Pasi Tuominen

Cellular prepaid service in an environment of multiple intelligent network protocols

A Master's Thesis submitted to examination for the degree of Master of Science in Electrical Engineering in Espoo, Finland on the 8th of June, 1999

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In this Master’s thesis, I have studied how to implement a prepaid service in circumstances where various protocols for intelligent networks are available. New capabilities are introduced by each protocol standard. By merging the ‘best’ parts of these specifications, an optimal solution can be obtained. The goal was to achieve an improved service concept of prepaid service for cellular networks.

The concept of intelligent networks is introduced. The components that are included in an IN environment are presented. The protocol specifications needed to standardise the interfaces between these entities are concentrated on. The variations between the protocols for fixed and mobile networks are studied. Based on this, the capabilities that are feasible to implement as a cellular service are chosen.

The system architecture of a SCP product is introduced. This system is called Intelligent Network Server and is based on the Tandem platform.

It is proposed that the introduction of the new service concept would be done stepwise. The modifications needed in the network components for each phase are considered. After the final step, Call Party Handling of the CS2 and Location information handling of the CAMEL are taken into use in mobile network environment. The user interaction in announcement interface is enhanced, too.

The evolution of the Internet towards the telecommunication networks is considered. The first applications are proposed. They are based on and can be taken as enhancements to the existing network structure.

The proposed service concept is found attracting to the market of cellular networks. Combining the IN protocols for mobile and fixed networks is challenging but the outcome would provide a network operator with the edge to gain market share.

Keywords: Intelligent network, CAMEL, CS2, WIN, Prepaid service


Avainsanat: Älyverkko, ennakkomaksupalvelu, CAMEL, CS2
Preface

I wrote this Master's thesis in the ICL Finland, Telecomms department. I would like to thank my colleagues in ICL for giving me the opportunity to focus on this work. Special thanks go to Tapani Lehtinen, the instructor of my work, and to Seppo Kallasmaa, the senior system specialist, for their inspiring insights. I am grateful to professor Iiro Hartimo, the supervisor of my work, for his valuable advice helping me in the process.

My beloved wife, Maiju, with her constant encouragement deserves the greatest thanks.

In Helsinki, the 8th of June, 1999

Pasi Tuominen
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### Abbreviations

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<th>Description</th>
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<tbody>
<tr>
<td>AIN</td>
<td>Advanced Intelligent Network</td>
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<td>ANSI</td>
<td>American National Standards Institute</td>
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<td>BCQM</td>
<td>Basic Call State Model</td>
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<td>CCF</td>
<td>Call Control Function</td>
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<td>CEG</td>
<td>Communication Event Group</td>
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<td>CLID</td>
<td>Calling Line Identification</td>
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<tr>
<td>CO</td>
<td>Central Office</td>
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<tr>
<td>CP</td>
<td>Connection Point</td>
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<td>CPE</td>
<td>Customer Premises Equipment</td>
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<td>CPH</td>
<td>Call Party Handling</td>
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<td>CS</td>
<td>Call Segment</td>
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<tr>
<td>CSA</td>
<td>Call Segment Association</td>
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<tr>
<td>CSTA</td>
<td>Computer Supported Telecommunication Applications</td>
</tr>
<tr>
<td>CS1</td>
<td>Capability Set 1</td>
</tr>
<tr>
<td>CS2</td>
<td>Capability Set 2</td>
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<tr>
<td>CS3</td>
<td>Capability Set 3</td>
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<tr>
<td>CT</td>
<td>Computer Telephony</td>
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<td>CTI</td>
<td>Computer Telephony Integration</td>
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<td>CUSF</td>
<td>Call Unrelated Service Function</td>
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<td>CVS</td>
<td>Connection View State</td>
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<td>Abbreviation</td>
<td>Description</td>
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<tr>
<td>DFP</td>
<td>Distributed Functional Plane</td>
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<td>DP</td>
<td>Detection Points</td>
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<td>DTMF</td>
<td>Dual Tone Multi Frequency</td>
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<tr>
<td>EDP</td>
<td>Event Detection Point</td>
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<tr>
<td>EO</td>
<td>End Office</td>
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<tr>
<td>ETSI</td>
<td>European Telecommunication Standardisation Institute</td>
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<tr>
<td>FE</td>
<td>Functional Entity</td>
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<td>FSM</td>
<td>Finite State Machine</td>
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<td>HLR</td>
<td>Home Location Registry</td>
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<tr>
<td>IH</td>
<td>Interface Handler</td>
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<tr>
<td>IN</td>
<td>Intelligent Network</td>
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<td>INAP</td>
<td>Intelligent Network Application Protocol</td>
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<td>INF</td>
<td>Intelligent Network Forum</td>
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<td>IP</td>
<td>Intelligent Peripheral</td>
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<tr>
<td>ISDN</td>
<td>Integrated Services Digital Network</td>
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<tr>
<td>IS-41</td>
<td>Interim Standard 41</td>
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<tr>
<td>ITU-T</td>
<td>International Telecommunication Union – Telecommunication Standardisation Sector</td>
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<tr>
<td>IVR</td>
<td>Interactive Voice Response</td>
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<td>PIC</td>
<td>Points In Call</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<td>--------------------------------------------</td>
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<tr>
<td>PIN</td>
<td>Private Identification Number</td>
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<tr>
<td>PNP</td>
<td>Private Numbering Plan</td>
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<tr>
<td>POI</td>
<td>Point Of Initiation</td>
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<td>POR</td>
<td>Point Of Return</td>
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<td>PSTN</td>
<td>Public Switch Telephone Network</td>
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<tr>
<td>PTN</td>
<td>Personal Telecommunication Number</td>
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<tr>
<td>SCE</td>
<td>Service Creation Environment</td>
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<td>SCF</td>
<td>Service Control Function</td>
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<td>SCP</td>
<td>Service Control Point</td>
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<td>SDF</td>
<td>Service Data Function</td>
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<td>SIB</td>
<td>Service Independent Building Blocks</td>
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<td>SMS</td>
<td>Service Management System</td>
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<tr>
<td>SN</td>
<td>Service Node</td>
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<td>SRF</td>
<td>Specialised Resource Function</td>
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<td>SSF</td>
<td>Service Switching Function</td>
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<tr>
<td>SSP</td>
<td>Service Switching Point</td>
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<tr>
<td>SS7</td>
<td>Signaling System No.7</td>
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<tr>
<td>STP</td>
<td>Signaling Transfer Point</td>
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<tr>
<td>TCAP</td>
<td>Transaction Capability Part</td>
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<td>TCB</td>
<td>Transaction Control Block</td>
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<tr>
<td>TCP</td>
<td>Transaction Control Protocol</td>
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<tr>
<td>TDP</td>
<td>Trigger Detection Point</td>
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<tr>
<td>UI</td>
<td>User Interaction</td>
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IX
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>UPT</td>
<td>Universal Personal Telecommunications</td>
</tr>
<tr>
<td>VLR</td>
<td>Visitor Location Registry</td>
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<tr>
<td>VoIP</td>
<td>Voice over IP</td>
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<tr>
<td>VPN</td>
<td>Virtual Private Network</td>
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<td>VRU</td>
<td>Voice Response Unit</td>
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1. Introduction

The 'Prepaid service' is an increasingly popular service concept offered by telephone network operators. It can be implemented in several different ways in service control environment. In this thesis, the opportunities offered by various protocol specifications for intelligent networks are studied and based on those, a new IN prepaid service concept for cellular networks is introduced.

The creation of switched network services depends more and more of Intelligent Networks. When IN services are compared to switch based services one can see the difference in the flexibility in modifying a service. A switch based service is limited to few options that may be changed by either the service provider or the customer. If a modification of the service logic is wanted it has to be done by conceptual changes in the switch.

Currently, there is a distinction in the IN protocols between the mobile and fixed telephone networks. The CS2 is designed for fixed network needs and therefore the special requirements of cellular networks, like terminal mobility (roaming), should be met with a modified standard. For this purpose, there already exists a new standard specification called CAMEL [1] but this contains very limited set of capabilities compared to the CS2.

The capabilities of IN are standardised in order to offer a generic interface for various components in the network. Currently a second phase of these standards, called CS2, is being implemented by manufacturers and operators [2]. Among the new issues brought by CS2 the introduction of multi party call control (named as Call Party Handling) is considered to be particularly interesting.

Currently there are two standardisation bodies, ITU-T and ETSI, that define the IN standards for fixed networks. The CPH concept was introduced to standard as informative text in the appendices of ITU-T recommendations [3] and [4], which suggest a partial solution in IN CS1. Not until IN CS2, however, was a more complete solution to CPH standardised using the so called 'Connection View State' approach.
At the same time with the evolution of CS2 there has been a work going on to develop the CAMEL specification. This work is aimed to enhance the IN capabilities of mobile networks.

The manufacturers of telecommunication switches are required to follow these standards. This must be done in order to ensure the compatibility of the network components from various vendors.

The aim of this thesis is to implement an improved version of the prepaid service for cellular network environment. Amongst the various protocols for intelligent networks an optimal combination of the existing standards is picked up to build up a new service concept. This service concept is the first one to utilise the capabilities of both CS2 and CAMEL in a single service.
2. Background

2.1 Intelligent Network (IN)

2.1.1 Description

The Intelligent Network (IN) is a distributed network architecture designed to provide a rapid deployment and custom configuration of telecommunication services. The architecture is service-independent and features migration of service logic away from the traditional central office switches to network elements that can be easily managed and controlled. As a result, IN-based features can be both service independent and switch independent. It should be noted however that the switch must have some basic and common IN capabilities including detection of a trigger, and communication with service logic elements that may act upon the call (based upon specific service logic).

2.1.2 IN architecture and components

The Intelligent Network (IN) consists of the Service Switching Points (SSP), Signalling Transfer Points (STP), Service Control Points (SCP), Service Creation Environment (SCE), Service Management System (SMS), and the Intelligent Peripherals (IP, not to be confused with the Internet Protocol). It may also contain an adjunct or Service Node (SN).

According to the International Telecommunications Union (ITU) terminology, these components are represented by logical functions. A description of the physical components is provided in the figure below.
Figure 1: IN network architecture

The protocol families are defined in a standardised structure. The network architecture is divided into several hierarchical levels. There exists a similarity with the OSI model layers, although the model is not very strictly followed.
The telecommunication services, one of which is the prepaid service, are on the top level of this model. Intelligent network protocols, like CS2 or CAMEL, are located in the lowest level.
There are several families of IN protocols. CS1 and CS2 are based on the work of the
international standardisation bodies ITU-T and ETSI. The CAMEL protocol is mainly a
subset of CS1 and is aimed for cellular networks.

2.1.3 ANSI standards
For the market of the United States, there is a similar distinction between the protocols
for IN, like in the Europe; 'advanced IN' (AIN) is the fixed network protocol and the
'wireless IN' (WIN) is the cellular one. [5]

2.1.3.1 Standardisation bodies
Subcommittee TR-45.2 shall co-ordinate, for the purpose of consistency, and to promote
efficient and timely development of standards, with other Subcommittees within TR-45,
other TR Committees, other international, foreign or national standards bodies and
appropriate industry organisations as their work requires. Subcommittee TR-45.2 shall
support efforts to promote standards developed within the Subcommittee at
international, foreign or national standards forums [6].

Subcommittee TR-45.2 operates within the Mission Statement of the
Telecommunications Industry Association (TIA) and under the direct supervision and
guidelines of Committee TR-45.

The Standards development programs of Subcommittee TR-45.2 operate under the
accreditation awarded to the Telecommunications Industry Association by the American
National Standards Institute. Subcommittee TR-45.2 operates under the guidelines of
the Telecommunications Industry Association.

2.2 IN Services
IN provides for the rapid deployment of services in a cost-efficient manner by an
effective use of system resources.

With powerful functionality such as originating and terminating call screening, flexible
routing, flexible billing, number translation, voice processing and data processing, many
IN or Advanced Intelligent Network (AIN) services can be offered. Examples include:

- Number Translation Services
• Freephone Services

• Premium Rate Services

• Personal Number

• Single Number Services

• Local Call Rate

• Fax

• Find Me Services

• Follow Me Services

• Originating/Terminating Call Screening

• Virtual Private Network Services

• Voice and media processing services such as voice recognition

• Card Services

• Proprietary Card

• Prepaid Card/Debit Billing

• Commercial Card

• Mobile Services

• Call Forwarding

• Calling Party Pays

• Simultaneous Ringing

• Sequential Ring

• Carrier Selection Services

• Interactive Voice Response (IVR) Service
In addition to new revenue-generating opportunities, the capability to apply call control and call manipulation at both the originating and terminating end helps improve network cost efficiencies and minimises the cost of resource utilisation. For example, trunk connections do not need to be set up in advance when placing a long distance call. They are only set up once it is determined that the called party is available.

2.2.1 Prepaid service

The prepaid service is a card service where a subscriber can access a mobile network without a permanent contract with an operator. Although initially introduced to attract the 30 percent of all applicants that could not obtain wireless service because of their credit profile, prepaid service is attracting other segments of consumers.

To attract new customers, the prices of prepaid calls are usually set at lower level compared to ‘traditional’ mobile subscriptions.

Prepaid has exploded in Europe. For example, about 95 percent of Telecom Italia Mobile’s (TIM) new customers chose a prepaid option during the year 1998 [7]. Prepaid represents more than 40 percent of TIM’s customer base. The same trend can be seen in the Latin America, where a Mexican wireless operator, Telcel, offers several prepaid plans, which attributed significantly to its 100 percent increase in new customers in the year 1998.

Wireless service providers in the United States did not launch multiple prepaid plans until the year 1998. Those who decide to use prepaid wireless service include students, security-only users, budget-conscious users, corporations seeking to limit non-business use, subscribers wanting to remain anonymous, and users who do not wish to sign a service contract. As an example, the operators BellSouth Mobility and SBC Mobile in the US are pursuing the prepaid market aggressively. BellSouth plans to sign up 30 percent to 40 percent of its new customers on prepaid options, while SBC Mobile seeks to sign up 20 percent.

Prepaid plans enable mobile network operators to avoid costs associated with billing, bad debt, customer service, and acquisition. This compensates the lower revenues generated from prepaid customers.
2.3 Intelligent network server (INS)

The system called 'IN server' (INS) is the product on which the IN services are built. This system is based on the hardware architecture of the Tandem computers. The Compaq telecommunication network system (CTNS) is the provider of INS.

Tandem Intelligent Network Server SCP platform is based on Tandem Himalaya series RISC hardware and Non Stop Kernel (NSK) and Signalling Terminal 2000 (ST2000) SS7-gateway [8]. It offers common SCP services for the applications including MTP- and SCCP-protocol handling, statistics collection, job scheduling, alarm and event distribution, Service Execution Logic (SEL) run-time environment etc.

Applications running on top of the platform software are responsible of validating and parsing TCAP- and INAP-messages, collecting statistics and implementing the Service Execution Logic.

Standard Tandem tools and methods are used to ensure fault tolerance and to meet the high availability demands of the telephone network element. These methods include both mirrored disks; battery backup's and other hardware related methods and primary/backup applications. The scalability of Tandem hardware offers possibility to upgrade the system up to 100 CPU's with linear performance gain.

The Service Control Point (SCP) is a network element that provides the Service Control Function (SCF). The SCP functionality resides on a Tandem Himalaya hardware platform executing the Tandem NonStop Kernel (NSK) operating system and is composed of the following software:

- Intelligent Network Server (INS) platform middleware
- Shared IN application utilities
- Service Logic Control Engine (SLCE)
- Service Element’s (SE)
- and if deployed on the existing SCP platforms:
  - Number Translation Services (NTS)
- Calling Card Validation (CCV)
- Switch Initiated Update (SIU)

### Figure 4: SCP applications

| SCP | Shared Utilities | SLCE API 
<table>
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<tbody>
<tr>
<td>NTS, CCV, SIU</td>
<td>Utilities API</td>
</tr>
<tr>
<td>SE 1</td>
<td>SE2</td>
</tr>
<tr>
<td>INS API</td>
<td>INS Middleware</td>
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#### 2.3.1 Himalaya Hardware Platform

The Tandem Himalaya hardware platform consists of loosely coupled multiprocessors which provide both hardware and software fault tolerance and are designed to fit into the power and environmental requirements of the standard Central Office, or switch site. These systems are linearly expandable, multiprocessor systems, designed for continuous availability. Each system is expandable up to 16 processors in a single node. Under normal operation within each node, all processors share the workload. In the event that a processor fails, the workload of that processor is taken up by the others, without the need for operator intervention.

#### 2.3.2 NonStop Kernel (NSK) Operating System

NonStop Kernel is a message-based operating system specifically designed to support the parallel architectures like the Tandem's system. Working in conjunction with the
distributed hardware, it provides the foundation for fault tolerance, high performance and linear growth, security, data integrity, and distributed data.

2.3.3 Intelligent Network Server (INS) Middleware

The Intelligent Network Server (INS) middleware consists of both software and hardware. The software is a layer between the NSK functionality and the Intelligent Network (IN) applications and provides a set of services common to all IN applications. It provides for highly efficient transaction processing and replication and management of SCP processes.

If the solution is deployed on the K-Series version of the product, the hardware consists of the INS Communications Server (INS) which provides a signalling link interface to the network. The INS consists of distributed microprocessor based controllers that each provide unique functions, such as link processing, communication to host, and general purpose processing. The INS along with its resident software provide the Message Transfer Part (MTP) and Signalling Connection Control Part (SCCP) layers of the SS7 protocol required to interconnect to other network elements.

If the solution is deployed on so called ‘S-Series’, the hardware consists of the ServerNet Wide Area Network (SWAN) controllers, which provide the signalling link interface to the network. Each SWAN component consists of three microprocessor based controllers that each provide the MTP Level 2 functionality of one signalling link required to interconnect to other network elements. The remainder of the protocol stack resides in the S-Series CPUs. The SWAN enclosure is connected to the S-Series host via Ethernet links to a ServerNet resident Ethernet I/O card. As the next development step of the product, the SWAN units will be replaced with ServerNet resident I/O controllers, referred to as Klamath, that provide the MTP Level 2 functionality.

2.3.4 INS as a platform for prepaid service

The presented system architecture provides a flexible setting for the prepaid service. The cellular prepaid requires good scalability from the platform because of the rapid increase of the number of new customers in mobile networks. INS offers to a network operator easily scalable hardware architecture. This is important in today’s prepaid market where high volumes of subscriptions may arise in a relatively short time. In tight competitive
situation, customers tend to choose an operator who can offer an instant access to mobile services.

The characteristics of the prepaid service include a short lifecycle of a subscription. A customer may hold a contract for only a few days. This sets high demands to the maintainability of the customer database. The available service management environment meets well these requirements, too.
3. Protocol specifications for IN

3.1 CAMEL

Customised Applications for Mobile network Enhanced Logic (CAMEL) is a protocol specification designed for IN services in a mobile network. It originates from the CS1 and in fact is its subset when viewed into the INAP (or CAP as it is called in CAMEL) interface. However, there is another important dimension in CAMEL. That is the ability to communicate with the location databases in VLR and HLR. This allows the introduction of terminal mobility with the network intelligence. Those capabilities, when combined, open up a new point of view to the world of telecommunications.

3.1.1 The phases of CAMEL

CAMEL is developed in two phases. In the first phase, the basic terminal mobility is defined for IN services. The mobile originated and mobile terminated call related activities are included in this specification. For the CAMEL phase 2, the supplementary service invocations are added.

The mechanism described addresses especially the need for information exchange among the PLMN, HPLMN and the CAMEL Service Environment (CSE) for support of such operator specific services [9]. The second phase of CAMEL enhances the capabilities of phase 1. Following new topics were added:

- New trigger detection points were defined.

- It is possible to interact with a user using announcements, voice prompting and information collection via in band interaction or USSD interaction.

- It is possible to control the call duration and to transfer e-values from a serving node to the mobile station.

- The CSE can be informed about the invocation of GSM supplementary services (ECT, CD, MPTY).

- For easy postprocessing, charging information from a serving node can be integrated in normal call records.
3.1.2 Architecture

3.1.2.1 Functional Entities used for CAMEL

The functional architecture needed to support CAMEL is described. Also the additions needed to the basic GSM functionality are described. Figure 1 shows the functional entities involved in calls requiring CAMEL support. The architecture is applicable to the second phase of CAMEL.

![Diagram of CAMEL architecture](image)

**Figure 5:** Functional architecture for support of CAMEL

3.1.2.1.1 HLR

The HLR stores for subscribers requiring CAMEL support the information relevant to the current subscription regarding O-CSI, T-CSI, TIF-CSI, U-CSI and SS-CSI. The UG-CSI is stored as global data applicable to all CAMEL subscribers. The O-CSI is sent to the VLR in case of Location Update or if the O-CSI is updated. The SS-CSI is sent to the VLR in case of Location Update or if the SS-CSI is updated. The O/T-CSI is sent to the GMSC when the HLR responds to a request for routing information. The TIF-CSI, U-CSI and the UG-CSI are stored in the HLR only. The HLR may provide an interface towards the gsmSCF for the Any Time Interrogation procedure.
3.1.2.1.2 GMSC
When processing the calls for subscribers requiring CAMEL support, the GMSC receives an O/T-CSI from the HLR, indicating the GMSC to request instructions from the gsmSSF. The GMSC monitors on request the call states (events) and informs the gsmSSF of these states during processing, enabling the gsmSSF to control the execution of the call in the GMSC.

3.1.2.1.3 MSC
When processing the calls for subscribers requiring CAMEL support, the MSC receives an O-CSI from the VLR indicating the MSC to request instructions from the gsmSSF. The MSC monitors on request the call states (events) and informs the gsmSSF of these states during processing, enabling the gsmSSF to control the execution of the call in the MSC. When processing an invocation of any of the supplementary services ECT, CD and MPTY, the MSC receives a SS-CSI from the VLR, indicating that a notification of the invocation of the supplementary service shall be sent to the gsmSCF.

3.1.2.1.4 VLR
The VLR stores the O-CSI and SS-CSI as a part of the subscriber data for a subscriber roaming in the VLR area.

3.1.2.2 Interfaces defined for CAMEL
The different interfaces applicable to CAMEL are described. In this thesis, the interfaces related to the gsmSCF are considered. The functions specific to CAMEL are specified on a high level.

3.1.2.2.1 HLR - VLR interface
This interface is used to send the CAMEL related subscriber data to the visited PLMN and for provision of MSRN. The interface is also used to retrieve subscriber status and location information of the mobile subscriber or to indicate suppression of announcement for a CAMEL service.
3.1.2.2 GMSC - HLR interface

This interface is used at terminating calls to exchange routing information, subscriber status, location information, subscription information and suppression of announcements. The O/T-CSI that is passed to the IPLMN is sent over this interface.

3.1.2.2.3 gsmSSF - gsmSCF interface

This interface is used by the gsmSCF to control a call in a certain gsmSSF and to request the gsmSSF to establish a connection with a gsmSRF. Relationships on this interface are opened as a result of the gsmSSF sending a request for instructions to the gsmSCF.

3.1.2.2.4 gsmSCF - HLR interface

This interface is used by the gsmSCF to request information from the HLR. As a network operator option the HLR may refuse to provide the information requested by the gsmSCF. This interface is also used for USSD operations, both for gsmSCF-initiated dialogues and MS-initiated dialogues (relayed via HLR). It is a network operator option whether to support or not USSD operations on this interface.

3.1.2.2.5 gsmSCF - gsmSRF interface

This interface is used by the gsmSCF to instruct the gsmSRF to play tones/announcements to the users.

3.1.2.2.6 MSC - gsmSCF interface

This interface is used by the MSC to send supplementary service invocation notifications to the gsmSCF.

3.1.3 Description of CAMEL BCSMs

3.1.3.1 General Handling

The BCSM is used to describe the actions in an MSC/GMSC during originating, forwarded or terminating calls. The BCSM identifies the points in basic call processing when Operator Specific Service (OSS) logic instances (accessed through the gsmSCF) are permitted to interact with basic call control capabilities.
3.1.3.2 Originating Basic Call State Model (O-BCSM)

The O-BCSM is used to describe the actions in an MSC during originating (MSC) or forwarded (MSC or GMSC) calls. When encountering a DP the O-BCSM processing is suspended at the DP and the MSC/GMSC indicates this to the gsmSSF which determines what action, if any, shall be taken in case the DP is armed.

3.1.3.2.1 The DPs of the O-BCSM

- DP2 (Collected_Info), TDP-R. Indication that the O-CSI is analysed.
- DP4 (Route_Select_Failure), EDP-N, EDP-R. Indication that the call establishment failed.
- DP5 (O_Busy), EDP-N, EDP-R. Indication that a busy indication is received from the terminating party.
- DP6 (O_No_Answer), EDP-N, EDP-R. Indication that an application timer associated with the DP6 expires.
- DP7 (O_Answer), EDP-N, EDP-R. Indication that the call is accepted and answered by the terminating party.
- DP9 (O_Disconnect), EDP-N, EDP-R. A disconnect indication is received from the originating party or from the terminating party.
- DP 10 (O_Abandon), EDP-N. Indication that a disconnect indication is received from the originating party during the call establishment procedure.
- DP 50 (O_Not_Reachable), EDP-N, EDP-R. Not reachable event can be determined upon a cause IE in the ISUP release message.

3.1.3.3 Description of Terminating Basic Call State Model (T-BCSM)

The T-BCSM is used to describe the actions in a GMSC during terminating calls. When encountering a DP the T-BCSM processing is suspended at the DP and the GMSC indicates this to the gsmSSF which determines what action, if any, shall be taken in case the DP is armed.
3.1.3.3.1 The DPs of the T-BCSM

- DP12 (Terminating_Attempt_Authorised), TDP-R. Indication that the T-CSI is analysed.
- DP13 (T.Busy), EDP-N, EDP-R. Indication that a busy indication is received from the destination exchange.
- DP14 (T_No_Answer), EDP-N, EDP-R. Indication that an application timer associated with the DP14 expires.
- DP15 (T_Answer), EDP-N, EDP-R. Call is accepted and answered by terminating Party.
- DP17 (T_Disconnect), EDP-N, EDP-R. A disconnect indication is received from the terminating party or from the originating party.
- DP18 (T_Abandon), EDP-N. A disconnect indication is received from the originating party during the call establishment procedure.
- DP51 (T_Not_Reachable), EDP-N, EDP-R. Not reachable or call establishment failure event can be determined from the HLR or upon a cause IE in the ISUP release message.

3.1.4 Any time interrogation

It shall be possible for the CSE (as part of an OSS, including special handling of mobile terminating calls) to interrogate for information about a particular subscriber, for which it is entitled to do so (e.g. the subscriber belongs to the same HPLMN as the CSE). The retrieved information can be subscriber status or location information.

3.2 CS2

The concept of CPH is presented first by the new services that are allowed with CS2 and then the modifications in the protocol specification.

3.2.1 New services

The starting point for CS2 was set by so called benchmark services. This set of services was seen as the driving force for a new standard. In the appendix1 these services are
listed. Following services require CPH capabilities when implemented as IN based services:

- Call transfer: supports the transfer of an active call from one party to another
- Call waiting: allows an incoming call to be answered when subscriber is participating in another call
- Conference calling: enables three or more parties to participate in a call
- Call hold: allows a call party to be put on hold
- Call retrieve: enables the retrieval of a call party from hold
- Call toggle: supports the ability of a subscriber to toggle between multiple call parties
- Secure answering: requires the called party to provide authentication information before participating in a call

These services require the ability of IN to request changes to the connectivity of a stable call.

3.2.2 CPH of CS2

CPH brings several benefits for the development of services. As was explained earlier, the service creation with IN is far more flexible compared to tailoring the switch based services.

The ability to play an announcement during a stable call enables the IN service logic to support audible calling name delivery and sophisticated charging services. The CPH capabilities defined in IN CS2 build on numerous industry contributions to the understanding of how IN control may be applied to multiparty calls.

CPH is realised in IN CS2 by making mid-call events visible to IN service logic and allowing the SCF to modify the connectivity of the call. Service logic can request changes related to the basic call state model (BCSM), which is a finite state machine describing the progress of a call. It can also request specialised resources to perform user interaction with one or more parties during a stable call.
ITU-T Q.1224 [10] describes the Connection View State approach (CVS) [11,12] to support CPH. To realise CPH, the CVS approach supports the following IN capabilities:

3.2.3 Call processing events

Call processing events are events that may be reported to an SCF during stable call. For example, a hook-flash is reported to a SCF as a mid-call trigger. To support CPH, the SSF may detect triggers and requested events in the context of a call. In the first case, a trigger is armed statically, as a TDP, at the SSF. When the trigger goes off and this is reported to the SCF, an IN service is invoked. In the second case, a requested event is armed dynamically, as an EDP, by the SCF and the service logic is informed in case the event occurs.

3.2.3.1 Atomic operations sent by a SCF

Atomic operations, i.e. not divisible into more elementary operations, are sent by a SCF to request a change in connectivity, a new BCSM state, or user interaction. These operations may be sent either in response to a trigger or requested event, or asynchronously e.g. on expiration of a SCF timer. Transitions from one CVS to another occur as a result of SSF processing of atomic operations.

A set of atomic operations has been added to IN CS2. They are used to request a change in connectivity. In the following, these operations are categorised according to the Connection View object on which they act.

3.2.3.1.1 Leg

- MoveLeg: moves a leg from one CS to an associated CS.
- SplitLeg: creates a new CS in the CSA and moves the indicated leg to this new CS. This effectively puts the leg on hold.
- DisconnectLeg: releases the resources associated with the indicated leg.

3.2.3.1.2 Call Segment

- MergeCallSegments: merges two associated CSs into a single CS. All legs are attached to the remaining Connection Point.
• MoveCallSegments: moves a CS from one CSA to another. This is useful, for example, in associating an incoming call with a stable two-party call to realise call waiting.

3.2.3.1.3 Call Segment Association

• CreateCallSegmentAssociation: creates a new empty CSA. To add a CS to this CSA, for example, MoveCallSegments would subsequently be issued.

3.2.3.2 Mid-Call User Interaction

For IN CS2, an SCF may request the SSF to connect one or more end users to an SRF during stable call. The SRF may interact with end users, for example, by playing an announcement and collecting digits. To support mid-call user interaction, the following IN CS1 operations have been extended:

• ConnectToResource: requests the switch to connect end users to an SRF.

• PlayAnnouncement: requests a SRF to provide an announcement, tone, or display text to the end users.

• PromptAndCollectUserInformation: requests a SRF to prompt the end users for input. The SRF sends any information collected from the end users to the SCF.

The extensions for IN CS2 enable us to specify, to which end users the interaction applies. Mid-call user interaction may be requested for a:

• Leg: to play a tone, or send display text to the leg.

• CS: to play an announcement, or prompt and collect user information. The treatment is applied to all legs in the CS.

3.2.3.2.1 An example procedure

In the following an example of a CPH call flow is described (Fig.6). It is the functional model required for a ‘Secure answering’ service. The notations used correspond to the CVS model.
1. Mid-call event

Figure 6: An example of CPH
A mid-call event (1.) is reported to the SCF. As a response, SCF sends a SplitLeg operation (2.), which puts the passive leg on hold. After that, the SCF addresses a ConnectToResource and PlayAnnouncement operations (UI) to each CS. When the user interaction is complete, a MergeCallSegments (3.) operation restores the original two-party call.

3.2.3.3 Functionality
The goal is to allow the system to control two separate UI dialogues with both parties being involved in an IN-call. Two options are available to handle this functionality. The first one is within the existing CS1 architecture, the second one is introducing the CS2-architecture defined by ITU-T and ETSI. The CS1 variant is not reusable for the final CPH solution and therefore it will not be implemented. On the other hand it is feasible to create the CS2 structure right from the start.

3.2.3.4 CS2 architecture
In the CS2 structure the theoretical model is enhanced. Three new components have been added. A CS (Call Segment), a CSA (Call Segment Association) and an IH (Interface Handler).
3.2.3.4.1 CS

A Call Segment represents the view that SCP has of the legs being connected from one to another in a so called 'connection point'. With each CS a BCSM (Outgoing or Terminating) and a Finite State Machine for CS is coupled.

The first component indicates which are the points in call where the SCP wants to be only notified or alternatively wants the CCF to freeze the processing and wait for further instructions.

The second component is a Finite State Machine formatting validated received operations into CCF call handling instructions (e.g. arming dynamic detection points). On the other hand, the CCF events are transformed into operations sent to the SCP (e.g. hit detection points).

3.2.3.4.2 CSA

Once a leg has been disconnected (not released) from a connection point (e.g. to be able to set up another connection) a new CS (and therefor a new connection point) is created. Creation of a CS is a function of the CSA. Both created CSs are associated but they do
not know of the existence of each other. The CSA controls both CSs and the interface towards the SCP. A specific Finite State Machine will handle this functionality.

### 3.2.3.4.3 IH

For each call needing a SCP interaction, a dialogue with the SCP will be set up. There can be several interaction dialogues running simultaneously. It is the IH’s function to create the CSAs and to route each operation to a corresponding CSA.

### 3.2.4 Charging issues

The CS2 specification does not put a lot of emphasis on the charging functions. Therefore these issues have to be handled in other forums.

A call with multiple legs is difficult to map to current charging scenarios where there is only a single B leg configuration defined. Further development of standards is needed. This can be done either at national level or at higher level, f. ex. by ETSI. In the first case, the definitions may be tailored for country specific needs and thus quickly taken into use. The second case means perhaps more delay introducing the charging concept, but on the other hand offers a universal solution.

### 3.3 TIA standards

The standardisation organisation, called TIA, in the United States has defined its own specifications for IN. The organisational structure is shown in the appendix 3. They have a common background with the European standards but there are some differences in some extent. The signalling traffic variations in these architectures compared to the European ones are minimal. A notable detail is the handling of the announcement interface. There is used a simpler way of connecting a calling party to announcement device.

### 3.4 Conclusions

The current development phase of mobile networks does not support the CPH capabilities defined in CS2 but a limited selection of these functions can be introduced in mobile environment, too. Terminal mobility must be allowed with the support of IN services. The CAMEL specification offers the means for global service management.
4. Prepaid service

This chapter presents a service concept that is based on the cellular prepaid service. Compared to the traditional prepaid service concept, the following capabilities are added: the enhancements into user interaction interface, e.g. playing of announcements, using the CPH. To effectively support terminal mobility, the capabilities of CAMEL are included, too.

4.1 Description

The prepaid service allows the mobile customer to pay for telecommunications services prior to usage. In European market, a common way to implement a prepaid service is to charge the outgoing calls. The usual billing practice in US, called post usage billing, allows the subscriber to pay for telecommunication services after usage with proper credit in place. Prepaid service concept enables the service operator to control, limit and prohibit the calls of a service user based on pre-defined amount of charging units.

Prepaid is an IN implementation of a pre-paid cellular service, utilising existing and new IN infrastructure in a mobile network. Prepaid allows GSM subscribers to control their expenditure on cellular services by charging their accounts with credit and having their balance decremented in real time as calls are made. Once credit has expired, the subscriber is restricted from making most calls, although the subscriber will continue to receive calls for a configurable period of time.

A prepaid subscriber establishes an account with the service provider to access telecommunications services in home and roaming networks. Charges for these services are applied to the subscriber’s prepaid account by decrementing the account in real time. The prepaid subscriber may be notified about the account information at the beginning, during or at the end of the service via tones or announcements or short message service. When the account balance is low, the subscriber is notified so that the subscriber may replenish the account. When the account balance is below a pre-defined threshold, the subscriber’s use of telecommunications services is de-authorised. The subscriber may replenish the account by calling a specific prepaid replenishment directory number.
A chargeable event is any event initiated either by the network or the user that may result in a decrement of the prepaid account balance. A chargeable event may occur during a telecommunication service. A chargeable event has a beginning and an end, which are used to start and stop the corresponding prepaid invocation.

4.2 Optimised service concept

Amongst the protocol variations presented above, an optimal set of operations is selected in order to construct the prepaid service for cellular network. This concept compromises the standard specifications by mixing their capabilities but enables a sophisticated solution to meet the requirements of flexibility in mobile services.

The prepaid service is built based on the enhanced leg management and announcement handling capabilities of CS2 and the terminal mobility functions of CAMEL.

The basis of the solution is the combination of CPH and CAMEL. The functions brought by CPH provide us with an user-friendly interface. The usage of CAMEL would extend the geographical usability of this service outside the home network of a subscriber. To enhance the performance of the service logic, the IP handling is adapted from the IS41.

4.2.1 Leg management

In the prepaid service, the most critical phase of a call, when viewed from the end user's perspective, is the sending of a notification to a caller about his credit. At this moment, the other telephone user would be left without any notice about what is going on. The situation can be improved by using the CPH at this phase of the call.

The service logic can issue the connection to be split into two separate call segments. The first segment would then serve the calling party's connection to an IP and the second one takes care of informing the called party. In the split phase of a call the calling party can deal with his account replenishment while the called party might be encouraged to purchase a prepaid card of his own. After the customer care procedures are finished, the call segments can be joined together, again.

In the CS2 context, the connection to IP uses the signalling link quite heavily. The service logic has to control first the initiating SSP and then the assisting SSP during the
same connection phase. If this procedure repeats with the other call segment as well, the signalling load would grow to unwanted figures. Therefore, for each call segment, an operation ‘CCDIR’ can be sent. In this concept, the SCP only waits the reports from each call segment of completed IP procedures.

CS2 offers also new methods to support the IP interface. With so called ‘script’ operations the SCP can order freely definable media functions, or scripts, to be recorded or played. This capability brings even more possibilities to the enhancement of service logic without increasing the complexity of the IN platform.

4.2.2 Terminal mobility

The enhancements to mobile network intelligence presented in the CAMEL specification would cause some additional load to the service logic and the signalling links. When a mobile station leaves its home network, the only possibility to keep on offering IN services to it is to update the service logic with the information about the location of the subscriber. The SCF can request location information from the HLR (which asks this from the VLR) of a subscriber. Having this information available, the services can be extended, for example, to allow a lower charging rate for connections originated from the home network compared the ones from visiting network.

4.3 The choice of a technology

To effectively support prepaid service in a mobile network we need to utilise the Camel protocol. This allows us to cope with the roaming cases, too. However, the Camel, even the phase 2, is somewhat limited in offering means for sophisticated services. More options for service development is introduced with the CS2 protocol.

4.3.1 The comparison between protocols

The capabilities of protocols Camel and CS2 are compared on the basis of the INAP interface definition concerning the similar operations. On top of that, CS2 brings new possibilities in handling the connections to IP. These include the so called ‘Script operations’, that is the ability of the specialised resource function to allocate freely definable UI scripts to be recorded by and played to an user.
The basic operation set required in a Prepaid service contains the opening of the IN dialogue with an operation ‘Initial Detection Point’. Then the service logic sets the time limit for the connection according to the credit limit of the calling subscriber. This is indicated in the sub-parameters of the operation ‘Apply Charging’. The appearances of these operations are compared parameter by parameter between Camel and CS2.

The wireless IN protocol defined for the US market is corresponding to the Camel of Europe. The concept based on CS2 and Camel is definable for the WIN, too. The different philosophy between the IS41 and INAP is illustrated in the following table. The announcement playing functions are not necessarily controlled by the SCF in IS41, but they can be handled by the serving MSC. On the other hand, the credit limit supervision is supported by the SSF of INAP but in IS41, it has to be solely controlled by the SCF.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>IP</th>
<th>SCP</th>
<th>SMSC</th>
<th>IS41</th>
<th>INAP</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>&lt;</td>
<td>&lt;</td>
<td>ORREQ</td>
<td>InitialDP?</td>
<td>SCP checks balance</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>&gt;</td>
<td>&gt;</td>
<td>Oreq</td>
<td>Continue?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>&lt;</td>
<td>&lt;</td>
<td>ANLYZD</td>
<td>InitialDP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>&gt;</td>
<td>&gt;</td>
<td>Anlyzd</td>
<td>RRE,SCI,AC,AC,Continue</td>
<td>SCP instruct MSC to proceed</td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>&lt;</td>
<td>&lt;</td>
<td>O_ANSWER</td>
<td>Call is answered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f</td>
<td>&gt;</td>
<td>&gt;</td>
<td>CCDIR</td>
<td>SCP instruct MSC to play announcement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g</td>
<td>&lt;</td>
<td>&lt;</td>
<td>Cedir</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h</td>
<td>&gt;</td>
<td>&gt;</td>
<td>HCPC,ETC</td>
<td>Send call to IP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>&gt;</td>
<td>&gt;</td>
<td>ARI</td>
<td>IP Requests instructions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>j</td>
<td>&lt;</td>
<td>&lt;</td>
<td>PA</td>
<td>SCP instructs IP to play “bleep”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>k</td>
<td>&gt;</td>
<td>&gt;</td>
<td>SRR</td>
<td>IP reports to SCP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>l</td>
<td>&gt;</td>
<td>&gt;</td>
<td>DFC,</td>
<td>SCP instructs MSC to reconnect call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>m</td>
<td>&lt;</td>
<td>&lt;</td>
<td>O_DISCONNECT</td>
<td>AC, Call is disconnected by MSC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>&gt;</td>
<td>&gt;</td>
<td>o_disconnect</td>
<td>Continue</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Comparison between IS41 and INAP

4.3.1.1 Connecting to IP

When the service logic wants to connect a caller to an announcement using INAP, it has to create the controlling connection to the IP with the help of a MSC. This is done by sending the operation ‘Establish temporary connection’ (ETC) to SSP. The MSC acting as a SSP receives this operation and consequently sends an ‘Initial address message’ (IAM) to an ‘assisting SSP’ to request assistance for playing announcements. After that, there exists a signalling connection between the SCP and the assisting SSP.
If the SSP is equipped with an internal IP, there is no need to route to an assisting SSP. Instead, an operation 'Connect to resource' (CTR) is used to invoke the integrated announcement device. After the controlling connection is established, the next operation would be 'Prompt and collect' (PAC). This is used to play an appropriate announcement to and to gather information from a caller, most usually dialled digits. The PAC operation is issued as many times as needed in the service in question. The service logic controls the user interaction procedure and expects reports from the SSP of each transaction.

In case of 'IS41', the procedure is simpler on the point of view of the SCP. The service logic need to send a single operation, CCDIR, to control the IP connection. When the SSP receives this operation, it relays the controlling operations towards the IP and takes care of the whole procedure until ready to report the completed announcement cycle to SCP.

4.4 Location information

A subscriber in a mobile network can be tracked down by its location information. Based on this information, the calls can be charged accordingly. For example, if a mobile station is detected to be located in an office (outside of his home cell), a higher tariff could be applied compared to home usage. In the following, the operations for handling the location information defined in CAMEL are presented. The procedures of the interface signalling between IN components are described in the appendix 2.

4.4.1 gsmSCF to HLR information flows

The service logic can obtain information from the HLR of a subscriber. This message interface is needed in cases where a subscriber is roaming in a visiting network.

4.4.1.1 Any Time Interrogation Request

The location information and the status of a mobile subscriber is stored and updated by the HLR. This data is needed in order to control the IN service. The SCF requests the necessary data from the HLR to point its signalling connection to a correct MSC in a visiting network.
4.4.1.2 Unstructured SS Request

This operation is used to fetch data of activated supplementary services from the subscriber's database.

USSD-Arg ::= SEQUENCE {
    ussd-DataCodingScheme USSD-DataCodingScheme,
    ussd-String USSD-String,
    ...
}

4.4.2 HLR to gsmSCF information flows

4.4.2.1 Any Time Interrogation res

HLR returns the data requested by SCF with this message.

4.5 Handling of announcements

The INAP specifications define the announcement resources as intelligent peripherals (IP). They are pieces of equipment that play pre-recorded announcements to and are capable of receiving information from a caller. The received information can be dialled digits or spoken words, depending on the complexity of the concept of the IP.

The announcements of a prepaid service are mainly used for managing the credit balance of a subscriber. A caller may open up his account when connected the first time to a credit service. After the initialisation of an account, a caller may at any time add up his credit to allow himself more airtime.

4.5.1 CS2 enhancements

A more user-friendly solution of playing announcements can be implemented by means of the leg management of CS2. For example, if a caller's credit limit is about to run short, the service logic can instruct an announcement to both parties of the call. The calling party would hear a notification of his low balance and would be given a possibility to update his credit instantly. At the same time, the called party would hear another announcement that asks him to hold on for a while. After these procedures, the legs can be joined again.

The protocol level for the CPH was defined earlier. The announcements can be activated with the new operations that allow scripts to be used in the IP interface. These scripts
are freely modifiable media functions that allow sending and receiving of, not just speech, but other forms of information as well.

4.6 Procedures of the SCF

The operations used in the service are described in the Appendix 4. They carry the following information:

The dialogue is opened with the operation ШР. This operation contains the identity information of the calling subscriber. Based on this information, the gsmSCF sends an inquiry about the location information of the calling subscriber. The HLR of the calling subscriber receives this message. If it notifies that the subscriber is currently in a visiting network it sends a request to the VLR in order to get the current location information. This data is returned to the gsmSCF.

The SCF may decide whether to allow the call origination from a visiting network, if this is the case. It can set a special charging rate and inform the caller about this. The call is routed (by SSP) to the destination number and the SCF stays in the monitoring state.

The service logic can activate a 'Heartbeat' function in the operation AC, which causes the intermediate reports to be generated by the SSF. When the SCF receives an intermediate ACR, it sends again a request to the HLR to clarify the location of the subscriber. If the subscriber has moved to another network during the connection the SCF can run the checks about the allowed geographical locations and assign a new charging rate or prohibit the continuation of the call.

The announcement dialogue is opened for both calling and called subscribers. This is possible with the CPH operations. A 'Split Leg' operation divides the connection into two separate connection configurations or call segments. In this state, an announcement can be played simultaneously to both parties and further media functions may be performed with an operation 'Script Run'. The original A-subscriber is advised to update his credit, if it is about to run short. The B-side may receive information and hear advertisements. The SRF returns information about the completed UI-phase with the operation 'Script Event'.

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The legs are joined again together with the operation 'Merge Call Segments'. The SCF issues another 'Apply Charging' operation and returns to the monitoring state.

4.7 Business Functions

The network operator or a service provider has to maintain the prepaid service subscriber databases in order to generate profit from this service effectively. Most of these actions are performed dynamically for a subscriber as calls are made and the service logic is invoked. Each of these functions are managed in the service logic of the SCP. The following business functions are required in the prepaid service:

4.7.1 Subscriber Management

This is the management of subscriber specific data used by the prepaid service for a mobile user. This function includes the following business functions:

4.7.1.1 Subscriber Connection

A mobile user purchases a prepaid contract and his account is assigned into the system.

4.7.1.2 Subscriber Disconnection

The credit account of a mobile user is empty and he does not want to continue his subscription.

4.7.1.3 Subscriber Reconnection

A mobile user with a previous account wants to purchase a new contract though being disconnected earlier.

4.7.1.4 Subscriber Transfer

A subscription to a service profile may be transferred to another one.

4.7.1.5 Subscriber Migration

A mobile user wants to use another service provider. It may migrate from one service provider to another with the migration function.
4.7.1.6 *Subscriber Updates*

The information stored in the database of an subscriber is updated.

4.7.2 *Service Management*

This is the management of non-subscriber data used by the Prepaid service. This function includes the following business function:

- Tariff Management

4.7.3 *Service Control*

This function is used to control the processing of IN calls and includes the following business functions:

- Call Rating (for:)
  - Mobile Originated calls made in the HPLMN
  - Mobile Originated calls made in the FPLMN (Roaming)
  - Mobile Terminated calls received while in the FPLMN (Roaming)
  - Mobile Originated Short Message Service requests (SMS-MO)
  - CallBack Voice Alert (Ring Back call)
- Call Barring
- Account Balance Maintenance

4.7.4 *Re-charge*

This function is used to allow subscribers to increase their balance via credit/debit card or a voucher.

4.7.5 *Service Data Function*

This function is used to provide access to customer and network data for real time access by the Service Control function.
4.7.6 Data Interchange
This function is used to exchange Subscriber Management Data and Service Management Data with external (i.e. non-Prepaid) systems.

4.7.7 Voucher Generation
This function is used to generate voucher information to be used to print vouchers.

4.7.8 Voucher Management
This function is used to manage the voucher database.

4.7.9 Notification
This function is used to provide real time notification of events to users to the system. The users of the system to which notification of events is passed includes:

- Mobile Station
- Telecommunications Managed Networks (TMN)

4.7.10 Collecting Information
This function is used to collect information, which is used to process Prepaid or Recharge calls, in real time. Information about the following is collected:

- Mobile User
- Voucher
- Credit/debit card

4.7.11 Accounting
This function is used to bill a Service Provider for charges incurred by the subscribers belonging to the Service Provider.

4.7.12 Reporting
This function is used to provide management information reports for the Prepaid service and its components.
4.8 Prepaid with IS-41 / WIN

When a subscriber, that is using the prepaid service, places a call, the dialled digits are received by the Serving MSC. At this point, the Initial_Origination trigger is encountered. When the Serving MSC detects the Initial_Origination trigger, it sends the OriginationRequest invoke message to the SCP associated with the trigger and waits for a response. The SCP must verify that the subscriber has prepaid assigned and activated and validate the prepaid account balance. If the checks are met, the SCP starts a CRAA timer and returns the OriginationRequest return result to the MSC. If the checks are not met, the SCP must send the appropriate announcement to the prepaid subscriber.

When the MSC receives the OriginationRequest return result message, it analyses the dialled digits and prepares to route the call. At this point, the Calling_Routing_Address_Available trigger is encountered. When the Serving MSC detects the Calling_Routing_Address_Available trigger, it sends the Analyzed invoke message to the SCP associated with the trigger and waits for a response. The SCP stops the CRAA timer. The SCP may send announcements to the subscriber about the prepaid account balance at this point. The SCP must calculate the Best Guess Charge Rate for the call at this point. Once the Charge Rate is calculated, the SCP sets the Answer timer and sends the Analyzed return result message to the MSC.

The MSC extends the call and waits for answer.

When the called party answers, the O_Answer trigger is encountered. When the Serving MSC detects the O_Answer trigger, it sends the OAnswer invoke notification message to the prepaid SCP associated with the trigger. The call is cut through and connected and the MSC waits for the call to complete. The SCP stops the Answer timer. The SCP must calculate the Exact Charge Rate for the call at this point and start continuous decrementing of the prepaid account balance. The SCP sets a watchdog Maximum Disconnect timer and waits for the next event from the MSC.

If the Calling Party disconnects first, the O_Disconnect trigger is encountered. When the Serving MSC detects the O_Disconnect trigger, it sends the ODisconnect invoke message to the SCP associated with the trigger and waits for a response. The SCP stops the Maximum Disconnect timer and stops decrementing the prepaid account balance.
The SCP sends the ODisconnect return result message to the MSC. The SCP clears the prepaid application context for the call.

If the Called Party disconnects first, the O_Suspend trigger is encountered. When the Serving MSC detects the O_Suspend trigger, it sends the OSuspend invoke message to the prepaid SCP associated with the trigger and waits for a response. The SCP stops the Maximum Disconnect timer and stops decrementing the prepaid account balance. The SCP may send announcements to the subscriber about the prepaid account balance at this point. The SCP sends the OSuspend return result message to the MSC. The SCP clears the prepaid application context for the call.

If the account balance reaches an assigned threshold, the SCP must take appropriate action.

If any of the timers expires (CRAA, Answer or Maximum Disconnect), the SCP must take appropriate action.

4.8.1 Announcements/IP Interface
Announcements may be sent during Call Origination from the prepaid subscriber via the AnnouncementList parameter from the SCP in OriginationRequest, Analyzed and OSuspend return result messages to the Serving MSC. Announcements may be sent during Call Delivery to the prepaid subscriber via the AnnouncementList parameter from the SCP in the Analyzed return result message to the Originating MSC. In this case, the MSC is responsible for playing the tone or announcement and is not capable of collecting information from the subscriber.

Alternatively, a Specialised Resource Function (SRF) may be located on an Intelligent Peripheral (IP) device. A special interface is used to send announcements and collect responses from the subscriber via the IP. The MSC is responsible for connecting the subscriber to the IP. The SCP controls the functions of the IP. The IP interface is especially useful for account replenishment.

The following messages make up the IP interface:

- SEIZRES
Announcements may be sent during Call Origination from the prepaid subscriber via the IP interface after the OriginationRequest, Analyzed and OSuspend invoke messages are received by the SCP. It is not possible to send announcements via the IP interface during Call Delivery to a prepaid subscriber.

When the SCP determines that an IP is required to play an announcement to the prepaid subscriber, it sends a SeizeResource invoke message to the IP identifying the necessary resource and requesting routing instructions. When the IP receives the SeizeResource invoke, it allocates a TLDN to the appropriate resource and returns the SeizeResource return result with the TLDN to the SCP. The SCP sends a ConnectToResource invoke message to the Serving MSC with instructions to set up a call to the IP. The MSC sets up the call to the IP. When the call is detected at the IP, the IP sends an InstructionRequest invoke message to the SCP requesting call processing instructions. The SCP sends a SpecializedResourceFunctionDirective to the IP indicating the announcement to play. The IP plays the announcement and sends the SRFDirective return result to the SCP. The SCP sends a DisconnectResource invoke message to the MSC and the InstructionRequest return result to the IP. The Serving MSC disconnects the call to the IP. The SCP-IP conversation is concluded.

If the MSC is unable to establish the connection to the IP, the ConnectionFailureReport message is sent to the SCP.

4.9 Installing the service

The requirements for the introduction of this new service concept into network are the system updates in the IN elements. A starting point would be an existing IN based
prepaid service of a service provider who wants to extend the service into more flexible context.

As the first step, the terminal mobility would be unleashed with the CAMEL functions. This affects SCP, SSP, HLR and VLR systems. Between those components, the location information must be processed and transmitted. For each connection from a subscriber to the service logic the location data of the user is checked. Modifying the network components is a fairly straightforward task. The outcome from this update would already cause trembles to the current cellular services market. The first implementation of terminal mobility will attract a huge amount of new business and home users.

The leg management enhances even further the possibilities for creating services. This development step is possible provided that SSP supports the significantly more complex architecture of CPH compared to CS1 world. From the point of view of the SCP, the increased need of capacity is merely linear, not exponential.

The final modification concerns the announcement interfaces. The intelligent peripheral equipment (either internal or external) should be able to support the full scale of media contents. Both the SCP and the IP must be able to support the operation set containing the script operations.

By taking the proposed actions, a network operator or a service provider achieves the technological edge that helps it to beat the competitors in the fast moving mobile services market.
5. Internet protocol and IN

The convergence of IN and the Internet would provide us with enormous possibilities of creating new services. However, the reliability problems of IP networks slow the evolution down. Therefore, one should remain in the 'traditional' network architecture as long as the obstacles with IP are beaten.

The primary problems related to the convergence of IN and IP lie in the overlap period. Existing equipment of operators should be replaced by ones supporting the IP signalling. As long as the risk level of gaining profits with the new technology is higher compared to old concept the old system must be supported. One can say, that the future investments are paid with the revenues gathered from existing products.

The first feasible application to be introduced into the market is the 'voice over IP' (VoIP). The service control logic could decide whether to use IP in some parts of the routing path (or even throughout the call).

One possible scenario is linking the SCP directly with the Internet, thus allowing the connections to be established both the circuit and packet switched networks.

![Figure 8: A SCP connected to the Internet](image)
Another scenario would be the usage of an internet connection directly from the intelligent peripheral equipment.

Figure 9: Intelligent peripheral connected to internet

5.1 Expanded Intelligent Peripheral

The integration of IN and IP can be started in the announcement interface. There the traditional systems are replaced with gateways that allow connections to Internet and the telephone network. The announcements could be directly converted from web pages to speech by a concept of ‘SpeechHTML’ [13]. With this functionality, a caller is connected in fact directly to the service provider’s web site instead of an announcement device. The user’s inputs are converted to text format by speech recognition device and are thus available to the web server like in a ‘normal’ web session. This would allow a very flexible administration of the service data and the platform would be set ready for the future media functions, like playing a video clip to a mobile terminal.
A conversion server (called SpeecHTML Gateway) reads HTML tags and translates expected mouseclicks into expected voice response, whether spoken or touchtoned. If a page contains a form, the caller is prompted for the information to fill in the fields. When callers choose from a list of options, answers are recognised from speech; free-form answers are recorded.

Since the URL goes fresh into the conversion server with every phone call, an update to a site causes an instant update to the IVR used, as well.
6. Conclusions

In this thesis, a new service concept for cellular networks was developed. The starting point for this concept was the existing prepaid service. The CAMEL protocol for cellular networks offers the tools for accessing the location information. This is utilised in the new service concept in order to achieve advanced charging scenarios.

The IN CS2 standard was studied, focusing into the CPH capabilities. These capabilities set new requirements for a switch. It must be able to split the active connection into two parts and control the multiple legs. The principles of the required modifications in a system were stated. The CPH allows for the prepaid service to provide both the A- and B-party with an announcement interface.

The proposed enhancements to the service logic would require some additional development impact into existing SLCE. More critical, however, to the system architecture is to handle the growth of signalling traffic. The controlling of increased number of network elements and the complexity of leg management operations reflects to the demands for capacity of the platform. The scalability of the components of the presented service control system, called INS, would become tested in this setting.

The superiority of the new solution lies on the terminal mobility capabilities that allow the network operator or the service provider to manage effectively the charging of its customers. Another enhancement for the service is the introduction of CPH. This enables some unseen service scenarios, like provision of a simultaneous UI connection for call parties.

The introduced approach contains a risk worth mentioning. There is no guarantee that mixing two protocol standards together receives a general approval. However, carefully chosen capabilities shown in this thesis contain the most promising features.

6.1 Further development of IN

The next phase of IN standards will be called the IN CS3. It is going to include functions for broadband support. Contributions to this standard have proposed a number of solutions to enable broadband IN services to manage multiple connections.
A broadband video conference could be initiated by an IN service logic request to set up bidirectional connections to the conference participants and bridge them together. Broadband charging services could be enhanced by the ability of IN to request the release of a stable connection.

However, before the broadband capabilities are actually needed by the telecommunication market, the ongoing building of CS2 based narrowband networks must be finished.

Another dimension is offered by the evolution of Internet. The dilemma between the philosophies of the IN and the Internet should be solved. The use of IN suggests the migration of intelligence from terminal equipment towards service control environment, whereas the use of Internet as a telecommunication network contains quite an opposite philosophy. The convergence of these two worlds is market driven and the first applications will set the directions of the evolution.
References

[1] GSM 09.78: "Digital cellular telecommunications system (Phase 2+); CAMEL Application Part (CAP) specification - Phase 2".
[9] Customised Application for Mobile network Enhanced Logic (CAMEL) - Phase 2; Stage 2 (GSM 03.78) (November 1997)
[14] Digital cellular telecommunications system (Phase 2+); Mobile Application Part (MAP) specification (GSM 09.02 version 5.7.0)
[15] Presentations from the Informational Session on Global Wireless Standards held October 17-18, 1998, in Minneapolis, USA
APPENDIX 1: Service Aspects from Q.1221

The services and service features that are to be supported by IN CS2 are fundamental to the IN CS2 Service Independent Building Blocks (SIBs), call processing model and service control principles. Three types of services have been identified in IN CS2: telecommunication service, service management service and service creation services. The last two types of services are first introduced in IN CS2.

Tables 2/Q.1221 and 3/Q.1221 list IN CS2 benchmark services and service features, which, in addition to IN CS1 related telecommunication services/service features, can be used to identify and verify the service-independent capabilities of IN CS2.

**Telecommunication Services**

As in IN CS1, IN CS2 capabilities are intended to support single-ended single-point-of-control services and service features.

**Benchmark Telecommunication Services**

<table>
<thead>
<tr>
<th>Internetwork Freephone (IFPH)</th>
<th>Call Transfer (TRA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internetwork Premium Rate (IPRM)</td>
<td>Call Waiting (CW)</td>
</tr>
<tr>
<td>Internetwork Mass Calling (IMAS)</td>
<td>Hot Line (HOT)</td>
</tr>
<tr>
<td>Internetwork Televoting (IVOT)</td>
<td>* Multimedia (MMD)</td>
</tr>
<tr>
<td>Global Virtual Network Service (GVNS)</td>
<td>* Terminating Key Code Screening (TKCS)</td>
</tr>
<tr>
<td>* Completion of Call to Busy Subscriber (CCBS)</td>
<td>Message Store and Forward (MSF)</td>
</tr>
<tr>
<td>Conference Calling (CONF)</td>
<td>* International Telecommunication Charge Card (ITCC)</td>
</tr>
<tr>
<td>Call Hold (CH)</td>
<td>* Mobility Services (UPT)</td>
</tr>
</tbody>
</table>

**TABLE 2/Q.1221 Target Set of IN CS2 Telecommunication services**

Note 1: Above service names apply to the descriptions of targeted services, and not to the user-network interface descriptions provided by ITU-T SG 1.

Note 2: Network implementation aspects may be important for some services.

*: These services may be partially supported in IN CS2. For example, they may be supported at the GFP level but not supported at the protocol level. Some of these services may also require capabilities beyond IN CS2.

**Benchmark Telecommunication Service Features**

<table>
<thead>
<tr>
<th>User Authentication (UAUT)</th>
<th>Inter-Network Service Identification (INSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Registration (UREG/Outgoing Call Registration)</td>
<td>* Inter-Network Rate Indicator, Forward (INRI-F)</td>
</tr>
<tr>
<td>Secure Answering (SANSW)</td>
<td>* Inter-Network Rate Indicator, Backward (INRI-B)</td>
</tr>
<tr>
<td>Follow-on (FO)</td>
<td>* Real Time Flexible Rating (RTFR)</td>
</tr>
<tr>
<td>Flexible (Call) Origination Authorisation (FOA)</td>
<td>* Originating Carrier Identification (OCI)</td>
</tr>
<tr>
<td>Flexible (Call) Termination Authorisation (FTA)</td>
<td>* Terminating Carrier Identification (OTC)</td>
</tr>
<tr>
<td>Provision of Stored Messages (PSM)</td>
<td>* Resource Allocation (RAL)</td>
</tr>
<tr>
<td>* Multiple Terminal Address Registration (MTAR)</td>
<td>* Delivery of Complementary Information (DCI)</td>
</tr>
</tbody>
</table>
**Intended Recipient Identity Presentation (IRIP)**
- Blocking/unblocking of incoming calls (BUIC)
- Terminal Authentication (TAUT)
- Handover
- Terminal Location Registration (TLR)
- Terminal Attach/Detach (ATDT)
- Terminal Paging (TPAG)
- Radio Paging (RPAG)
- Emergency Calls in Wireless (ECW)
- Terminal Equipment Validation (TEV)
- Cryptographic Information Management (CIM)
- Automatic Call Back (ACB)
- Call Hold (CH)
- Call Retrieve (CRET)
- Call Transfer (CTRA)
- Call Toggle (CTOG)
- Call Waiting (CW)
- Meet-Me Conference (MMC)
- Multi-Way Calling (MWC)
- Call Pick-up (CPU)
- Calling Name Delivery (CND)
- Message Waiting Indication (MWI)
- Feature Use Charging (FUC)
- Services On-Demand (SOD)

**Service Indication (SIND)**
- Service negotiation (SNEG)
- Call Forwarding (CF)
- B-ISDN Multiple Connections Point to Point (BI-MCPP)
- B-ISDN Multi-casting (BI-MCAST)
- B-ISDN Conferencing (BI-CONF)
- Call Connection Elapsed Time Limitation (CCEL)
- Special Facility Selection (SFS)
- Concurrent Features Activation with Bi-Control (CFA-BC)
- Customised Call Routing with Public network (CCR-PU)
- Customised Call Routing with Private network (CCR-PR)
- Internetwork Service Profile Interrogation (ISPI)
- Internetwork Service Profile Modification (ISPM)
- Internetwork Service Profile Transfer (ISPT)
- Reset of UPT registration for incoming calls (IRUR)
- Mobility Call Origination (MCO) (Mobile Call Origination/UPT outcall)
- Mobility Incall Delivery (MID) (Mobile User Call Term./UPT incall delivery)
- Data Communication Between Different Protocol Terminals (DCPT)
- *Charge Determination (CDET)
- *Charge Card Validation (CCV)
- Call Disposition (CD)
- Enhanced Call Disposition (ECD)
- User Service Interaction (USI)

**Service Management Services**

Service management services/service features are supported by IN CS2. The following list represents service names but not user-network interface descriptions provided by ITU-T SG 1.

**Benchmark Service Management Services and Service Features**

<table>
<thead>
<tr>
<th>TABLE 3/Q.1221 Target Set of IN CS2 Telecommunication Service Features</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Service Customization Services</strong></td>
</tr>
<tr>
<td>Telecommunications Service Customization (TSC)</td>
</tr>
<tr>
<td>Service Control Customization (SCC)</td>
</tr>
<tr>
<td>Service Monitoring Customization (SMC)</td>
</tr>
<tr>
<td><strong>Service Control Services</strong></td>
</tr>
<tr>
<td>Subscriber Service Activation/Deactivation (SSAD)</td>
</tr>
<tr>
<td>Subscriber Monitoring Activation/Deactivation (SMAD)</td>
</tr>
<tr>
<td>Subscriber Profile Management (SPM)</td>
</tr>
<tr>
<td>Subscriber Service Limiter (SSL)</td>
</tr>
<tr>
<td>Subscriber Service Invocation (SSI)</td>
</tr>
</tbody>
</table>

| **Service Monitoring Services**                                       |
| Subscriber Service Report (SSR)                                       |
| Billing Report (BR)                                                  |
| Subscriber Service Status Report (SSSR)                               |
| Subscriber Traffic Monitoring (STM)                                   |
| Subscriber Service Management Usage Report (SMUR)                    |

| **Other Management Services**                                         |
| Subscriber Service Testing (SST)                                      |
| SMP Usage Report (SUR)                                                |
| Subscriber Security Control (SSC)                                     |

**TABLE 4/Q.1221 Target Set of IN CS2 Service Management Services/Service Features**

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**Service Creation Services**

Service creation services/service features are supported by IN CS2. The following list represents service names but not user-network interface descriptions provided by ITU-T SG1.

Benchmark Service Creation Services and Service Features

<table>
<thead>
<tr>
<th>Service Specification Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feature Interaction Detection</td>
</tr>
<tr>
<td>Cross-Service Feature Interaction Detection</td>
</tr>
<tr>
<td>Feature Interaction Rule/Guidelines Generation</td>
</tr>
<tr>
<td>Service and SIB Cataloguing</td>
</tr>
<tr>
<td>Created Service Resource Utilisation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Service Development Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creation Interface Selection</td>
</tr>
<tr>
<td>Creation Initiation</td>
</tr>
<tr>
<td>Editing</td>
</tr>
<tr>
<td>Combining</td>
</tr>
<tr>
<td>Data Population Rule Generation</td>
</tr>
<tr>
<td>SMP Service Creation</td>
</tr>
<tr>
<td>Syntax and Data Checking</td>
</tr>
<tr>
<td>Service and SIB Archiving</td>
</tr>
<tr>
<td>Service Configuration Control</td>
</tr>
<tr>
<td>SIB Configuration Control</td>
</tr>
<tr>
<td>Network Configuration Tracking Capability</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Service Verification Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCE Testing</td>
</tr>
<tr>
<td>Created Service Simulation</td>
</tr>
<tr>
<td>Created Service Live Testing</td>
</tr>
</tbody>
</table>

**Service Deployment Services**

<table>
<thead>
<tr>
<th>Service Deployment Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMP-Created Service Data and SLP Update</td>
</tr>
<tr>
<td>Service Distribution</td>
</tr>
<tr>
<td>SIB Distribution</td>
</tr>
<tr>
<td>Data Rule Distribution</td>
</tr>
<tr>
<td>Feature Interaction Rule Distribution</td>
</tr>
<tr>
<td>Multiple SMP Support</td>
</tr>
<tr>
<td>Network Tailoring</td>
</tr>
<tr>
<td>Network Element Capability Specification</td>
</tr>
<tr>
<td>Network Element Function/Capability Assignment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Service Creation Management Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCE Access Control</td>
</tr>
<tr>
<td>SCE Usage Scope</td>
</tr>
<tr>
<td>SCE Recovery</td>
</tr>
<tr>
<td>SCE Release Management</td>
</tr>
<tr>
<td>SCE Capability Expansion</td>
</tr>
<tr>
<td>SCE Conversion</td>
</tr>
<tr>
<td>Cross-SCE Service Maintenance</td>
</tr>
<tr>
<td>SCE-to-SCE System Consistency</td>
</tr>
<tr>
<td>SCE Service/Modular/System Transference</td>
</tr>
<tr>
<td>Conversion of Created Services</td>
</tr>
<tr>
<td>Service Management Interaction</td>
</tr>
</tbody>
</table>

TABLE 5/Q.1221 Target Set of IN CS2 Services Creation Services/Service Features

**Network Support of IN CS2 Services**

The services are to be supported over various networks. For IN CS2 applications the following networks are considered:

i. PSTN

ii. ISDN (Public and Private Networks)

iii. PLMN
Appendix 2: MAP Location updating

The location updating procedure is used to update the location information held in the network. This location information is used to route incoming calls, short messages and unstructured supplementary service data to the roaming subscriber. Additionally, this procedure is used to provide the VLR with the information that a subscriber already registered, but being detached, is reachable again. The use of this Detach / Attach feature is optional for the network operator [14].

To minimize the updates of the subscriber’s HLR, the HLR holds only information about the VLR and MSC the subscriber is attached to. The VLR contains more detailed location information, i.e. the location area the subscriber is actually roaming in. Therefore, the VLR needs to be updated at each location area change, whereas the HLR needs updating only in the following cases:

- when the subscriber registers in a new VLR, i.e. the VLR has no data for that subscriber;
- when the subscriber registers in a new location area of the same VLR and new routing information is to be provided to the HLR (change of MSC area);
- if the indicator "Confirmed by HLR" or the indicator "Location Information Confirmed in HLR" is set to "Not Confirmed" because of HLR or VLR restoration, and the VLR receives an indication that the subscriber is present.

If a mobile subscriber registers in a visitor location register (VLR) not holding any information about this subscriber and is identified by a temporary mobile subscriber identity (TMSI) allocated by a previous visitor location register (PVLR), if the PVLR identity can be derived from LAI the new VLR must obtain the IMSI from PVLR to identify the HLR to be updated. If the IMSI cannot be retrieved from PVLR, it is requested from the MS.

The following MAP services are invoked by the location update procedure:

MAP_UPDATE_LOCATION_AREA
MAP_UPDATE_LOCATION
MAP_CANCEL_LOCATION
MAP_INSERT_SUBSCRIBER_DATA
MAP_SEND_IDENTIFICATION
MAP_PROVIDE.IMSI
MAP_AUTHENTICATE
MAP_SET_CIPHERING_MODE
MAP_FORWARD_NEW_TMSI
MAP_CHECK.IMEI
MAP_ACTIVATE_TRACE_MODE
MAP_TRACE_SUBSCRIBER_ACTIVITY
Figure: Interface and services for location updating when roaming within a visitor location registers area (without need to update HLR)
Figure: Interface and services for location updating when changing the VLR area
### Interface and services for location updating involving both a VLR and an HLR, when IMSI cannot be retrieved from the previous VLR

**updateLocation** OPERATION

**ARGUMENT**

```plaintext
updateLocationArg SEQUENCE {
  imsi OCTET STRING (SIZE (3 .. 8)),
  msc-Number [1] IMPLICIT OCTET STRING (SIZE (1 .. 20)) (SIZE (1 .. 9)),
  vlr-Number OCTET STRING (SIZE (1 .. 20)) (SIZE (1 .. 9)),
  imsi [10] IMPLICIT OCTET STRING (SIZE (4) ) OPTIONAL,
  extensionContainer SEQUENCE {
    privateExtensionList [0] IMPLICIT SEQUENCE SIZE (1 .. 10) OF SEQUENCE {
      extId MAP-EXTENSION .&extensionId ( {
        ...} ),
      extType MAP-EXTENSION .&ExtensionType ( {
        ...} [ @extId ] ) OPTIONAL) OPTIONAL,
      pcs-Extensions [1] IMPLICIT SEQUENCE {
        ...} OPTIONAL,
      ...} OPTIONAL,
    ...} OPTIONAL,
  }
}
```

**RESULT**

```plaintext
updateLocationRes SEQUENCE {
  hlr-Number OCTET STRING (SIZE (1 .. 20)) (SIZE (1 .. 9)),
  extensionContainer SEQUENCE {
```
The message flows for successful retrieval of subscriber information related to an any time interrogation from the CAMEL server are shown in figure below.

The following MAP services are used to retrieve routing information:

MAP_ANY_TIME_INTERROGATION
MAP_PROVIDE_SUBSCRIBER_INFO
Appendix 3 : TIA standards

This chart shows the connections between various standardisation bodies related to the ANSI [15].

ANSI Linkage to Other Industry Sectors
Appendix 4: Message flow of the service

The ‘optimised service concept’ consists of a set of operations. These components are selected from IN protocols CS2, CAMEL and WIN.

The operations contain following information:

The dialogue is opened with the operation IDP. This operation contains the identity information of the calling subscriber.

ASN code of CAMEL:

```
InitialDPArg ::= SEQUENCE {
    serviceKey     OCTET STRING,  OPTIONAL,
    calledPartyNumber  OCTET STRING,  OPTIONAL,
    callingPartyNumber  OCTET STRING,  OPTIONAL,
    callingPartysCategory  OCTET STRING,  OPTIONAL,
    iPSSPCapabilities  OCTET STRING,  OPTIONAL,
    locationNumber  OCTET STRING,  OPTIONAL,
    originalCalledPartyID  OCTET STRING,  OPTIONAL,
}
```
### Extensions

<table>
<thead>
<tr>
<th>Extension Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>highLayerCompatibility</td>
<td>Optional, high-level compatibility information.</td>
</tr>
<tr>
<td>additionalCallingPartyNumber</td>
<td>Optional, additional calling party number information.</td>
</tr>
<tr>
<td>bearerCapability</td>
<td>Optional, bearer capability information.</td>
</tr>
<tr>
<td>eventTypeBCSM</td>
<td>Optional, event type BCSM information.</td>
</tr>
<tr>
<td>redirectingPartyID</td>
<td>Optional, redirecting party ID information.</td>
</tr>
<tr>
<td>redirectionInformation</td>
<td>Optional, redirection information.</td>
</tr>
<tr>
<td>IMSI</td>
<td>Optional, International Mobile Subscriber Identity.</td>
</tr>
</tbody>
</table>

### Subscriber State
- subscriberState
- locationInformation
- ext-basicServiceCode
- calledPartyBCDNumber
- dateAndTime
- timezone

### InitialDPArg

```asn1
InitialDPArg [PARAMETERS-BOUND : bound] ::= SEQUENCE {
    serviceKey,  
    calledPartyNumber,  
    callingPartyNumber,  
    callingPartyBusinessGroupID,  
    callingPartysCategory,  
    cGEncountered,  
    iPSSPCapabilities,  
    IPAvailable,  
    locationNumber,  
    originalCalledPartyID,  
    terminalType,  
    extensions [15] SEQUENCE SIZE(1..bound.&numOfExtensions) OF  
        ExtensionField,  
        highLayerCompatibility,  
        serviceInteractionIndicators,  
        additionalCallingPartyNumber,  
        forwardCallIndicators,  
        bearerCapability,  
        eventTypeBCSM,  
        redirectingPartyID,  
        redirectionInformation,  
        cause,  
        ISDNAccessRelatedInformation,  
        INServiceCompatibilityIndication,  
        genericNumbers,  
        serviceInteractionIndicatorsTwo,  
        forwardGVNS,  
        createdCallSegmentAssociation,  
        uISIServiceIndicator,  
        uSIInformation,  
        carrier,  
        IMSI,  
        subscriberState,  
        locationInformation,  
        ext-basicServiceCode
}
```

### ASN Code of CS2

The ASN code of CS2 includes various fields such as serviceKey, calledPartyNumber, callingPartyNumber, and more, each with optional or mandatory status. The code structure is designed to handle various scenarios in call processing, including compatibility, service interaction, and specific indicators related to the call context.
Based on this information, the gsmSCF sends an inquiry about the location information of the calling subscriber. The HLR of the calling subscriber receives this message. If it notifies that the subscriber is currently in a visiting network it sends a request to the VLR in order to get the current location information. This data is returned to the gsmSCF.

anyTimeInterrogation OPERATION
ARGUMENT
  anyTimeInterrogationArg SEQUENCE {
    subscriberIdentity [0] CHOICE {
      imsi [0] IMPLICIT OCTET STRING (SIZE (3 .. 8)),
      msisdn [1] IMPLICIT OCTET STRING (SIZE (1 .. 20)) (SIZE (1 .. 9))},
    requestedInfo [1] IMPLICIT SEQUENCE {
      locationInformation [0] IMPLICIT NULL OPTIONAL,
      subscriberState [1] IMPLICIT NULL OPTIONAL,
      extensionContainer [2] IMPLICIT SEQUENCE {
        privateExtensionList [0] IMPLICIT SEQUENCE SIZE (1 .. 10) OF
          SEQUENCE {
            extld MAP-EXTENSION .&extensionId ( {
              ... } ),
            extType MAP-EXTENSION .&ExtensionType ( {
              ... } [ @extld ] ) OPTIONAL) OPTIONAL,
        pcs-Extensions [1] IMPLICIT SEQUENCE {
          ... ) OPTIONAL,
          ... } OPTIONAL,
          ... },
        gsmSCF-Address [3] IMPLICIT OCTET STRING (SIZE (1 .. 20)) (SIZE (1 .. 9))},
      extensionContainer [2] IMPLICIT SEQUENCE {
        privateExtensionList [0] IMPLICIT SEQUENCE SIZE (1 .. 10) OF
          SEQUENCE {
            extld MAP-EXTENSION .&extensionId ( {
              ... } ),
            extType MAP-EXTENSION .&ExtensionType ( {
              ... } [ @extld ] ) OPTIONAL) OPTIONAL,
        pcs-Extensions [1] IMPLICIT SEQUENCE {
          ... ) OPTIONAL,
          ... } OPTIONAL,
          ... },
    }},
  }
}
RESULT
  anyTimeInterrogationRes SEQUENCE {
    subscriberInfo SEQUENCE {
      locationInformation [0] IMPLICIT SEQUENCE {
        ageOfLocationInformation INTEGER (0 .. 32767) OPTIONAL,
        geographicalInformation [0] IMPLICIT OCTET STRING (SIZE (9)) OPTIONAL,
        vlr-number [1] IMPLICIT OCTET STRING (SIZE (1 .. 20)) (SIZE (1 .. 9)) OPTIONAL,
        locationNumber [2] IMPLICIT OCTET STRING (SIZE (2 .. 10)) OPTIONAL,
        cellIdOrLAI [3] CHOICE {
          cellIdFixedLength [0] IMPLICIT OCTET STRING (SIZE (7))},
        },
When the location information is clarified the service logic orders the SSP to establish a User Interaction (UI) connection. If the initiating SSP contains an internal IP, the operation CTR contains the routing address to the IP. Otherwise, an operation ETC has
to be used, which routes the connection to an assisting SSP. After the UI connection is established, the announcement can be started with PA or PAC. The WIN protocol enables the service logic to replace the heavy controlling connection (CTR, PAC/PA) with a single operation CCDIR. With this operation, the SSP is responsible to complete the UI phase alone and only to report the completed dialogue.

ConnectToResourceArg {PARAMETERS-BOUND : bound} ::= SEQUENCE {
  resourceAddress CHOICE {
    ipRoutingAddress [0] IPRoutingAddress {bound},
    legID [1] LegID,
    ipAddressAndLegID [2] SEQUENCE {
      ipRoutingAddress [0] IPRoutingAddress {bound},
      legID [1] LegID,
    ... },
    none [3] NULL,
    callSegmentID [4] CallSegmentID {bound},
    ipAddressAndCallSegment [5] IPRoutingAddress {bound},
    callSegmentID [6] CallSegmentID {bound},
    ... },
  extensions [7] SEQUENCE SIZE(1..bound.&numOfExtensions) OF ExtensionField {bound} OPTIONAL,
  serviceInteractionIndicators [8] ServiceInteractionIndicators {bound} OPTIONAL,
  serviceInteractionIndicatorsTwo [9] ServiceInteractionIndicatorsTwo OPTIONAL,
}

EstablishTemporaryConnectionArg {PARAMETERS-BOUND : bound} ::= SEQUENCE {
  assistingSSIPRoutingAddress [0] AssistingSSIPRoutingAddress {bound},
  correlationID [1] CorrelationID {bound} OPTIONAL,
  partyToConnect CHOICE {
    legID [2] LegID,
    callSegmentID [3] CallSegmentID {bound},
  ... },
  scfID [4] ScfID {bound} OPTIONAL,
  extensions [5] SEQUENCE SIZE(1..bound.&numOfExtensions) OF ExtensionField {bound} OPTIONAL,
  serviceInteractionIndicators [6] ServiceInteractionIndicators {bound} OPTIONAL,
  serviceInteractionIndicatorsTwo [7] ServiceInteractionIndicatorsTwo OPTIONAL,
}

PlayAnnouncementArg {PARAMETERS-BOUND : bound} ::= SEQUENCE {
  informationToSend [0] InformationToSend {bound},
  disconnectFromIPForbidden [1] BOOLEAN DEFAULT TRUE,
  requestAnnouncementComplete [2] BOOLEAN DEFAULT TRUE,
  extensions [3] SEQUENCE SIZE(1..bound.&numOfExtensions) OF ExtensionField {bound} OPTIONAL,
  connectedParty CHOICE {
    legID [4] LegID,
    callSegmentID [5] CallSegmentID {bound},
  ... },
}

PromptAndCollectUserInformationArg {PARAMETERS-BOUND : bound} ::= SEQUENCE {
  ...}
If the SCF allows the call origination from a visiting network it can set a special charging rate for this call and inform the caller about this. The credit limit is set in the database of the service logic and a corresponding timer value is set into the operation AC. The service logic lets the call to be routed (by SSP) to the destination number and starts monitoring the connection.

ASN code of CAMEL:

```
ApplyChargingArg ::= SEQUENCE {
  aChBillingChargingCharacteristics [0] AChBillingChargingCharacteristics,
  sendCalculationToSCPIndication [1] BOOLEAN OPTIONAL,
  partyToCharge [2] LegID OPTIONAL,
  extensions [3] SEQUENCE SIZE(1..bound.&numOfExtensions) OF ExtensionField OPTIONAL
}
```

 ASN code of CS2:

```
ApplyChargingArg {PARAMETERS-BOUND : bound} ::= SEQUENCE {
  aChBillingChargingCharacteristics [0] AChBillingChargingCharacteristics {bound},
  sendCalculationToSCPIndication [1] BOOLEAN OPTIONAL,
  partyToCharge [2] LegID OPTIONAL,
  extensions [3] SEQUENCE SIZE (1..bound.&numOfExtensions) OF ExtensionField {bound} OPTIONAL
}
```

The service logic can activate a 'Heartbeat' function in the operation AC, which causes the intermediate reports to be generated by the SSF. When the SCF receives an intermediate ACR, it sends again a request to the HLR to clarify the location of the subscriber. If the subscriber has moved to another network during the connection the
SCF can run the checks about the allowed geographical locations and assign a new charging rate.

The announcement dialogue is opened for both calling and called subscribers. This is possible with the CPH operations. A ‘Split Leg’ operation divides the connection into two separate connection configurations or call segments. In this state, an announcement can be played simultaneously to both parties and further media functions may be performed with an operation ‘Script Run’. The original A-subscriber is advised to update his credit, if it is about to run short. The B-side may receive information and hear advertisements. The SRF returns information about the completed UI-phase with the operation ‘Script Event’.

```plaintext
SplitLegArg {PARAMETERS-BOUND : bound} ::= SEQUENCE {
  legToBeSplit [0] LegID,
  newCallSegment [1] INTEGER (2..bound.&numOfCSs),
  extensions [2] SEQUENCE SIZE (1..bound.&numOfExtensions) OF
    ExtensionField {bound} OPTIONAL,
  ...
}

ScriptRunArg {PARAMETERS-BOUND : bound} ::= SEQUENCE {
  ulScriptId UISCRIPT.&id({SupportedUIScripts  {bound}}),
  ulScriptSpecificInfo [0] UISCRIPT.&SpecificInfo({SupportedUIScripts {bound}}[@ulScriptId]) OPTIONAL,
  extensions [1] SEQUENCE SIZE (1..bound.&numOfExtensions) OF
    ExtensionField {bound} OPTIONAL,
  DisconnectFromIPForbidden [2] BOOLEAN DEFAULT TRUE,
  callSegmentID [3] CallSegmentID {bound} OPTIONAL,
  ...
}

ScriptEventArg {PARAMETERS-BOUND : bound} ::= SEQUENCE {
  ulScriptId UISCRIPT.&id({SupportedUIScripts  {bound}}),
  ulScriptResult [0] UISCRIPT.&Result({SupportedUIScripts {bound}}[@ulScriptId]) OPTIONAL,
  extensions [1] SEQUENCE SIZE (1..bound.&numOfExtensions) OF
    ExtensionField {bound} OPTIONAL,
  callSegmentID [2] CallSegmentID {bound} OPTIONAL,
  lastEventIndicator [3] BOOLEAN DEFAULT FALSE,
  ...
}
```

The legs are joined again together with the operation ‘Merge Call Segments’. The SCF issues another ‘Apply Charging’ operation and returns to the monitoring state.

```plaintext
MergeCallSegmentsArg {PARAMETERS-BOUND : bound} ::= SEQUENCE {
  sourceCallSegment [0] CallSegmentID {bound},
  targetCallSegment [1] CallSegmentID {bound} DEFAULT initialCallSegment,
  extensions [2] SEQUENCE SIZE (1..bound.&numOfExtensions) OF
    ExtensionField {bound} OPTIONAL,
  ...
}
```