communications with another party using a name to identify that party. This might be a logical name referring to a job function, an advertising response line etc. and would be resolved into a real terminal address by the UMTS system transparently to the user. Names can be stored in an address book which will be accessible from any terminal that the user is registered on.

Some naming schemes should be fully independent of the supporting serving network and the home environment, allowing users to transfer this name to another home environment. This will not preclude naming schemes that are related to one home environment only. It will be possible to map a name or a range of names to any of the USIMs belonging to a home environment. Names will allow extended character sets and may be used to identify groups as well as individual terminals or people.

Different naming schemes will be capable to coexist. Names that can be ported between home environments on international, regional, national and home environment basis will be supported.

1.2 Service Numbers

Service numbers will be used to identify user profiles stored in network nodes (e.g., a profile in the HLR or an IN database). It will allow the unique identification of the home environment of the user and is related to this home environment only. The international mobile subscriber identifier is an example in the GSM network (see ITU-T E.212 recommendation). It is used to identify the user profile and to route service requests to the home location register (HLR).

1.3 Routing Numbers

A routing number is used by the network only for routing to the access point of the called party. It could point either to a temporary access point for mobile subscribers or to fixed line access points. In this case a name is converted into a routing number directly. It will be possible to derive the serving network from the structure of this number for routing and inter-operator charging purpose. The mobile station roaming number MSRN in the GSM systems, is a candidate for a routing number in mobile networks, today it is allocated from the subscriber numbering space of the serving network. Sophisticated signalling systems may also support the direct routing to a mobility database, e.g. GSM HLR, with a service routing number (SRN).

2 Message Flows

The message flows for signalling explained in the following sections are separated in flows concerning the originating party (A-party) for the advanced addressing and flows concerning the terminating party (B-party) for intelligent communication management. Each of these solutions might be optimal for different services depending on the number of customers and complexity of the service. It has to be analysed in the ongoing work for which type of service which scenario is the best in respect to performance, complexity and security.

2.1 Name Translation Service

Assuming that a name in future telecommunication systems is related to an end user, group of users or functional entities, it does not reflect the home environment. Therefore a translation into a routable address will be necessary. For a name translation service two different basic solutions can be identified. One solution is based on network intelligence and the second on more sophisticated terminals. Both are described in the following sections.

2.1.1 CAMEL / IN Solution

This solution is based on existing and future CAMEL or IN services and is shown in figure 1. To establish a communication, the user enters a name. This is transferred without modifications to the serving switch (GMSC) that is supporting CAMEL / IN functions. The connect request is triggered based on the nature of the address (name) and is sent to a serving CSE in an IDP message. The CSE resolves the name to a routable address and sends this back to the switch.

Two answers are possible. In case A, the CSE returns a routing number (RN) that directs a call to the final destination, e.g., a fixed line. In case B, the CSE returns a service routing number (SRN), e.g., an IMSI that points to a serving HLR of the called party. This allows the switch to establish a GSM/UMTS call set-up and to request a mobile station roaming number (MSRN) that will direct the call to the current location of the mobile user.

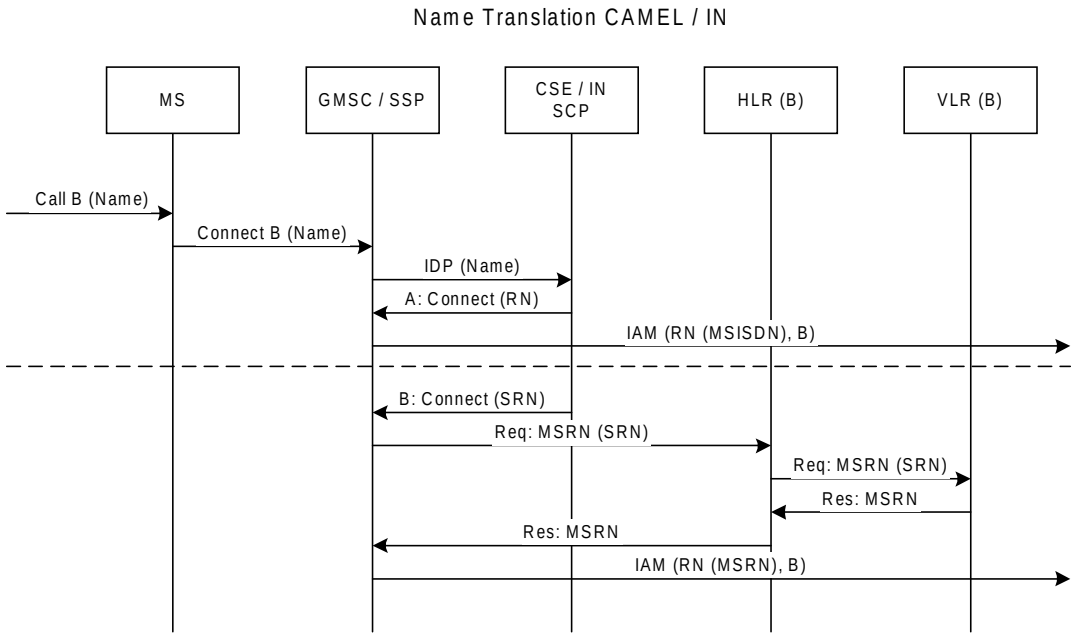

Figure 1: Name Translation CAMEL / IN

2.1.2 Name Service Solution

The second solution is shown in figure 2. It is based on the capability of future sophisticated terminals or smart cards. Again the user enters a name. This is checked with a local cache in the terminal or possibly the smart card. If no entry is available, a database is contacted. The result is stored in the local cache and the call processing will continue. Also in this case the database might answer with a different type of routing numbers (RN) that allows to connect directly to the final destination (A) or to perform a GSM/UMTS call processing (B). Due to the fact that the name routing relation stored in the local cache might have changed, appropriate error procedures are necessary.

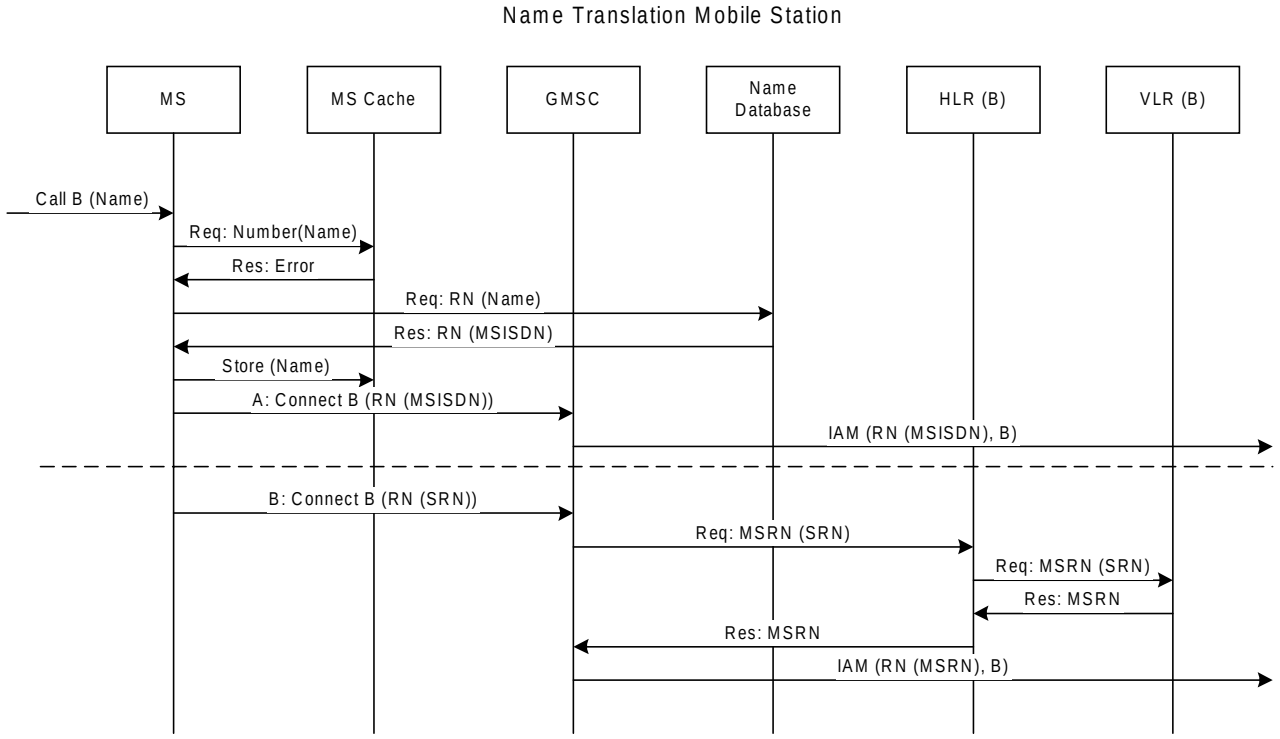

Figure 2: Server Based Name Translation

2.2 Terminating Communication Management Services

For terminating cases mainly two different methods for service provisioning can be separated. Solutions based on CAMEL / IN technology and solutions based on service nodes not within the network. Both solutions can be extended to inter-work with intelligent terminals or smart cards and are explained in the following.

2.2.1 CAMEL / IN Solution including Terminal Interaction

A sophisticated solution is illustrated in figure 3. As in the name translation service, it is assumed that future terminals and smart cards are capable of handling sophisticated applications, e.g., a flexible screening list. This can be realised with an agent that was sent from a central service logic to the terminal. Figure 3 presents the necessary signalling messages only.

An incoming call results in a normal GSM/UMTS call processing except that the switch is advised to monitor a busy trigger detection point (TPD) for this call. The agent of the mobile station analyses the incoming call and decides to return the call control to the CSE (A). It returns the call with a busy condition. Based on this condition the switch contacts the CSE and a result is sent back.

If the agent in the mobile station can decide on its own, it might redirect the call directly using the call deflection (CD) supplementary service.

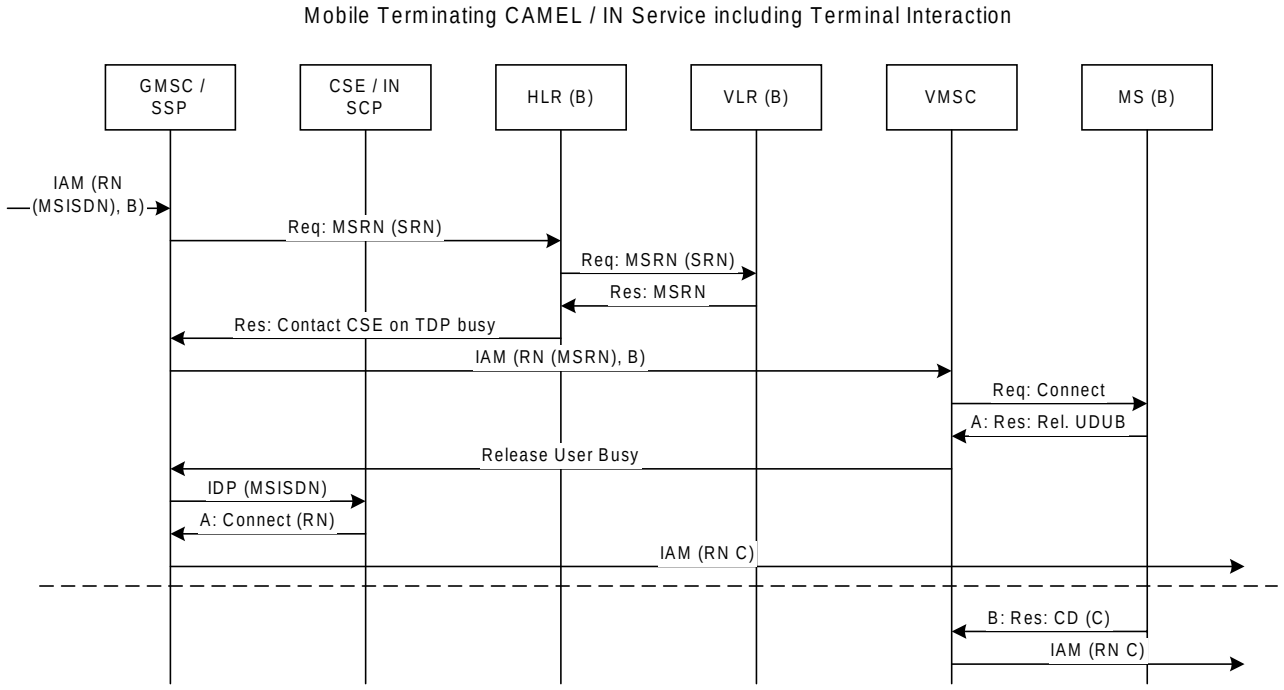

Figure 3: Subscribed Terminated CAMEL / IN Service incl. Terminal Interaction

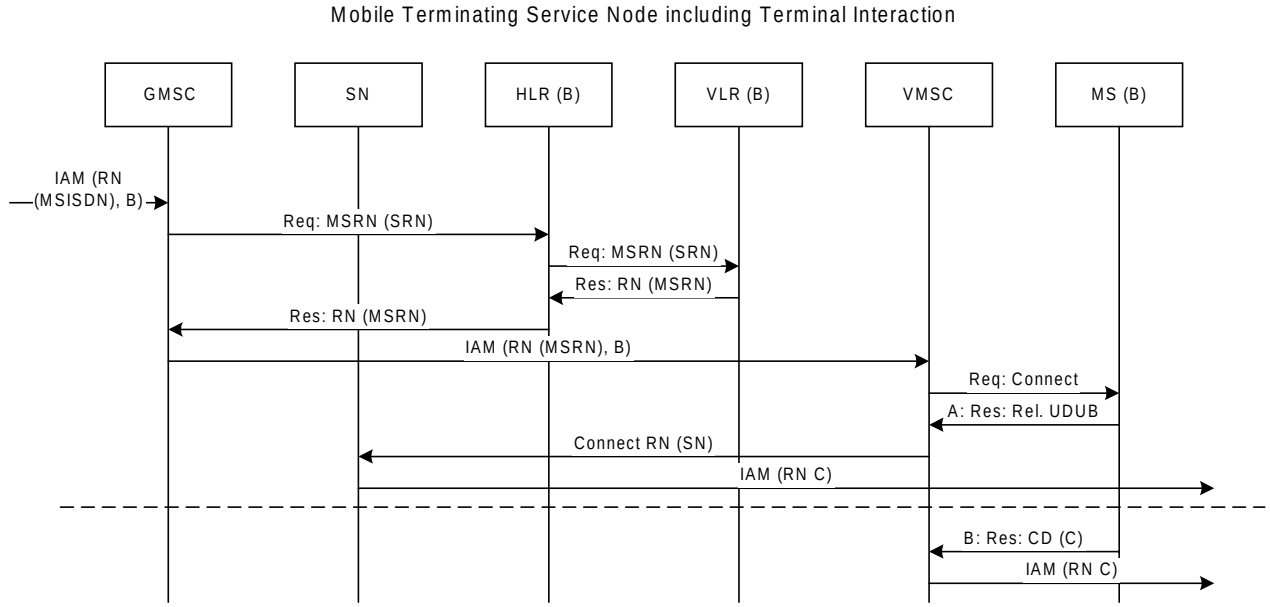

Figure 4: Terminating Service Node incl. Terminal Interaction

2.2.2 Service Node (Intelligent Communication Manager)

A solution with less functionality in the network is the introduction of service nodes. Similar as for the dialled CAMEL / IN services the calls are routed directly to a service platform that is connected to a switch. The service node analyses the call information and redirects the call depending on the service logic (A). Similar as in the name translation the node might answer with an HLR address, depending on the development of future call handling, and allow a direct GSM/UMTS call handing (B) (see figure 4).

Like in the CAMEL case with terminal interaction, the call is routed to the user's terminal first. Depending on the service logic of the agent in the mobile station, the call is routed to the service node using the UDUB (user determined user busy) release cause (A) for further call processing, or to a final destination using the call deflection (CD) function (see figure 4).

Besides call forwarding the service node can provide more possibilities for a user's communications management such as a mailbox for recording incoming communication requests (voice, fax, email), call filtering/rejection and user notification via SMS or email.

Additionally, a combination and conversion of different services is possible, e.g., in order to forward a fax as an email and vice versa to forward a recorded voice message as an email or to read a recorded voice message to the user. This service is called Intelligent Communication Management and will be explained in the context of agent-based service provisioning in more detail in the next section.

3 Agent-based Service Provisioning

In UMTS it will be possible for a user to be associated with one or a number of user profiles, which the user can select and activate on a per call basis. The user profile contains information which may be used to personalise services for the user.

Since the service node can offer a set of complex features for incoming communication requests the user should be able to configure his profile according to his current requirements in a comfortable way, e.g., using a graphical user Interface (GUI). For this purpose the following requirements should be considered:

- cost effective connection management, e.g., no permanent expensive data connection to the service node as long as there are no packet services like GPRS available,
- the possibility to use different terminals for service access, and
- low signalling load across the network.

3.1 Service Provisioning via Agents

With these requirements in mind an agent-based approach will be an appropriate solution. A terminal agent (TA) on the corresponding terminal provides an interface to the user to authenticate himself and request the service (configuration of the service node). This might include, e.g., the advanced addressing functionality. On the service provisioning side provider agents manage the service requests connecting to a central register, where all services should be registered. Before responding to the service request the provider agent has to verify whether the terminal agent on the connected terminal is up-to-date or should be updated. If so, the new version of the terminal agent or sub-agents for specific services will migrate to the terminal and will replace the old one. This automatic version control enables the user to always have the current version of the terminal agent without the need of manual downloading and new services can be added flexibly to the system and can be announced and offered to the user via the terminal agent, see figure 5.

Once the suitable version of the terminal agent is available on the terminal the user can access a service. The terminal agent sends this information to the service node to check whether the user is authorised to access the required service. If so, the service node instructs the corresponding user interface agent (UIA) to move to the connected terminal and provide the appropriate GUI to the user. After a successful service request the provider agent instructs the so called user interface agent (UIA) to transfer the appropriate service specific GUI to the requesting terminal. The chosen GUI is adapted to the network capabilities and the features of the currently used terminal. The required data concerning the network and terminal capabilities are delivered by the terminal agent when connecting the provider agent at the beginning of the session.

After the UIA arrives at the terminal the data connection to the provider agent can be dropped and the user can access the service, e.g., to configure his profile through the corresponding GUI. A data connection should be established after the remote configuration is accomplished in order to update the modified data on the service provisioning side. This is achieved by communication between the UIA and the provider agent service node, e.g., using messaging.

The previous paragraphs described the principal usage of agents. The performance can be enhanced by different methods, e.g., caching agent code and user profile data. The implications of these new possibilities are being investigated in the CAMELEON project.

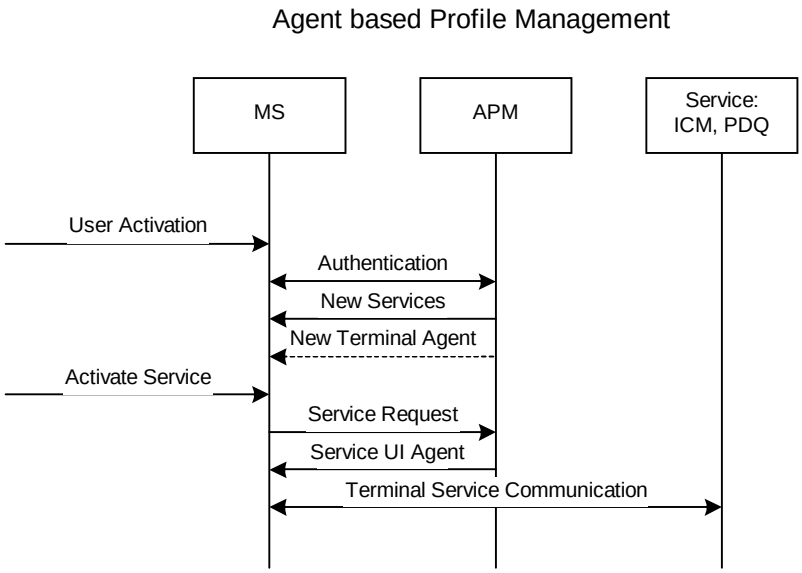

Figure 5: Agent-Based Profile Management

3.2 Service Prototypes

The agent-based approach explained above can also be used for a flexible service provisioning in future communication networks which is currently being investigated within the ACTS project CAMELEON.

The two most important topics for future mobile users will be:

- Easy handling of the desired telecommunication services, including the opportunity to customise the 'look and feel' of services and to subscribe to services 'on demand' easily.
- Global availability and consistent performance of telecommunication services.

In the framework of the CAMELEON project different agent-based service prototypes are being developed and implemented to deliver the VHE concept (Virtual Home Environment) explained above.

One of the CAMELEON prototype implementations is the APM (Adaptive Profile Management) where the focus is mostly on the terminal independent service provisioning which is an essential aspect of the VHE concept and offers the following capabilities:

- Flexible service provisioning
- Remote, network and platform independent modification of all user profiles for different services
- Handling of different terminals with different capabilities for service access
- Ability to dynamically download updated services

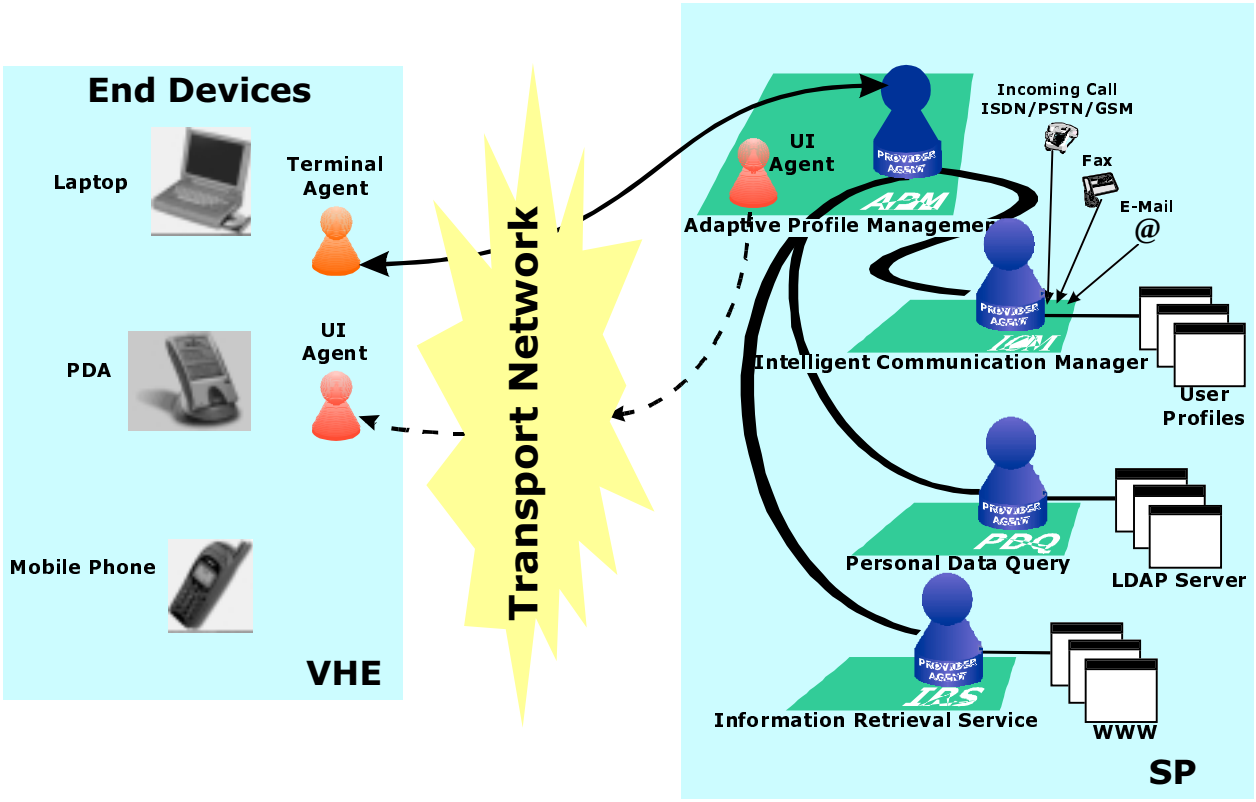

Figure 6: Agent-Based Service Provisioning

Regardless of the available terminal and the underlying platform (e.g., PC, workstation, PDA or mobile phone) the users have the possibility to access their personalised services. The presentation of the services is adapted to the network capabilities and the terminal which is currently used.

Currently, the APM provides access to three sub-services namely ICM (Intelligent Communication Manager), PDQ (Personal Data Query), and IRS (Information Retrieval Service). However, more new services may be added flexibly to the system.

The APM has three different usage aspects which make it suitable for an agent-based implementation: Management, Invocation and Execution. Management refers to the modification of the profiles and is split into user management and automatic sensitive management by the networks. Using agent technology the user can send remote modification messages from any network irrespective of the connection status, etc. Sensitive management will adapt the profile to the terminal and network currently used. This includes adaptation to various user interfaces from PC-screens to mobile telephones with only small displays. Invocation and Execution of the various profiles requires a central service control entity if an agent based solution is not applied. Using agent technology, which is a sophisticated type of distributed processing environment, it is possible to run the service in any network by simply executing one common agent platform for all users.

As mentioned above the APM is on top of other sub-services represented as Provider Agents such as Intelligent Communication Manager (ICM), Personal Data Query (PDQ) and Information Retrieval Service (IRS) which can be accessed terminal independently and can be presented adaptively to the capabilities of the current terminal and network connection (see Figure 6).

Personal Data Query – PDQ

This service offers to the user the possibility to query data from a personal database by SMS (e.g., address, telephone/fax/mobile phone number, email address, birthdays and others).The personal data are stored in an LDAP (Lightweight Directory Access Protocol) database which can be accessed by the PDQ service through JNDI (Java Naming and Directory Interface). This information can either be stored on a local LDAP server or on any LDAP server

which is accessible via the Internet. An incoming SMS contains a personal data query which should be performed by the LDAP server. The results in turn will be sent to the user via SMS.

There are several possibilities to send and receive SMS messages:

- Via air interface if the server is connected to a GSM module
- Sending and receiving SMS messages as email
- Using the ISDN gateway of the SMSC to send SMS messages

Information Retrieval Service - IRS

This service itself is a totally agent-based service offering the user an efficient retrieval service for information, that is distributed over different platforms in heterogeneous networks. An example is the automatic booking of flights or other travel arrangements in the Internet. The user delegates certain functions, e.g., find a flight at a date and time to a certain city, without having to know about details of the task execution. Any information service (e.g., WWW pages, LDAP databases, etc.) with data important for the user can be accessed. The mobile agent with a certain degree of autonomy collects the information and returns with an evaluated result back to the current terminal of the user.

Intelligent Communication Manager - ICM

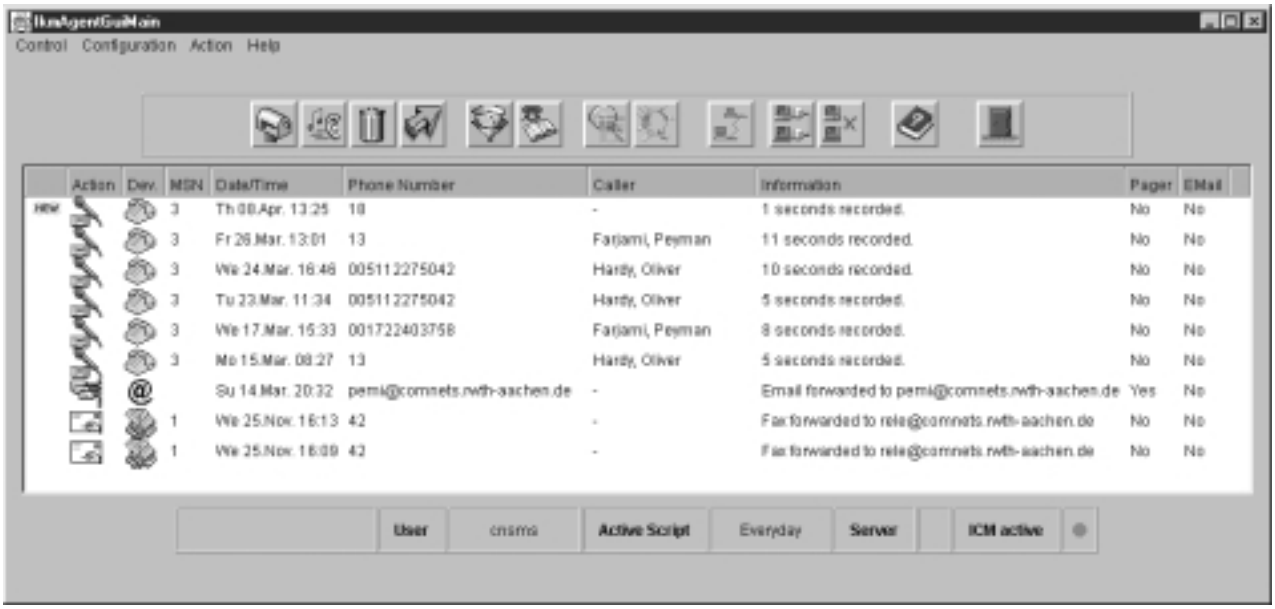

Figure 7: Multi-media mailbox of the ICM

The ICM is the core service of the APM system providing a personal communication environment to the user in order to have a flexible and personalised mechanism to control the reachability for all subscribed communication services.

This service offers the user the possibility to organise and automatically control any kind of incoming communication requests (voice, fax, email, SMS, etc.). The management of personal communication is based on the specification of special conditions (caller/sender, time, subject, etc.) in the so-called user profiles (filter scripts), that can be configured remotely and adapted to the current requirements of the user.

The ICM's main features are as follows:

- Call (voice, fax, email) recording
- Call rejection
- Caller/application interactions via DTMF-detection or voice menu
- Call forwarding/deflection
- User registration/de-registration

- User notification, e.g., via pager service, SMS, or email
- Conversion of recorded voice- and fax messages for sending them as email
- Forwarding of incoming email to a fax machine

A multi-media mailbox informs the user about the recent personal communication activities performed by the ICM, e.g. in order to view the received faxes or emails and to play the recorded voice messages (see Figure 7) [Noll].

All services (ICM, PDQ and IRS) explained above can be accessed over the APM offering the adaptation of the service presentation according to the end device specific parameters.

Conclusion

To meet the requirements of addressing in tomorrow's telecommunication systems, which are a user friendly addressing format and a clear delimitation of different names, addresses and numbers, the presented advanced addressing mechanisms need to be elaborated and analysed in more detail. First studies of communication relations of different user groups have shown that the caching of addressing data in the terminal will increase the performance and decrease the signalling load in the network and the data servers. The introduction of a three layered architecture for naming and addressing purposes is likely to fit the service needs for end users, serving networks and home environments. The possible structure of the new number types like names, service numbers and routing numbers has to be studied in detail.

Sophisticated agent technology and evolving terminal performance will allow the introduction of service logic in the terminal for certain types of services. Agent technology allows the co-existence of different types of agents: e.g., intelligent, autonomous, and mobile. These agents can use the same mechanisms for communication and thus allow a very flexible service architecture. This will lead to more reliable and performant services. A failure of a central service node will affect less users and the intelligent distribution will decrease the signalling load in the network. The results and experiences in the CAMELEON project have shown that agent technology is a very promising field which can be integrated with other technologies (e.g., MExE, SAT, Camel/IN). Mainly security and performance aspects will determine the long term application and inter-working of these technologies in future networks.

Abbreviations

APM	Adaptive Profile Manager
APM-PA	APM-Provider Agent
CAMEL	Customised Application for Mobile network Enhanced Logic
CD	Call Deflection
CSE	Camel Service Environment
GMSC	Gateway Mobile Switching Centre
GPRS	General Packet Radio Service
HLR	Home Location Register
IAM	Initial Address Message
ICM	Intelligent Communication Manager
IDP	Initial Detection Point
IMSI	International Mobile Subscriber Identity
IN	Intelligent Network
IRS	Information Retrieval System
LDAP	Lightweight Directory Access Protocol
PDQ	Personal Data Query
RN	Routing Number
MS	Mobile Station
MSRN	Mobile Station Roaming Number
RN	Routing Number
SAT	SIM Application Toolkit
SMS	Short Message Service
SRN	Service Routing Number
TDP	Trigger Detection Point

TA	Terminal Agent
VLR	Visitor Location Register
UI	User Interface
UIA	User Interface Agent
UA	User Agent
USIM	User Service Identity Module

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