MobileIN: Harmonized services over heterogeneous Mobile, IN and WLAN infrastructures

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Abstract— **The Intelligent Network (IN) concept, extensively applied in PSTN and mobile networks, has introduced a concrete separation between core switching functionality and value added service logic that allowed applications deployment with minimal impact on the underlying network. But, although IN properly addressed the issue of new services deployment, application developers still needed specific telecommunications expertise. Also, application services still need customization so as to bind efficiently the various network technologies and service creation environments such as CAMEL for IN services realisation over mobile networks. The introduction of new services for IN and CAMEL networks typically necessitates extensions to the Capability Sets (CS) supported by the deployed protocols (INAP, CAP, MAP, etc) used for the communication between network elements. Nevertheless, the complexity of existing telecommunication protocols and network architectures have rendered network operators reluctant to adopt the proposed protocol extensions and advanced Capability Sets, despite the relevant standardisation efforts. This is clearly reflected in the case of INAP CS-2, 3, 4, which enjoyed limited acceptance by manufacturers and network operators. MobileIN aims at resolving such problems by elaborating a modular and scalable architecture for the delivery of unified value-added services to Mobile, PSTN, WLAN networks and IP clients. As is illustrated in the last sections, the MobileIN concept is expected to emerge considerable impact on the way IP Multimedia Services (IMS) are provided over next generation network (NGN) technologies.**

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Index Terms— **Mobile, IN, WLAN, Heterogeneous Networks, Harmonised Services, Services Creation and Execution, 3GPP IMS**

I. Introduction

Though Intelligent Networks (IN) have provided a coherent way of decoupling services logic from the network infrastructure, issues mostly related to the realisation of services creation and provision environment on core networks constituted the most serious confinement factors towards agile applications implementation However, IN is a major source of income for telecom operators seeking new ways to preserve their existing services infrastructure, and to further exploit them in the next generation networks with additional value added services. For example, Capability Sets (CS) 2, 3 and 4 offer these capabilities but in order to be facilitated by the operators new infrastructures installations are required.

A standardised framework, enabling the provision of advanced IN services across different operators networks, has been provided by CAMEL (Customized Applications for Mobile network Enhanced Logic). CAMEL adopted the IN architecture in the GSM/UMTS networks. The introduction of new services for IN and CAMEL networks typically necessitates extensions to the Capability Sets (CS) supported by the deployed protocols (INAP, CAP, MAP, etc) used for the communication between network elements. Nevertheless, the complexity of existing telecommunication protocols and network architectures have rendered network operators reluctant to adopt the proposed protocol extensions and advanced Capability Sets, despite the relevant standardisation efforts. This is clearly reflected in the case of INAP CS-2, 3, 4, which have met a very limited acceptance by manufacturers and network operators. Even in the case of UMTS standards, the CS3-4 sets have not yet been exploited. For example, in the TS 123 078, UMTS specification, only Capability Set 2 is being used for CAMEL Phase 3 and 4.

Furthermore, standardised APIs provided a powerful answer to the issue of rapid applications development. Industry initiatives such as JAIN and Parlay have demonstrated that open network Application Programming

Interfaces (APIs) provide the necessary speed of development. Since 2001, ETSI, Parlay and 3GPP have defined the Open Service Access standard (OSA), a collection of open network APIs that allow third party vendors to develop and deploy, applications by accessing the full functionality of the underlying network while still preserving supported logic integrity. However, service triggering and execution is still heavily dependent on switching network elements (MSC, Softswitches, SSPs, etc). This generally can jeopardise network integrity and requires considerably higher effort in the applications integration, testing and launching phases. Additionally, new components should be required so as to enable access to the OSA-based applications. These are the main reasons that no complete OSA applications can be found on the market.

Another aspect prohibiting rapid applications deployment comes out the fact service logic and subscriber data (e.g. user profile, location, etc) cannot be fully isolated physically and logically. In particular, subscriber data are dispersed across different entities (HLR, SCP, etc). This approach has particularly limited the realisation of IN for location-based services, which need to combine subscriber and service data from different operator networks.

In view of this situation, telecom operators seek for new ways of service infrastructures preservation representing a major source of income so as to exploit them in the next generation networkswhere there is considerable demand for customized and personalized services provision in combined multimedia IP applications over WLAN and mobile (GSM/GPRS/UMTS) networks.

II. INTRODUCING THE MOBILEIN CONCEPT IN CORE NETWORKS

The goal of the MobileIN concept is to elaborate a novel set of advanced, future-proof, personalised harmonised services for the mobile user and worker by taking full advantage of heterogeneous service infrastructures (Intelligent Network Services, Mobile Network Services, VoIP Services). The MobileIN concept builds on operators needs for preservation and enhancement of the existing services infrastructures (IN, CAMEL, LBS), instead of replacement so as to provide operators and 3rd party application developers with access to as yet unrealised revenue streams.

In this context, the MobileIN network architecture provides a state-of-the-art open framework for service creation and execution in multi-domain environments that in conjunction with open, scalable service access points will realise and demonstrate the developed sophisticated applications in a composite IP-PSTN-PLMN-WLAN environment. The strength and market impact of the envisaged services will emanate from exploiting the full potential of currently dispersed location information, subscriber data, and application logic, that up-to-date cannot be effectively combined by currently deployed schemes. The MobileIN concept is based on an optimized core network architecture allowing implementation of generic services deployment through the following steps:

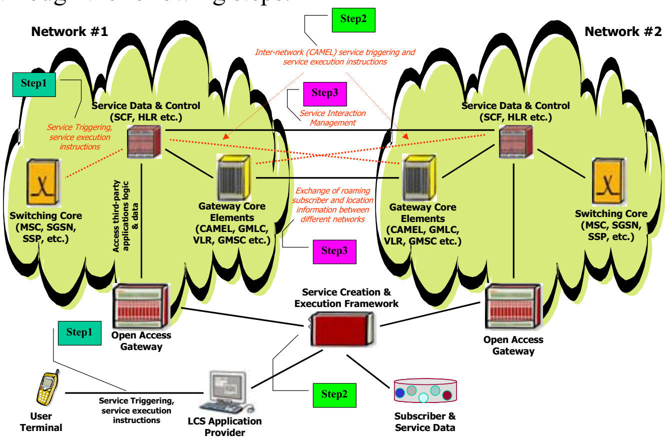

Fig. 1. Steps towards the introduction of MobileIN novel services

A. Step1: Relieve switching core from service execution responsibilities.

The first step towards separation of application logic from the underlying network infrastructure is the isolation of pure traffic switching functions from those sustaining user specific services. This is done by implementing mechanisms for directly triggering service logic at (third-party) applications servers (e.g. gsmSCF), instead of depending on the core network switching entities (e.g. gsmSSF). The proposed approach reduces significantly the risk of jeopardising networks integrity during launch of services. This can be achieved through the use of open access gateways capable of interoperating with terminal applications modules such as J2ME/J2EE and Symbian .

B. Step 2: Decouple IN applications from telecom services.

This step necessitates the development of a unified MobileIN Service Creation and Execution Framework that is used for discovering and accessing service data (e.g. passing mobile user location and/or persistent mobile subscriber information to the PSTN/IN networks) and service management components (e.g. discover an open access gateway that can be used for the control of a core-network switching function). The scope behind this is to extend available state-of-the-art techniques such as OSA and Parlay, providing unified flexible and extendible tools (APIs) for developing services across the PSTN, UMTS, 2G, and WLAN-plant networks.

C. Step 3: Resolve inter-network IN service interaction outside the network.

This step extends the Service Creation and Execution Framework by moving functions implementing to services interoperability issues (e.g. interworking between different networking technologies and protocol variants) outside the networks. The proposed approach complement schemes such as CAMEL, and remove the need for deploying high-cost and typically inflexible signaling-gateway systems. These issues can be effectively resolved with minimum cost/effort by utilising advanced state-of-the-art technologies (e.g. WSDL, SOAP) for achieving applications interoperability.

D. Step 4: Flexibly integrate available intelligent network components.

Another goal to which MobileIN concept aims at also is the preservation of available network operators infrastructure investments and revenues. This implies critical but yet minimal network enhancements/additions to overcome Capability Sets 2, 3, and 4 limited deployment. To achieve this, the MobileIN proposes extensions to standardised IN and CAMEL protocols such as INAP and CAP, while also provides extensions enabling flexible mapping of OSA APIs to CAMEL and IN protocols.

III. MOBILEIN ARCHITECTURE

A general view of the MobileIN network architecture is shown in Figure 2.

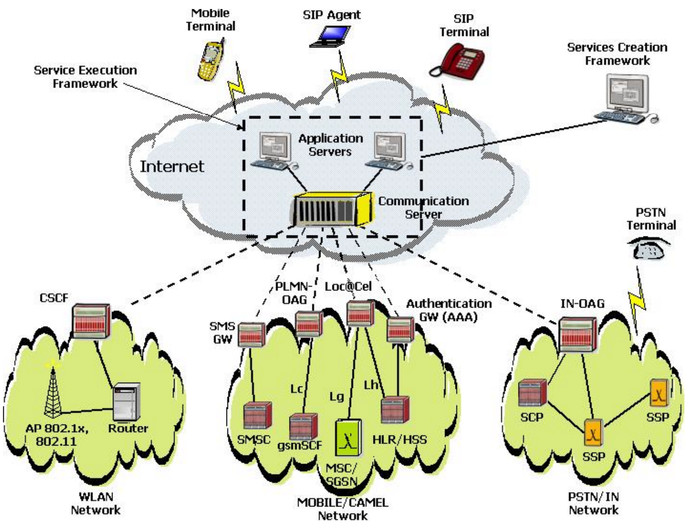

Fig. 2. Overview of the MobileIN network architecture

The **MobileIN Service Creation and Execution Framework (SCEF)** is where the MobileIN services are created, executed and discovered. Application Servers are where the MobileIN Applications are placed, are located on the top of the MobileIN SCEF. The Communication Server hides from the applications the details of communication with the network elements.

The **MobileIN IN Open Access Gateway (IN-OAG)** is an Open Access Gateway that provides interfaces to the IN Core components. It is based on an already available gateway from IST-2001-33465 GEMINI project, which is provided by ALCATEL SEL and enhanced for the purposes of the MobileIN project. The gateway supports the 3GPP 29.198 series of 3GPP OSA APIs in order to provide open, secure interfaces to SCP, SSP core IN components for service triggering and extraction of user-related information.

The **MobileIN PLMN Open Access Gateway (PLMN-OAG)** is an Open Access Gateway that provides interfaces to mobile Core components. The gateway supports a set of 3GPP OSA APIs in order to provide open, secure interfaces to gsmSCF and other core components. The APIs enables the service provider to trigger PLMN CAMEL components for service logic execution (e.g. gsmSCF, gprsSSF etc.).

The **MobileIN Authentication Gateway** was developed in the context of IST-32449 EVOLUTE project by ALCATEL SEL. This gateway provides AAA-HLR interworking capabilities for subscriber and service authentication and authorization between mobile, WLAN and SIP-based networks.

Alcatel brings to the project the **SMS Gateway** available from the IST-2001-35283 POLOS project, which constitutes a low-volume SMS gateway supporting an air interface with the SMSC using a GSM module.

The **Call Session Control Function (CSCF)** is the main entity of the IMS architecture. It is basically a SIP server with additional capabilities and may take on various roles in the IMS.

The **Loc@Cel** is a location server provided by PTIN destined to obtain geographical position of mobile units. It offers several location methods for 2G (GSM), 2.5G (GPRS) and for 3G (UMTS).

At the network level there are three different network environments that will be provided by the operators in the project: Wireless LAN environment, Mobile/CAMEL Network and PSTN/IN Network.

IV. MOBILEIN SERVICES

MobileIN aims to provide a set of services that utilise currently dispersed information (user location information, subscriber data, application logic) that up-to-date cannot be effectively combined by currently deployed schemes such as the CAMEL framework. In addition, it will demonstrate the project concept by providing already defined but not yet realised services in Capability Sets 2-4 for PSTN IN and PLMN CAMEL networks.

In order to offer the aforementioned sets of services, MobileIN through its technical approach tackles the follow limitations:

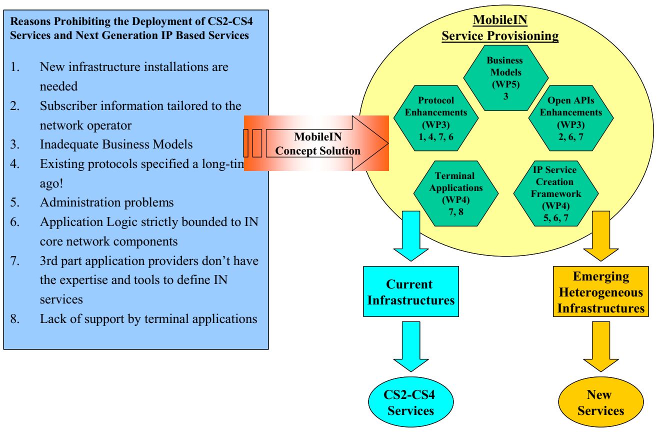

Fig. 3. The Mobile requirement-driven approach

The innovation of the MobileIN services is highlighted in the paragraphs below and they are categorized as follows:

1. **Advanced Location-Based Address translation and Call rerouting/distribution Services:** This category of services involve extending currently deployed address translation and call rerouting/distribution services by introducing the user location aspect, and providing seamless service delivery across different network operators' infrastructures. At least one of the involved parties is a mobile user. The location information of one or more parties is utilised during services execution.

2. **CAMEL-based Services:** Present CAMEL functionality typically involves the handling of PLMN-originated calls on the basis of information regarding the calling/called user numbers, and the calling user location. This information is typically provided to the gsmSCF on service triggering using an InitialDP operation.

Scenarios presented in MobileIN involve the use of extended service logic integrated within a "legacy" CAP-enabled gsmSCF platform. The term "extended service logic" in this case refers to the capability of the gsmSCF to exploit information contained in header fields of an initiating SIP INVITE message. These fields (e.g. From, To, Via, Priority, Organisation, etc) can provide useful user context information affecting service execution.

Other scenarios involve the offering of prepaid services to SIP-based users. The approach described exploits legacy infrastructure investments (gsmSCF) for the offering of prepaid services using standardised interfaces (OSA, CAP, etc). In this sense the operator is offered the opportunity to reuse existing PLMN billing infrastructure instead of duplicating charging systems for legacy and SIP users.

3. **Virtual Calling:** The UPT Service offers the ability to the callers to dial just one number in order to reach the callee. The Mobile-IN Service Creation and Execution Framework (SCEF) will fork the call in all different networks that the callee is subscribed (PSTN, Cellular, WLAN-SIP), causing a sequential or a parallel ringing in all these devices.

4. **VPN:** A virtual private network (VPN) is an imaginary network within a network. VPN gives the service user the feeling of in-house connections to any destination connected, like in a PBX (Private Branch Exchange). In reality, the connections are switched through the public network.

5.**Verification of Internet Access:** The security offered by PSTN is not only applied to the payload of the communication as such, but it can also be used as a tool to safeguard other transactions. As an example, a service provider could be involved in the provision of access control.

6. **Control Access: Incoming Call Screening:** The call screening service feature can constitute part of several service offerings and refers to the possibility of the network/user to authorize outgoing or incoming calls. A service can perform screening associated with either the A or the B party. Screening decisions are taken via the use of screening lists or, more general, tables. Screening lists can typically be managed by a subscriber that may or may not coincide with the end user. The calling user may override the default restriction by giving a PIN.

As a service example, a configuration possibility can be offered to the receiving user, for controlling or authorizing the calls to its PSTN or VoIP phone. Depending upon the complexity, the access and/or the exact deployment architecture, several options are envisaged.

7. **Prepaid:** An Application Server is being used for prepaid subscribers involving either Mobile SIP Terminal origination and WLAN SIP Terminal termination or WLAN SIP Terminal origination and PSTN Terminal termination.

V. MobileIN Services Examples

A. My Favourite Pizza using mobile phone

A user wants to order a pizza in his area. Instead of going through the telephone directory and searching for all the local Pizza delivery houses in the area he decides to use his new mobile phone application called "My favourite Pizza". Based on his location, his mobile phone screen displays a list of Pizza Houses in his area. The user enters his preference and his mobile phone creates a normal GSM call to the Pizza House selected.

The following paragraphs provide a more detailed description for the execution of this service based on the MobileIN network architecture.

Figure 4 summarises the interactions required for the provision of this service, which are specified in the sequel. The communication of the Application Server with the respective network components (i.e. Loc@Cel, IN-OAG) is performed through the Communication Server. For simplicity reasons in the figure above, the Application Server contacts directly the respective network components.

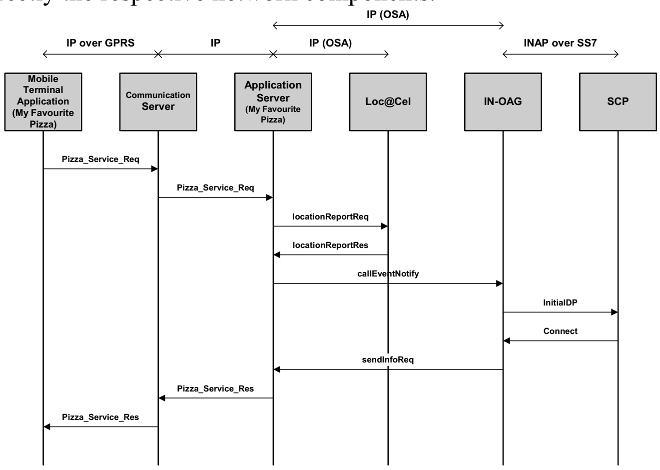

Fig. 4. My Favourite Pizza Service Scenario MSC

1. The "My Favourite Pizza" mobile terminal application requests the "Pizza" service from the Communication Server using the Pizza_Service Req message. This message provides Communication Server with an ID for this specific mobile terminal application, which has been installed to the user's mobile device.

2. The Communication Server searches for the correct and at the same time available Application Server responsible for this service and depending on user's ID. The Communication

Server forwards this service request (including the user's ID) to the "My Favorite Pizza" Application Server using the Pizza_Service Req message.

3. The Application Server, using the locationReportReq function provided by the Loc@Cel OSA API, requests the location of the specific user.

4. The Loc@Cel provides the Application Server with the requested location information for the specific user, using the locationReportRes method of the Loc@Cel OSA API.

5. Having the user's location information, the Application Server using the callEventNotify function provided by the IN-OAG's OSA API, requests from the IN-OAG to provide the Application Server with a list of the available and open at that time Pizza delivery houses in the area accompanied with their telephone numbers based on the user's location. The Application Server submits together with this request the user ID as well as its location (included in the eventInfo parameter) provided by the Loc@Cel.

6. The IN-OAG processes this request and using the InitalDP IN operation contacts the corresponding SCP in order to get the list of the pizza restaurants accompanied with their telephone numbers matching to the location information provided. The code of the service is provided to the SCP using the serviceKey parameter. The locationNumber parameter contains the code of the user geographical area, and the exact geographical longitude and latitude coordinates are included in the Extensions parameter of the InitialDP INAP message.

7. The SCP queries its internal database based on the user's location and using the Connect IN operation provides the IN-OAG with the requested list. The list is encoded in the ExtensionsField of the INAP message. The destinationRoutingAddress of the message contains a code that prompts the IN-OAG to use the destination addresses included in the ExtensionsField.

8. The IN-OAG provides the Application Server with the requested list based on the location information for the specific user, using the sendInfoReq method of the IN-OAG's OSA API. The list is encoded in the info parameter of the OSA function.

9. The Application Server provides Communication Server with the Pizza restaurants list using the Pizza_Service_Res message.

10. The Communication Server using the Pizza_Service_Res message provides the "My Favorite Pizza" mobile terminal application with the list of the available and open at that time Pizza delivery houses in the area accompanied with their telephone numbers based on the user's location. The user receives the list on his mobile phone application screen and is asked to enter his preferred pizza delivery choice. The user enters his preference and the "My Favourite Pizza" application, utilising the phone's call control API and the telephone number provided, initiates a regular call (GSM) to the Pizza restaurant.

B. *My Favourite Pizza using WLAN SIP phone and DTMF tones*

Assuming that a mobile user instead of using his (or her) mobile terminal whishes to use a WLAN terminal. In that case the problem is how to discover the location of that user. In that case we must assume that the application provider must provide an internal (or external) database with the application server, which should contain the location of all the WLAN Access Points in the areas that the application provider whishes to cover.

Imagine a mobile user who is staying in a hotel with WLAN access. This mobile user doesn't know any telephone numbers for ordering pizza from a local restaurant so his using his WLAN terminal initiates a call to well know pizza sip address.

In a more advanced mode the user will have the ability to choose between different pizza restaurants, which are located near to him. To accomplish that we will need an application server that provide a dynamically generated voice menu to the user, and the later could choose among the available pizza restaurants using DTMF tones.

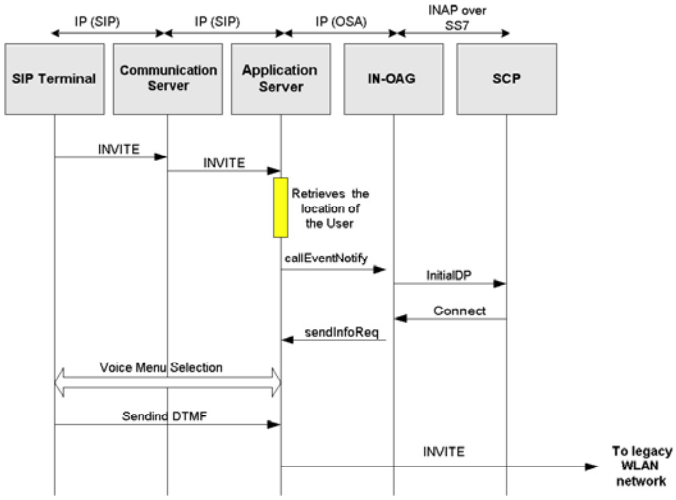

Fig. 5. My favorite pizza using a SIP terminal with pizza restaurant selection

The above Figure 5 summarizes the interactions for the provision of this service, which are described in the following steps. Before starting the scenario description it must be clarified that the communication to and from the Application Server is done through the Communication Server. But in the figures for simplicity reasons the Application Server is presented to communicate directly with all the external entities (e.g OAG, Loc@Cel etc).

1. The user initiates a SIP call by sending an INVITE to "my favorite pizza" sip address (e.g. sip:my_favorite_pizza@MobileIN.org)

2. The INVITE message through the legacy IMS network reaches the MobileIN Communication Server. The Communication Server searches for the correct and at the same time available Application Server responsible for this service. Then the Communication Server forwards this service request to the "My Favorite Pizza" Application Server.

3. The "My Favorite Pizza" Application Server after extracting the IP address of the WLAN Access Point (using the VIA field from the INVITE request) consults its internal (or external) database to retrieve the location of the user.

4. Having the user's location information, the Application Server using the callEventNotify function provided by the IN-OAG's OSA API, requests from the IN-OAG (through the

Communication Server) to provide the Application Server with all the telephone numbers of the nearest pizza restaurants based on the user's location.

5. The IN-OAG processes this request and using the InitialDP IN operation contacts the corresponding SCP in order to get the telephone numbers matching to the location information provided. The code of the service is provided to the SCP using the serviceKey parameter. The locationNumber parameter contains the code of the user geographical area, and the exact geographical longitude and latitude coordinates are included in the Extensions parameter of the InitialDP INAP message.
6. The SCP queries its internal database based on the user's location and using the Connect INAP operation provides the IN-OAG with the requested telephone numbers (provided by the destinationRoutingAddress parameter).
7. The IN-OAG provides the Application Server (through the Communication Server) with the requested list based on the location information for the specific user, using the sendInfoReq method of the IN-OAG's OSA API. The list is encoded in the info parameter of the OSA function.
8. The Application Server establishes a voice channel with the user and by a voice menu asks him to choose between the available pizza restaurants.
9. The user in order to provide his to the Application Server dials the requested DTMF tones.
10. Finally the Application Server initiates another call to the selected pizza restaurant and utilizing the 3rd party call control functionality that it has, provides this call to the existing session with the user.

VI. Conclusions

This paper has presented a modular and scalable architecture for the delivery of value-added services to Mobile, PSTN, WLAN and IP-based clients in a unified way.

Behind MobileIN concept, the motivation was to stimulate new techniques for supporting generic services creation and instantiation and over existing and next generation network infrastructures. MobileIN resolves efficiently this issue by providing:

- A set of novel harmonised services for the mobile user and worker by taking full advantage of heterogeneous service infrastructures (Intelligent Network Services, Mobile Network Services, VoIP Services etc).
- A set of extensions and additions to existing IN and CAMEL protocols and services like INAP and CAP in order to incorporate not yet deployed services from Capability Sets 2, 3, and 4 as well as to integrate the new MobileIN location aware services.
- A complete architecture comprising of a) a service creation and execution platform b) application servers and c) three prototype open access gateways for the interworking of the application framework with core PSTN IN, Mobile CAMEL networks and LBS components.

References

[1] MobileIN IST-2002-004498, Annex I "Description of Work"

[2] MobileIN IST-2002-004498 Deliverable D21 "MobileIN Architecture, Requirements and High-Level Specifications"

[3] MobileIN IST-2002-004498 Deliverable D22 "MobileIN Functional and Technical Specifications"