CAMEL Phase 3 in UMTS

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Master’s Thesis made for Nokia Networks
Contents

- Introduction
- Presentation of tools and methods
- Review of previous research
- Results
- Own contribution
- Conclusions
Introduction - Background

- When moving from 2G to 3G mobile networks, lots of new services are introduced.
- In 2G world, the main technique for controlling services has been IN, Intelligent Networks (CAMEL, Customized Applications for Mobile network Enhanced Logic).
- IN has many drawbacks and limitations.
- Services evolution -> Service control evolution.
- Thus, in 3G world, there shall be two main techniques for service creation and control: IN and open APIs (Application Programming Interface) between service and network layer.
Introduction - Study objectives

The following 4 study objectives are defined:

- To examine the evolution of service control, when moving from 2G to 3G world
- To find out IN evolution scenarios and what role IN plays in future mobile networks
- To represent the network architecture for latest CAMEL Phase (Phase 3), examine CAMEL protocol (CAP) interfaces in more detail and show as an example of how Prepaid service (PPS) is implemented by the help of CAMEL3 in 3GPP Release 1999 (R99) compliant UMTS network
- To examine, how can CAMEL3 core network signalling utilize open APIs (and vice versa)
Presentation of Tools and Methods

- A literature study was chosen as a research method

- Used literature:
  - public 3GPP standards (especially CAMEL-standards 23.078 and 22.078)
  - public research papers (IEEE Communications Magazine, BT Technology Journal, UMTS Forum Reports etc)
  - non-public Nokia Networks’s technical documentation
Review of Previous Research

- UMTS Standardization within 3GPP
- CAMEL Standardization within 3GPP
- 3GPP R99 Architecture
- CAMEL and Service Control in UMTS
UMTS Standardization within 3GPP
3GPP Domains and Subsystems

Circuit Switched Core Network Domain
- MSC
- MSC Server
- HLR

Packet Switched Core Network Domain
- SGSN
- GGSN
- HLR
  - Border GW
  - Firewall
  - LIG

Services Subsystem
- Location server
- Application server
- WAP gateway
- etc.

Internet Multimedia Core Network Subsystem
- CPS
- MGW
- HSS

SOURCE: [Vei00]
CAMEL Standardization within 3GPP
Why CAMEL?

- Limitations in IN based on ETSI Core INAP CS1
  - No mobile functionality (only vendor specific extensions)
  - Too much room for interpretations (multivendor system is difficult)
- Need for
  "IN" supporting mobile terminals
  - Services not covered by standardised GSM services
  - Services for subscribers roaming outside the HPLMN
  - Easier multivendor interaction
- The standardisation result was
  - Customised Applications for Mobile network Enhanced Logic
  or just CAMEL
What is CAMEL? (1/2)

- Animal
- IN network technology for mobile networks
- Etc

![Diagram of CAMEL network components]

CAMEL Subscription Info (CSI)

Visited PLMN/ MSC, VLR, SGSN

Home PLMN / HLR

SERVICES in SCP
What is CAMEL? (2/2)

Table 4. CAMEL Application Areas.

<table>
<thead>
<tr>
<th>CAMEL Application Area</th>
<th>Subareas</th>
<th>Affected Core Domain</th>
<th>Affected 3GPP Standards (other than CAMEL standards)</th>
<th>Used Protocols with CAMEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit Switched Call Control</td>
<td>MO call</td>
<td>CS</td>
<td>23.018, 23.072, 23.081, 23.082, 23.083, 23.084, 23.085, 23.086, 23.087, 23.088, 23.091, 23.093, 23.135, 23.079</td>
<td>CAP, MAP</td>
</tr>
<tr>
<td></td>
<td>MT call</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MF call</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPRS Interworking</td>
<td>GPRS Session</td>
<td>PS</td>
<td>23.060, 32.015</td>
<td>CAP, MAP</td>
</tr>
<tr>
<td></td>
<td>PDP Context</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short Message Service</td>
<td>MO-SMS</td>
<td>Both</td>
<td>23.040</td>
<td>CAP, MAP</td>
</tr>
<tr>
<td>Supplementary Service Invocation</td>
<td>-</td>
<td>CS</td>
<td>23.011, 23.091, 23.084, 23.072, 23.093</td>
<td>MAP</td>
</tr>
<tr>
<td>USSD</td>
<td>-</td>
<td>CS</td>
<td>23.090</td>
<td>MAP</td>
</tr>
<tr>
<td>Mobility Management</td>
<td>-</td>
<td>CS</td>
<td>23.018</td>
<td>MAP</td>
</tr>
<tr>
<td>Control and Interrogation of Subscription Data</td>
<td>HLR – SCP interface</td>
<td>CS, PS</td>
<td>23.008, 23.016</td>
<td>MAP</td>
</tr>
<tr>
<td>Subscriber State and Location Retrieval</td>
<td>MSC-GMLC interface</td>
<td>CS</td>
<td>23.016, 23.127</td>
<td>MAP</td>
</tr>
</tbody>
</table>

- CAMEL is an IN technology by the help of which value-added services can be offered to the mobile subscribers roaming in HPLMN or VPLMN
- CAMEL integrates IN techniques from fixed to mobile network
- CAMEL is based on ETSI’s Core Intelligent Network Application Part (INAP) and Mobile Application Part (MAP) protocols
- CAMEL is being developed in Phases (Phases 1-3; Phase 4 standardization work was started in autumn 2000)
- Main CAMEL standards (3GPP) are 22.078, 23.078 and 29.078
**CAMEL History: Standardization in Phases**

Table 6. Comparison between different CAMEL Phases.

<table>
<thead>
<tr>
<th>CAMEL Phase</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3GPP Domain affected</strong></td>
<td>CS</td>
<td>CS</td>
<td>CS, PS</td>
</tr>
<tr>
<td><strong>Phase Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Applicable to MO and MT calls</td>
<td>• Charging operations</td>
<td>• GPRS charging operations</td>
</tr>
<tr>
<td></td>
<td>• No charging operations</td>
<td>• New Call related Detection Points</td>
<td>• MO-SMS charging operations</td>
</tr>
<tr>
<td></td>
<td>• No announcements</td>
<td>• SS invocation notification</td>
<td>• Dialed services (D-CSL N-CSI)</td>
</tr>
<tr>
<td></td>
<td>• Limited Detection Points</td>
<td>• Announcements and tones</td>
<td>• SCP-HLR interface</td>
</tr>
<tr>
<td></td>
<td>• DTMF reception</td>
<td>• USSD between SCP and phone</td>
<td>• SCP control of CW, CF and MPTY</td>
</tr>
<tr>
<td></td>
<td>• Call Screenings</td>
<td>• Prepaid</td>
<td>• Mobility Management functions</td>
</tr>
<tr>
<td></td>
<td>• Call Forwardings</td>
<td>• Hunting</td>
<td>• GPRS Prepaid</td>
</tr>
<tr>
<td></td>
<td>• Call Redirections</td>
<td>• Announcements</td>
<td>• Enhancement of CS Prepaid</td>
</tr>
<tr>
<td></td>
<td>• Call Routings</td>
<td>• Freephone</td>
<td>• Service numbers</td>
</tr>
<tr>
<td></td>
<td>• Very simple VPN</td>
<td>• Premium Rate</td>
<td>• Multiple Subscriber Profile</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Personal Discount</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Location Dependent Discount</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reverse Charging</td>
<td></td>
</tr>
</tbody>
</table>

- **Phases 1-2 for Circuit Switched (CS) Core Domain**
- **Phase 3 for both CS and Packet Switched (PS) Core Domains**
- **Phase 4 for IP Multimedia Subsystem (IMS); not discussed within this M.Sc. Thesis**
- **Table is based on (Pal00)**
CAMEL Phase negotiation - requirements

- A network supporting CAMEL2 must also support CAMEL1.

- A network supporting CAMEL3 must also support CAMEL2 & CAMEL1.

- CAMEL4 shall provide the functionality of all previous CAMEL Phases. Phase 4 network signalling shall support interworking with CAMEL Phases 3 and 2.

- CAMEL3 is the lowest phase for SGSN.
CAMEL Phase negotiation - 2G/3G issues

- All CAMEL phases work in 2G and 3G.
- CAMEL1 and CAMEL2 Location Information contains a Cell-id parameter which contains the GSM cell or UMTS Service Area Identity (SAI).
- Starting from CAMEL3 an additional parameter indicates whether Cell-id contains actually SAI.
- 3G has higher data rates in CS and PS.
  - The CS Bearer Capability (BCIE) is indicated to SCP.
  - Inter-system CS handover is not visible to the SCP, nor change of user rate.
  - The PS QoS and change if QoS are indicated to the SCP.
  - Inter-system PS RAU is visible to the SCP.
- CS Multicall feature usage is seen as multiple independent calls in the SCP.

SOURCE: [Pal00]
UMTS Services by UMTS Forum

- Reports No. 9 and No. 13 introduce 6 UMTS Service Categories
- Each single service/application belongs to several Service Categories (not shown in the Figure, based on [Umt01])
CAMEL Control of 3G Services

Table 7. 3G services requiring possibly CAMEL Control.

<table>
<thead>
<tr>
<th>Service Category</th>
<th>Name of Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Services</td>
<td>Speech, emergency calls, low bit rate data, medium bit rate data, high bit rate data, high quality audio, low bandwidth video, high bandwidth video</td>
</tr>
<tr>
<td>Supplementary Services</td>
<td>Operator determined barring, user defined barring, call screening, call deflection, call forwarding unconditional, call forwarding on busy (no reply and not reachable), call waiting, call hold, call transfer, calling number identification presentation/restriction, connected number identification presentation/restriction, multiple subscriber profile, multi-party, call completion services (e.g. CCBS), closed user group, advice of charge, calling name presentation</td>
</tr>
<tr>
<td>Operator Specific Services</td>
<td>Short number dialling, prepaid, VPN</td>
</tr>
<tr>
<td>Other Services</td>
<td>Lawful interception, voice group-call service, voice broadcast service, SMS, fax, ASCI, MExE, location services, SoLSA</td>
</tr>
</tbody>
</table>

- UMTS services can be categorised into 4 different groups:
  - Basic
  - Supplementary
  - Operator Specific
  - Multimedia
- CAMEL control can be used with many services
- Table is based on (21978)
Prepaid Service (PPS) can be implemented in multiple ways.

PPS allows a mobile subscriber to pay for telecommunication services before the actual usage, i.e. in advance.

PPS subscriber establishes a prepaid account with the service provider for accessing telecom services.

IN Based Prepaid is just one type of Prepaid.

Figure is based on [Lil01].
3GPP R99 Architecture
R99 UMTS Network Architecture

- Mobile Terminal
- Radio Access
  - 2G RAN - BSS
  - 3G RAN - UTRAN
- Core Network
  - Circuit Switched Core Network Domain
  - Packet Switched Core Network Domain
- Services and Management Subsystem (e.g. IN/SCE)
- Figure is based on [Net01b]
In the 3GPP R99 UMTS network, SS7 signalling is heavily used for service control.

Two main alternatives for service creation and control:
- IN
- OSA/Parlay API

IN services are created in SCE (IN SIBs); IN Service Platform

OSA services are created in APPSEs (XML, Java servlets)

Figure is based on Mainm
CAMEL and Service Control in UMTS
Virtual Home Environment (1/2)

- Virtual Home Environment (VHE, see Figure) is defined as a concept for Personal Service Environment (PSE) portability across network boundaries and between terminals. The concept of the VHE is such that users are consistently presented with the same personalized features, User Interface customisation, and services in whatever network and whatever terminal (within the capabilities of the terminal).
Virtual Home Environment (2/2)

- IN and CAMEL are independent concepts from Virtual Home Environment (VHE)
- In practice, VHE can be implemented with CAMEL
- Figure is based on [Baz01]
VHE with OSA in R99 UMTS network

- **CAMEL (CAMEL server, CSE)** is a part of the VHE /OS A architecture

- The main goal of VHE /OS A concepts is to enable service development independently of the underlying networks

- The interface between service and network layer is standardized -> service creation becomes faster, easier and more

---

**Application Servers**

| Service | Service | Service | Service |

**Network layer**

- SCF
- UMTS call control servers
- HLR
- CAMEL server (CSE)
- MExE server
- SAT server
- SCF

**Transport network**

- Standardized OSA interfaces
- Service Capability Server (SCS)
- Service Capability Feature (SCF)

**SOURCE:**
[Bos01]
3G Service Creation with OS A

- Open Service Architecture (OS A) Capabilities may be meant for terminal- or network-centric applications
- Terminal vs. Network Centric Capabilities (OS A SCS s)
- Figure is based on [Har01a]
IN Architecture Model

- IN Conceptional Model (INCM) gives a framework concerning how network intelligence is provided and distributed within a certain network.
- INCM consists of four planes:
  - Service
  - Global Functional
  - Distributed Functional
  - Physical
- Figure (based on [Q1204]) represents Distributed Functional Plane architecture.
Mapping between INCM and commercial IN

- IN functionality is distributed according to INCM
- IN Service Platform (SCE, SCP, SMP, SMAP, IP etc)
  - SCP (gsmS CF)
- CS Core Domain
  - VMS C (gsmS SF)
  - GMS C (gsmS SF)
  - HLR
- PS Core Domain
  - SGS N (gprsS SF)
- SSFs and SCF are needed for CAMEL communication
- Figure is based on [Net01c]

Nokia Intelligent Networks Architecture
IN Evolution towards ISMF (1/2)

- The key requirements for future development of the IN are that customers can access a wider variety of services in a wider variety of ways, and that they can customize existing services or even create new ones as simply, quickly, and cost effectively as possible. (Bre00)

- In practice, due to the key requirements presented above, IN service logic should be accessible from Internet terminals and contain components residing in both SCPs and Internet nodes. In this way, new Mobile Internet Applications that provide the mutual support of network capabilities and Internet content may be offered to the mobile subscribers. (Bre00, Gre00b)

SOURCE: (Fin00)
IN Evolution towards IS MF (2/2)

- IN must evolve towards open APIs and Intelligent Middleware
- Intelligent Middleware consists of an Intelligent Service Mediation Function (IS MF) that handles the traffic between service and network layer
- IS MF consists of three main parts: Service Access, Service Capabilities and Transport
- Basic task of IS MF in Next-Generation Network (NGN) is to split different layers and functionalities from each other
- Figure 20 is based on
APPSE: CAMEL based Service Control

Figure is based on (Bos01)
APPSE: API based Service Control

Figure is based on (Bos01)
Important revolution occurs in the size of different business areas and their importance to the mobile product value chain. The Figure 23 (based on [Umt00a]) describes how this change occurs moving from 2G mobile telecom-like value chain towards Internet-like value chain, Multimedia Value Chain ([Umt99]). It shows quite clearly that Content and Services Provision have bigger roles, whereas core network’s importance diminishes, while intelligence is moving away from the core network (Network layer) towards applications (Service layer) ([Baz01]).
Product Value Chain Evolution (2G->3G)

- In the 3G World, different roles within the Value Chain are (Har01a): NO, SP, mobile virtual network operator (MVNO), mobile Internet service provider (M-ISP), portal (context) provider, application provider, content provider, payment processing provider and system security provider. The Figure below is based on (Har01a).
Wholesaling affects Network Charging

- Wholesaling means, in practice, access to 3rd party companies from the network operator's point of view. The network operator should implement this concept at every level (e.g. access to fibre, access to call control, access to applications or provision of content etc.) in order to utilize core network resources as efficiently as possible.

Transaction Flows (Who bills whom?)

1. Customer → Service Provider
2. Service Provider → Advertiser
3. Transport Provider → Content Provider
4. Content Provider → Service Provider
5. Customer → Transport Provider
6. Service Provider → Transport Provider

SOURCE: [Umt00b]
## 2G and 3G World Comparison

<table>
<thead>
<tr>
<th>Closed 2G World</th>
<th>Open 3G World</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Network side control of 2G services</td>
<td>- Network + Terminal side control of 3G services; service personalization</td>
</tr>
<tr>
<td>- IN Platform specific service creation and management: closed interfaces</td>
<td>- IN plays possibly middleware layer between applications and transport</td>
</tr>
<tr>
<td>- IN Platform + operator's own mobile portals contains application, call control and transport layers</td>
<td>- IN plays possibly middleware layer between applications and transport</td>
</tr>
<tr>
<td>- Skilled specialists (network operator personnel)</td>
<td>- Individual services can be controlled by 3rd party APPSEs (softswitch architecture)</td>
</tr>
<tr>
<td>- Long creation time of new service (years)</td>
<td>- Anyone can create new services</td>
</tr>
<tr>
<td>- Network Operator (NO) plays one role: network provider</td>
<td>- Rapid new service creation times</td>
</tr>
<tr>
<td>- Telecom world Value Chain and Business Models</td>
<td>- Network Operator (NO) has multiples roles: mobile portal, mobile ISP, communication infrastructure provider</td>
</tr>
<tr>
<td>- Price and Product: Simple price structure (airtime) and voice as main product (voice-centric)</td>
<td>- Internet world - like Value Chain and Business Models</td>
</tr>
<tr>
<td>- Partnerships: Vertical integration of network infrastructure and device distribution</td>
<td>- Partnerships: Service-specific price structures; subscriptions, messages, advertising, airtime, transactions</td>
</tr>
<tr>
<td>- &quot;Write once, run in one place&quot;</td>
<td>- Partnerships: Strategic partnerships to emulate end-to-end integration; Wholesaling</td>
</tr>
<tr>
<td>- Technologies: CAMEL, WAP, USSD, SMS</td>
<td>- &quot;Write once, run everywhere&quot;</td>
</tr>
<tr>
<td></td>
<td>- New entire services classes: m-business, location-based services, multimedia messaging, infotainment, edutainment etc.</td>
</tr>
<tr>
<td></td>
<td>- Network reconfiguration; Policy Based Network Management</td>
</tr>
<tr>
<td></td>
<td>- New technologies: MExE, USAT, APIs, VoIP: SIP (not in R99), SS7 over IP (not in R99), CORBA, new IETF protocols</td>
</tr>
</tbody>
</table>

- Below are 2G and 3G Worlds compared mainly in the context of Service Creation and Management (Fig. 26, based on [Dao02, Umt00c]). It is clearly seen that the evolution is radical: the world becomes from closed voice-centric, monopoly-like world towards open, IP data-centric world, where each market party must co-operate and network especially at horizontal level (horizontal integration) instead of the old vertical type of integration (network operator's point of view).
Results

- CAMEL Phase 3 in 3GPP R99
CAMEL Phase 3 in 3GPP R99

- CAMEL Phase 3 Architecture
- CAMEL3 Operation Principles
- CAMEL3 in SGSN
- CAMEL3 in MSC
- CAMEL3 in Service Platform
CAMEL Phase 3 Architecture
CAMEL 3 Architecture

Figure is based on (23078)
Concepts (1/2)

- **CSI** - CAMEL Subscription Information - part of subscriber data, which identifies that a subscriber has CAMEL service(s).
- **OSS** - Operator Specific Service (IN service)
- **gsmS CF** - GSM Service Control Function.
- **gsmS SF** - GSM Service Switching Function.
- **CAP** - CAMEL Application Part
- **HPLMN** - Home Public Land Mobile Network
- **VPLMN** - Visited Public Land Mobile Network
- **IPLMN** - Interrogating Public Land Mobile Network
Concepts (2/2)

- O-BCS M - Originating Basic Call State Model
- T-BCS M - Terminating Basic Call State Model
- gsmSRF GS M - Specialised Resource Function.
- USSD - Unstructured Supplementary Service Data
- gprsSSF GPR S - Service Switching Function
- SGSN - Serving GPRS Support Node
CAMEL 3 Operation principles
**Basic CAMEL 3 Operation**  
*(PDP Context is used as an example)*

- CAMEL 3 operation occurs in different phases. The three main phases are CSI from HLR, Encountering new Detection Point and Continuing/Releasing the Call. Let's look at certain signalling procedures, in this case related to the PDP Context. Figure is based on (23060, 23078).

- In addition, SCP can make inquiries to HLR and HLR can update CSI data in MGS & GGSN.
# CAMEL Subscription Information (CSI)

Table 11. CAMEL Subscription Information elements. Those CSIs that are not sent from HLR are marked with grey colour.

<table>
<thead>
<tr>
<th>Name of CSI</th>
<th>Description</th>
<th>Affected Core Domain</th>
<th>Affected Network Element</th>
<th>CAMEL Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-C SI</td>
<td>Dialed Services CAMEL Subscription Information (D-C SI) is transferred to the VPLMN (at Location Update) and IPI LMN (for an incoming call in GMSC). D-C SI is for HPLMN controlled dialled services.</td>
<td>CS</td>
<td>MSC\ VLR, GMSC</td>
<td>3</td>
</tr>
<tr>
<td>N-C SI</td>
<td>N-C SI is for VPLMN controlled dialled services.</td>
<td>CS</td>
<td>MSC\ VLR</td>
<td>3</td>
</tr>
<tr>
<td>GPRS-C SI</td>
<td>GPRS CAMEL Subscription Information (GPRS-C SI) is transferred to the VPLMN. GPRS-C SI is for control of GPRS Sessions and PDP Contexts.</td>
<td>PS</td>
<td>SGSN</td>
<td>3</td>
</tr>
<tr>
<td>M-C SI</td>
<td>Mobility Management CAMEL Subscription Information (M-C SI) is transferred to the VPLMN. M-C SI is for Mobility Management MAP notifications.</td>
<td>CS</td>
<td>MSC\ VLR</td>
<td>3</td>
</tr>
<tr>
<td>O-C SI</td>
<td>Originating CAMEL Subscription Information (O-C SI) is transferred to the VPLMN (at Location Update) and to the IPI LMN (for an incoming call in the GMSC). O-C SI is for Mobile Originating calls (in the VMSC) and Mobile Forwarding calls (in the VMSC).</td>
<td>CS</td>
<td>GMSC</td>
<td>1</td>
</tr>
<tr>
<td>SMS-C SI</td>
<td>Short Message Service CAMEL Subscription Information (SMS-C SI) is transferred to the VPLMN. SMS-C SI is for controlling Mobile Originating Short Message submissions.</td>
<td>CS, PS</td>
<td>SGSN + MSC\ VLR</td>
<td>3</td>
</tr>
<tr>
<td>SS-C SI</td>
<td>Supplementary Service Invocation Notification CAMEL Subscription Information (SS-C SI) is transferred to the VPLMN. SS-C SI is for Supplementary Services MAP notifications.</td>
<td>CS</td>
<td>MSC\ VLR</td>
<td>2</td>
</tr>
<tr>
<td>T-C SI</td>
<td>Terminating CAMEL Subscription Information (T-C SI) is transferred to the IPI LMN for an incoming call in the GMSC. T-C SI is for Mobile Terminating calls in the GMSC.</td>
<td>CS</td>
<td>GMSC</td>
<td>1</td>
</tr>
<tr>
<td>T IF-C SI</td>
<td>Translation information Flag CAMEL Subscription Information (T IF-C SI) is transferred to the VPLMN. T IF-C SI is used in the HLR for registering short Forwarded-to-Numbers (FTNs).</td>
<td>CS</td>
<td>MSC\ VLR</td>
<td>2</td>
</tr>
<tr>
<td>U-C SI</td>
<td>USSD CAMEL Subscription Information (U-C SI) is held in the HLR; it is not sent to any other node. U-C SI is for USSD application (for the served subscriber).</td>
<td>CS</td>
<td>HLR</td>
<td>2</td>
</tr>
<tr>
<td>UG-C SI</td>
<td>USSD General CAMEL Subscription Information (UG-C SI) is held in the HLR; it is not sent to any other node. UG-C SI is for USSD application (for all subscribers).</td>
<td>CS</td>
<td>HLR</td>
<td>2</td>
</tr>
<tr>
<td>VT-C SI</td>
<td>VMSC Terminating CAMEL Subscription Information (VT-C SI) is transferred to the VPLMN at Location Update. VT-C SI is for Mobile Terminating calls in the VMSC.</td>
<td>CS</td>
<td>MSC\ VLR</td>
<td>3</td>
</tr>
</tbody>
</table>
CAMEL Subscription Information (CSI) content

- Trigger Detection Point (DP2, DP12 etc)
- gsmS CF address (Global Title of the SCP)
- Service Key (identifies the service logic in the SCP)
- Default Call/SMS/GPRS Handling (Continue or Release, if CAP dialogue fails)
- Capability Handling (CAP protocol version, not for MAP CSIs)
- Trigger criteria (e.g. dialled number, basic service, reason code etc)
- CSI state (active/deactive)
- CSE Notification on CSI change.
CAMEL State Models

- (Call) State Model is the view that the SCP has about the progress of a call/short message/PDP context etc.

- State models consist of Detection Points (DP) and Point In Call (PIC) / Point In Association (PIA). DPs are reported to the SCP/CS E.

- Trigger Detection Point (TDP-R) is a detection point in which CAP dialogue is initiated by the SSF.

- Event Detection Point (EDP) is reported only if SCP has armed so. An EDP can either be armed as:
  - EDP-N: DP is reported and processing continues in SSF automatically.
  - EDP-R: DP halts processing in SSF, processing continues when the SCP sends down a final instruction (Continue, Connect, Release)
CAP over SS7 stack

API Interface

Figure is based on (29078)
CAMEL L3 in SGSN
CAMEL 3 GPRS Attach/Detach State Model

- DP Attach TDP-R
- DP Change Of Position GPRS Session TDP-R, EDP-N
- DP Detach EDP-N, EDP-R

### Diagram

- **Detached**
  - Attach request
  - User- or network initiated detach
  - Intra-SGSN Routeing area update

- **Attached**
  - Attach
  - Inter SGSN Routeing area update

- **AD_Exception**

### Source:
(23078)
CAMEL 3 PDP Context State Model

- DP PDP Context Establishment
  TDP-R, EDP-R, EDP-N
- DP PDP Context Establishment Acknowledgement
  TDP-R, EDP-R, EDP-N
- DP Change Of Position Context
  TDP-R, EDP-R, EDP-N
- DP PDP Context Disconnection
  EDP-N, EDP-R

SOURCE: (23078)
CAMEL 3 State Model for MO SMS

- DP_SMS_Collected_Info to DP-R
- DP_O_SMS_Failure to EDP-N, EDP-R
- DP_O_SMS_Submitted to EDP-N, EDP-R

SOURCE: (23078)
CAMEL 3 with GPRS Interworking

- In the Table 12 above (based on (23060, 23078)) four different parameters describing CAMEL 3 effect on the PDP Context are presented. At first, basic GPRS procedures belong either to Mobility (GPRS Session) or Session Management (PDP Context). Then, number of DPs among each signalling procedure is presented; usually it varies between 1-3. Next, affecting State Models are given and finally, the type of CAP dialogue. The CAP dialogue can be PDP Context or GPRS Session specific, i.e. individual PDP Contexts can be controlled within a group of active Contexts (per GPRS Session; CAMEL GPRS Scenario 1) or single basis (per PDP Context; CAMEL

<table>
<thead>
<tr>
<th>GPRS Signalling Area</th>
<th>GPRS Signalling Procedure</th>
<th>Number of DPs encountered</th>
<th>State Models: Attach/Detach vs. PDP Context</th>
<th>Type of CAP Dialogue: Session vs. Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM</td>
<td>GPRS Attach</td>
<td>1</td>
<td>Attach/Detach</td>
<td>Session</td>
</tr>
<tr>
<td>MM</td>
<td>GPRS Detach</td>
<td>1</td>
<td>Attach/Detach</td>
<td>Session</td>
</tr>
<tr>
<td>SM</td>
<td>PDP Context Activation</td>
<td>2</td>
<td>Both</td>
<td>Both</td>
</tr>
<tr>
<td>SM</td>
<td>PDP Context Modification</td>
<td>1</td>
<td>Both</td>
<td>Both</td>
</tr>
<tr>
<td>SM</td>
<td>PDP Context Deactivation</td>
<td>2</td>
<td>Both</td>
<td>Both</td>
</tr>
<tr>
<td>MM</td>
<td>Inter SGSN RAU</td>
<td>2</td>
<td>Both</td>
<td>Both</td>
</tr>
<tr>
<td>MM</td>
<td>SRNC Relocation</td>
<td>2</td>
<td>Both</td>
<td>Both</td>
</tr>
<tr>
<td>MM</td>
<td>Intersystem change (2G &lt;-&gt; 3G)</td>
<td>2</td>
<td>Both</td>
<td>Both</td>
</tr>
</tbody>
</table>

Table 12. CAMEL3 effect on GPRS Interworking.
GPRS Session based CAMEL Dialogue Handling

- Two CAMEL State Models must be implemented:
  - CAMEL GPRS Attach/Detach
  - CAMEL GPRS PDP Context

- CAMEL GPRS Control and Interaction per GPRS Session

  UE is in "Attached" state or goes from "Idle" to "Attached" state (during Attach procedure) when CAMEL Interaction, Triggering or Continuing CAP communication in EDP-R/EDP-N, starts

  CAMEL Interaction with SCP occurs within Session Dialogue
  
  CAMEL Triggering occurs once for the whole GPRS Session in the same SGSN

SOURCE: [23078]
PDP Context based CAMEL Dialogue Handling

- Single CAMEL State Model must be implemented:
  - CAMEL GPRS PDP Context
- CAMEL GPRS Control and Triggering per PDP Context during GPRS Session
  - UE always in "Attached" state when CAMEL interaction starts and ends
  - All CAMEL activities occur within PDP Context Dialogue
## CAPv3 Operations for GPRS

Table 14. The CAP operations for GPRS Interworking.

<table>
<thead>
<tr>
<th>CAP Operation</th>
<th>Direction</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>ActivityTestGPRS</td>
<td>SCP -&gt; SGSN</td>
<td>SCP tests CAP connection.</td>
</tr>
<tr>
<td>ActivityTestGPRSAck</td>
<td>SGSN -&gt; SCP</td>
<td>SGSN acknowledges.</td>
</tr>
<tr>
<td>ApplyChargingGPRS</td>
<td>SCP -&gt; SGSN</td>
<td>SCP sends threshold limits and tsw (Prepaid).</td>
</tr>
<tr>
<td>ApplyChargingReportGPRS</td>
<td>SGSN -&gt; SCP</td>
<td>SGSN reports transferred data and/or elapsed time.</td>
</tr>
<tr>
<td>ApplyChargingReportGPRSAck</td>
<td>SCP -&gt; SGSN</td>
<td>SGSN acknowledges.</td>
</tr>
<tr>
<td>CancelGPRS</td>
<td>SCP -&gt; SGSN</td>
<td>SCP cancels all DPs and reports.</td>
</tr>
<tr>
<td>ConnectGPRS</td>
<td>SCP -&gt; SGSN</td>
<td>SCP gives new APN.</td>
</tr>
<tr>
<td>ContinueGPRS</td>
<td>SCP -&gt; SGSN</td>
<td>SCP orders SGSN to continue suspended processing.</td>
</tr>
<tr>
<td>EntityReleasedGPRS</td>
<td>SGSN -&gt; SCP</td>
<td>SGSN informs SCP on abnormal event in SGSN.</td>
</tr>
<tr>
<td>EntityReleasedGPRSAck</td>
<td>SCP -&gt; SGSN</td>
<td>SCP acknowledges.</td>
</tr>
<tr>
<td>EventReportGPRS</td>
<td>SGSN -&gt; SCP</td>
<td>SGSN informs SCP on DPs encountered.</td>
</tr>
<tr>
<td>EventReportGPRSAck</td>
<td>SCP -&gt; SGSN</td>
<td>SCP acknowledges.</td>
</tr>
<tr>
<td>FurnishChargingInformationGPRS</td>
<td>SCP -&gt; SGSN</td>
<td>SCP gives free format charging data into CDR.</td>
</tr>
<tr>
<td>InitialDPGPRS</td>
<td>SGSN -&gt; SCP</td>
<td>Establishes CAP connection (1st operation).</td>
</tr>
<tr>
<td>ReleaseGPRS</td>
<td>SCP -&gt; SGSN</td>
<td>SCP orders SGSN to release GPRS Session and/or PDP Contexts.</td>
</tr>
<tr>
<td>RequestReportGPRSEvent</td>
<td>SCP -&gt; SGSN</td>
<td>SCP orders SGSN to notify, when new DP is met.</td>
</tr>
<tr>
<td>ResetTimerGPRS</td>
<td>SCP -&gt; SGSN</td>
<td>SCP refreshes gprsSSF</td>
</tr>
</tbody>
</table>

- The CAP operations between the SGSN's gprsSSF and the SCP's gsmSCF are presented in next page (Table 14, based on [23078, 29078]). As it can be seen, the GPRS Interworking includes 18 different CAP operations for the CAMEL3. Those CAP operations that are seen in Figures for the IN Based Prepaid have been marked with grey colour.
CAMEL 3 with MO-SMS

- In the Table 13 below (based on (23060, 23078)) corresponding parameters for SMS Sending are presented. The CAMEL3 affects only MO-SMS Sending (MT-SMS is a Phase4 issue). Then, number of the DPs is, in the case of the MO-SMS, 2 due to the fact that the SCP must be contacted before and after MO-SMS sending has been occurred. The MO-SMS includes only one State Model that is common for both Domains (CS, PS). The MO-SMS CAMEL utilizes long TCAP dialogues. (23078).

Table 13. CAMEL3 effect on MO-SMS.

<table>
<thead>
<tr>
<th>SMS Signalling Area</th>
<th>SMS Signalling Procedure</th>
<th>Number of DPs encountered</th>
<th>State Model</th>
<th>Type of CAP Dialogue</th>
</tr>
</thead>
<tbody>
<tr>
<td>MO-SMS (packet-switched)</td>
<td>MO-SMS Sending</td>
<td>2</td>
<td>MO-SMS</td>
<td>MO-SMS</td>
</tr>
</tbody>
</table>
CAPv3 Operations for MO-S MS

Table 15. The CAP operations for MO-SMS (PS + CS).

<table>
<thead>
<tr>
<th>CAP Operation</th>
<th>Direction</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>ConnectSMS</td>
<td>SCP -&gt; SGSN</td>
<td>SCP gives new APN.</td>
</tr>
<tr>
<td>ContinueSMS</td>
<td>SCP -&gt; SGSN</td>
<td>SCP orders SGSN to continue suspended processing.</td>
</tr>
<tr>
<td>EventReportSMS</td>
<td>SGSN -&gt; SCP</td>
<td>SGSN informs SCP on DPs encountered.</td>
</tr>
<tr>
<td>InitialDPSMS</td>
<td>SGSN -&gt; SCP</td>
<td>Establishes CAP connection (1st operation).</td>
</tr>
<tr>
<td>FurnishChargingInformationSMS</td>
<td>SCP -&gt; SGSN</td>
<td>SCP gives free format charging data into CDR.</td>
</tr>
<tr>
<td>ReleaseSMS</td>
<td>SCP -&gt; SGSN</td>
<td>SCP orders SGSN to release MO-SMS Sending.</td>
</tr>
<tr>
<td>RequestReportSMSEvent</td>
<td>SCP -&gt; SGSN</td>
<td>SCP orders SGSN to notify, when new DP is met.</td>
</tr>
<tr>
<td>ResetTimerSMS</td>
<td>SCP -&gt; SGSN</td>
<td>SCP refreshes gprsSSF timers.</td>
</tr>
</tbody>
</table>

- The CAP operations between the SGSN's s ms S S F and the SCP's gsmS CF are presented in Table 15 (based on (23078, 29078)). As it can be seen, the MO-S MS includes 8 different CAP operations for the CAMEL 3. Those CAP operations that are seen in Figures for the IN Based Prepaid have been marked with grey colour.
CAMEL 3 in MSC
CAMEL 3 O-B CSM

- DP Collected_Info TDP-R
- DP Analysed_Information TDP-R
- DP Route_Select_Failure TDP-R, EDP-N, EDP-R
- DP O_Busy EDP-N, EDP-R
- DP O_No_Answer EDP-N, EDP-R
- DP O_Answer EDP-N, EDP-R
- DP O_Disconnect EDP-N, EDP-R
- DP O_Abandon EDP-N, EDP-R

SOURCE: (23078)
CAMEL 3 T-BCSM

- DP Terminating_Authorised
  - TDP-R
- DP T_Busy
  - TDP-R, EDP-N, EDP-R
- DP T_No_Answer
  - TDP-R, EDP-N, EDP-R
- DP T_Answer
  - EDP-N, EDP-R
- DP T_Disconnect
  - EDP-N, EDP-R
- DP T_Abandon
  - EDP-N, EDP-R

SOURC E: (23078)
CAMEL 3 State Model for MO SMS

- DP SMS_Collected_Info → DP-R
- DP O_SMS_Failure → EDP-N, EDP-R
- DP O_SMS_Submitted → EDP-N, EDP-R

SOURCE: (23078)
Table 17. CAMEL3 effect on Circuit Switched Call Control.

<table>
<thead>
<tr>
<th>CS Phone Call Signalling Area</th>
<th>CS Phone Call Signalling Procedure</th>
<th>SubArea of Signalling</th>
<th>State Models: O-BCSM vs. T-BCSM</th>
<th>Number of DPs in the State Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM</td>
<td>IMSI Attach</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>MM</td>
<td>IMSI Detach</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CC</td>
<td>Mobile Originated Call</td>
<td>-</td>
<td>O-BCSM</td>
<td>8</td>
</tr>
<tr>
<td>CC</td>
<td>Mobile Forwarded Call</td>
<td>-</td>
<td>Both</td>
<td>8 + 6 = 14</td>
</tr>
<tr>
<td>CC</td>
<td>Mobile Terminated Call</td>
<td>-</td>
<td>T-BCSM</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>• in GMSC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• in VMSC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Line Identification</td>
<td>Both</td>
<td></td>
<td>8 + 6 = 14</td>
</tr>
<tr>
<td></td>
<td>• Call Forwarding Services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Call Barring Services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Call Deflection Services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Closed User Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MM</td>
<td>Inter MSC Handover</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MM</td>
<td>Intersystem change (2G &lt;-&gt; 3G)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

- The CAMEL functionality affects the CS Domain in the following areas: Circuit Switched Call Control, Short Message Service, Supplementary Service Invocation, USSD, Mobility Management, Control and Interrogation of Subscription Data and Subscriber State and Location Retrieval (Table 4, based on (23078)). Most of them are already within earlier CAMEL Phases, i.e. Phase 1 and Phase 2; introducing the CAMEL3 just brings enhancements to these areas. The most important CAMEL Application Area is Circuit Switched Call Control. It includes State Models and CAP signals for controlling CS Phone Call (see Table 17, based on...
# CAP Operations for CS Phone Call

Table 18. The CAP operations for Circuit Switched Call Control. MSC contains gsmSSF + possibly internal SRF. IP contains gsmSRF.

<table>
<thead>
<tr>
<th>CAP Operation</th>
<th>Direction</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>ActivityTest</td>
<td>SCP -&gt; MSC</td>
<td>SCP tests CAP connection.</td>
</tr>
<tr>
<td>ActivityTestAck</td>
<td>MSC -&gt; SCP</td>
<td>MSC acknowledges.</td>
</tr>
<tr>
<td>ApplyCharging</td>
<td>SCP -&gt; MSC</td>
<td>SCP sends threshold limits and tsw (Prepaid).</td>
</tr>
<tr>
<td>ApplyChargingReport</td>
<td>MSC -&gt; SCP</td>
<td>MSC reports transferred data and/or elapsed time.</td>
</tr>
<tr>
<td>AssistRequestInstructions</td>
<td>IP, MSC -&gt; SCP</td>
<td>MSC, IP gives SCP info to associate with InitialDP.</td>
</tr>
<tr>
<td>CallGap</td>
<td>SCP -&gt; MSC</td>
<td>SCP activates/modify removes call gap mechanism from MSC.</td>
</tr>
<tr>
<td>CallInformationRequest</td>
<td>SCP -&gt; MSC</td>
<td>SCP orders MSC to record specific info on single call.</td>
</tr>
<tr>
<td>CallInformationReport</td>
<td>MSC -&gt; SCP</td>
<td>MSC reports SCP specific call info of a single call.</td>
</tr>
<tr>
<td>Cancel</td>
<td>SCP -&gt; MSC</td>
<td>SCP cancels all DPs and reports.</td>
</tr>
<tr>
<td>Connect</td>
<td>SCP -&gt; MSC</td>
<td>SCP orders MSC to route the call to a specific destination.</td>
</tr>
<tr>
<td>ConnectToResource</td>
<td>SCP -&gt; MSC</td>
<td>The ongoing call is connected to IP (gsmSRF).</td>
</tr>
<tr>
<td>Continue</td>
<td>SCP -&gt; MSC</td>
<td>SCP orders MSC to continue suspended processing.</td>
</tr>
<tr>
<td>ContinueWithArgument</td>
<td>SCP -&gt; MSC</td>
<td>SCP orders MSC to continue suspended processing with modified information.</td>
</tr>
<tr>
<td>DisconnectForwardConnection</td>
<td>SCP -&gt; MSC</td>
<td>SCP orders MSC to disconnect connection with IP (gsmSRF).</td>
</tr>
<tr>
<td>EstablishTemporaryConnection</td>
<td>SCP -&gt; MSC</td>
<td>SCP orders MSC to establish connection with e.g. IP (gsmSRF).</td>
</tr>
<tr>
<td>EventReportBCSM</td>
<td>MSC -&gt; SCP</td>
<td>MSC reports SCP on encountered DP (call-related event).</td>
</tr>
<tr>
<td>FurnishChargingInformation</td>
<td>SCP -&gt; MSC</td>
<td>SCP gives free format charging data into CDR.</td>
</tr>
<tr>
<td>InitialDP</td>
<td>MSC -&gt; SCP</td>
<td>Establishes CAP connection (1st operation).</td>
</tr>
<tr>
<td>PlayAnnouncement</td>
<td>SCP -&gt; MSC</td>
<td>SCP gives IP instructions on playing announcements/tones to subscriber.</td>
</tr>
<tr>
<td>PromptAndCollectUserInformation</td>
<td>SCP -&gt; MSC, IP</td>
<td>SCP interacts with the calling party to collect information.</td>
</tr>
<tr>
<td>PromptAndCollectUserInformationAck</td>
<td>MSC -&gt; SCP</td>
<td>MSC, IP acknowledges</td>
</tr>
<tr>
<td>ReleaseCall</td>
<td>SCP -&gt; MSC</td>
<td>SCP orders MSC to terminate the ongoing call.</td>
</tr>
<tr>
<td>RequestReportBCSMEvent</td>
<td>SCP -&gt; MSC</td>
<td>SCP orders MSC to notify, when new DP is met.</td>
</tr>
<tr>
<td>ResetTimer</td>
<td>SCP -&gt; MSC</td>
<td>SCP refreshes gprsSSF timers.</td>
</tr>
<tr>
<td>SendChargingInformation</td>
<td>SCP -&gt; MSC</td>
<td>SCP gives AoC information.</td>
</tr>
<tr>
<td>SpecializedResourceReport</td>
<td>MSC -&gt; SCP</td>
<td>MSC, IP responses to PlayAnnouncement operation (when</td>
</tr>
</tbody>
</table>

Table is based on (23078, 29078)
CAMEL 3 in Service Platform
CAMEL 3 in Service Platform

- There must be implemented within the gsmSCF exactly the same State Models, CAMEL Detection Points and CAP operations as in the gprsSSF and the gsmSSF. Otherwise, CAP communication between these entities will not succeed.

- From the Service Platform point of view, it consists of several IN elements and components and gives various benefits for the network operator, service provider and subscriber.
Own contribution: IN Based Prepaid by the help of CAMEL 3

IN Based Prepaid is used as an example to show, how CAMEL 3 can be utilized in both CS and PS Core Domains
IN Based Prepaid - Operation Principle

• From the charging point of view, the prepaid is an addition to normal charging. This means in practice that charges for telecommunication services are applied to the prepaid service account by decrementing this account in real-time. The prepaid mobile subscriber may be notified about his/her real-time account information at the beginning, during, or at the end of the telecommunications service currently in use. When the account balance is low enough the subscriber is possibly notified (via SMS sending or tone announcements) so that the subscriber has a chance to refill the account. When the account balance drops below a pre-defined threshold, the subscriber’s use of telecommunications services is barred by the service provider. The Prepaid is applicable to CS Phone Calls, Mobile Originated (MO), Mobile Forwarded (MF) and Mobile Terminated (MT), GPRS and MO-SMS.

• In the IN architecture the prepaid account is held in Service Control Point (SCP). The information that the subscriber is a CAMEL subscriber is provisioned to the HLR. All CSI elements available are downloaded from the HLR during Attach, Location Update and Inter SGSN RAU procedures to the MSC/SGSN. The SCP gives limits to the MSC (Apply Charging; time limit) and the SGSN (Apply Charging GPRS; time, data or both limits) and they report those limits back in Apply Charging Report.
IN Based Prepaid in PS Core Domain

- Session Management
  - PDP Context Activation
  - PDP Context Modification
  - PDP Context Deactivation

- Mobility Management
  - (UMTS) GPRS Attach
  - (UMTS) GPRS Detach
  - SRNC Relocation + Inter SGSN RAU

- MO-SMS Sending

- Micro-Billing Scenario (CAMEL3 + OSA API)
PDP Context Activation (Context Dialogue)

- PDP Context State Model
- DP PDP Context Establishment
- DP PDP Context Establishment Ack

The GPRS Session is going on and mobile subscriber tries to activate PDP Context, i.e. to start data transfer...

<table>
<thead>
<tr>
<th>MS</th>
<th>3G-SGSN</th>
<th>GGSN</th>
<th>SCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activate PDP Context Request</td>
<td>Initial DP GPRS (DP PDP Context Establishment)</td>
<td>Furnish Charging Information GPRS</td>
<td>Request Report GPRS Event</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Continue GPRS</td>
</tr>
<tr>
<td>Create PDP Context Request</td>
<td>Create PDP Context Response (Charging ID)</td>
<td>Event Report GPRS (DP PDP Context Establishment Ack)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Event Report GPRS Ack</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Apply Charging GPRS (maxTransferredVolume)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Apply Charging GPRS (maxElapsedTime)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Continue GPRS</td>
</tr>
<tr>
<td>Activate PDP Context Accept</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The mobile subscriber can now transfer data now. Simultaneously, Prepaid charging is going on, too.

Activity Test GPRS

Data limit is reached in 3G-SGSN - must be reported to SCP. If there are both limits - data and time - pending, BOTH limits are reported with two different ‘Apply Charging GPRS’ operations.

Apply Charging Report GPRS (transferredVolume, active) | Apply Charging Report GPRS Ack |
| Apply Charging Report GPRS (elapsedTime, active) | Apply Charging Report GPRS Ack |
| Apply Charging GPRS (maxTransferredVolume) | Apply Charging Report GPRS Ack |
| Apply Charging GPRS (maxElapsedTime) | Apply Charging Report GPRS Ack |
The GPRS Session is going on. This PDP Context is active. The subscriber tries to watch a video footage after reading an electric newspaper -> QoS is changing...

- Update PDP Context Request
- Update PDP Context Response
- Modify PDP Context Request
- Modify PDP Context Accept
- Apply Charging Report GPRS (Volume, Negotiated QoS)
- Apply Charging Report GPRS Ack
- Furnish Charging Information GPRS
- Apply Charging GPRS (maxTransferredVolume)

The GPRS Session is going on. This PDP Context is active and has new QoS parameters now.

**SGSN Initiated PDP Context Modification**

- **PDP Context State Model**
  - **Point In Association (PIA)**
  - **PDP_Context_Established**
**MS Initiated PDP Context Deactivation**

- **State Model**
  - MS
  - 3G-SGSN
  - GGSN
  - SCP

**PDP Context Disconnection**

The GPRS Session is going on. This PDP Context is active. The subscriber wants to stop the connection to Internet, i.e. to terminate the data transfer occasion.

- **Deactivate PDP Context Request**
  - Apply Charging Report GPRS (transferred volume, not active)
  - Furnish Charging Information GPRS
  - Event Report GPRS (DP PDP Disconnection met)
  - Event Report GPRS Ack
  - Continue GPRS

- **Delete PDP Context Request**
  - Delete PDP Context Response

- **Deactivate PDP Context Accept**

The GPRS Session is still going on. This PDP Context is deactivated, i.e. the subscriber can’t transfer any data with this PDP Context.
UMTS GPRS Attach (Session Dialogue)

- **GPRS Attach/Detach**
  - State Model
    - **DP Attach**
  - After Attach procedure, PDP Context(s) is activated ->
  - **DPs PDP Context Establishment and PDP Context Establishment Ack** (PDP Context State Model) for PDP Context are encountered; signalling is quite similar than in Context Dialogue (except that 'Initial DP GPRS' is not sent any more to SCP).

Mobile subscriber tries to attach to the Packet Switched Core Network Domain...

- **MS**
- **3G-SGSN**
- **SCP**
- **HLR**

- **Attach Request**
  - Insert Subscriber Data
  - **Initial DP GPRS (DP Attach)**
  - Request Report GPRS Event
  - **Apply Charging GPRS (Tcp + Tsw for GPRS Session)**
  - Furnish Charging Information GPRS (for GPRS Session)
  - Continue GPRS

- **Attach Accept**
  - Insert Subscriber Data Ack

Mobile subscriber is attached to the Packet Switched Core Network Domain (there is credit left in his Prepaid account in SCP).
UMTS GPRS Detach (Session Dialogue)

- **GPRS Attach/Detach State Model**
  - DP Detach

- **PDP Context State Model**
  - DP PDP Context Disconnection

The GPRS Session is going on. The mobile subscriber has stopped transferring data and tries to detach from the network...

- Detach Request
- Delete PDP Context Request
- Delete PDP Context Response
- Apply Charging Report GPRS (Data+Time; for PDP Context)
- Apply Charging Report GPRS Ack
- Furnish Charging Information GPRS (for PDP Context)
- Event Report GPRS (DP PDP Context Disconnection)
- Event Report GPRS Ack
- Continue GPRS (for PDP Context)

There may be several PDP Context Deactivations before DP Detach for GPRS Session is encountered...

- Apply Charging Report GPRS (Time; for GPRS Session)
- Apply Charging Report GPRS Ack
- Furnish Charging Information GPRS (for GPRS Session)
- Event Report GPRS (DP Detach)
- Event Report GPRS Ack
- Continue GPRS (for GPRS Session)

The GPRS Session is over and the subscriber is detached from the Packet Switched Core Network Domain.
**SRNC Relocation in old 3G-SGSN**

*(Session Dialogue)*

- Attach/Detach State Model
  - DP Detach, Change of Position
- PDP Context State Model
  - DP PDP Context Disconnection, Change of Position

---

**Mobile subscriber is roaming between two Routing Areas. Data Transfer is possibly going on (mobile in PMM-Connected mode):**

<table>
<thead>
<tr>
<th>MS</th>
<th>Old 3G-SGSN</th>
<th>New 3G-SGSN</th>
<th>GGSN</th>
<th>SCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source RNC decides to initiate SRNS relocation...</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Forward Relocation Request</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Establishment of Radio Access Bearers between Target RNC and new 3G-SGSN</td>
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<tr>
<td>Forward Relocation Response</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apply Charging Report GPRS (DataVolume active)</td>
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</tr>
<tr>
<td>Update PDP Context Request</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward Relocation Complete</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward Relocation Complete Acknowledge</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>SRNS Context Disconnection was encountered for all active PDP Contexts, before DP Detach for GPRS Session is met. All Downlink and Uplink data for this GPRS Session (for all active PDP Contexts) are transferred via new 3G-SGSN and new RNC (Target RNC).</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Source RNC detects that this relocation was successful (Iu-PS is released by the Old 3G-SGSN)</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**SC P**

**GGSN**

**New 3G-SGSN**

**Old 3G-SGSN**

**MS**

- Apply Charging Report GPRS (Time, for GPRS Session)
- Furnish Charging Information GPRS (for PDP Context)
- Event Report GPRS (DP Detach, Change of Position)
- Continue GPRS (for PDP Context)

- Forward Relocation Request
- Forward Relocation Response
- Update PDP Context Request
- Update PDP Context Response
- Forward Relocation Complete
- Forward Relocation Complete Acknowledge
- Apply Charging Report GPRS (Active)
- Furnish Charging Information GPRS (for PDP Context)
- Event Report GPRS (DP Detach, Change of Position)
- Continue GPRS (for PDP Context)
Inter SGSN RAU in new 3G-SGSN (Session Dialogue)

- Attach/Detach State Model
  - DP Change of Position Session
- PDP Context State Model
  - DP Change of Position Context

Inter SGSN RAU is going on. Old 2G/3G-SGSN has terminated CAP connection with SCP. New 3G-SGSN has already updated its PDP and MM Contexts. The GPRS Session and different PDP Contexts are active in new 3G-SGSN.

Routing Area Update Request

Update GPRS Location (Supported Camel Phases)
  - Insert Subscriber Data (GPRS-CSI + SMS-CSI)
  - Insert Subscriber Data Ack
  - Initial DP GPRS (DP Change of Position Session)

Prepaid account check. If no credit left, ‘Release GPRS’ is sent back.

Request Report GPRS Event (Change of Position Context)
  - Furnish Charging Information GPRS (for GPRS Session)
  - Apply Charging GPRS (Tc + Tsw for GPRS Session)
  - Continue GPRS (for GPRS Session)

Event Report GPRS (DP Change of Position Context)
  - Furnish Charging Information GPRS (for PDP Context)
  - Apply Charging GPRS (Time, Data, Tsw for PDP Context)
  - Continue GPRS (for PDP Context)

Session Dialogue is active for GPRS Session and its different PDP Contexts in new 3G-SGSN now (Prepaid charging is going on).
MO-S MS Sending

Mobile subscriber is attached to the Packet Switched Core Network Domain. The GPRS Session is going on. The subscriber tries to send a mobile-originated SMS (MO-SMS).

1. Mobile subscriber is attached to the Packet Switched Core Network Domain.
2. The subscriber tries to send a mobile-originated SMS (MO-SMS).
3. MO-SMS is sent to SMS Centre.
4. Delivery Report

MO-SMS Sending was successful. The GPRS Session is still going on.

• MO-S MS State Model
  • DP SMS_Collected_Info
  • DP_O_SMS_Submitted
In the Figure 56 below (based on [Gre01, Lil01, 23060, 23078, 29998]) the mobile subscriber reads an electric newspaper from a commercial Internet Site (News Services) and pays for that in real-time utilizing his Prepaid account within the SCP. The signalling is shown in the situation, where the Service Access has already been granted by the Core Network (Service Access level is not shown). Usually, the Prepaid account is common for both the Core Domains. As it can be seen, the gsmSCF does not handle service logic execution any more. The service logic execution is under the APPSE’s responsibility now (possibly outside Core Network, if it is owned by the 3rd party service provider).
IN Based Prepaid in CS Core Domain

- Call Control
  - Mobile Originated Phone Call
  - Mobile Terminated Phone Call
- Mobility Management
  - Location Update

ALL FIGURES ARE BASED ON [23018, 23078]
Mobile Originated Call Establishment

Mobile subscriber is attached to the Circuit Switched Core Network Domain and tries to make a phone call...

Setup (B#)

InitialDP (B#, IMSI, MSISDN, Location, CallRef#, ServiceKey)

RequestReportBCSMEvent (armed DPs)

FurnishChargingInformation

ApplyCharging (Tcp, Tsw, ReleaseIfExceeded=No, Tone)

Continue

ISUP_IAM (B#)

Connect

Alert

Circuit Switched Phone Call is established between A and B subscribers.

SCCP

PSTN

• CAMEL 3 O-BCS
• DP Collected_Info
Mobile Originated Call Release

Mobile subscriber is attached to the Circuit Switched Core Network Domain and CS phone call is going on. Time limit expires.

- Apply Charging Report (Time limit)
  - FurnishChargingInformation
  - ReleaseCall
  - ISUP_REL
  - FurnishChargingInformation

SCP ordered VMSC to terminate the CS phone call immediately. Thus, the mobile subscriber is detached from the Circuit Switched Core Network Domain.

- CAMEL3 O-BCS M
  • DP
  • O_Disconnect
Mobile Terminated Call Establishment

Mobile subscriber is attached to the Circuit Switched Core Network Domain and receives a phone call...

- CAMEL3 T -
  - BCS M
- DP Terminating Attempt_Authorized

Circuit Switched Phone Call is established between A and B subscribers.
Mobile Terminated Call Release

- **CAMEL3 T-BCSM**
  - **DP**
    - TDisconnect

Mobile subscriber is attached to the Circuit Switched Core Network Domain and terminates the ongoing call...

1. **ISUP-REL**
   - ApplyChargingReport (Time limit)
   - EventReportBCSM (T_Disconnect, leg-B etc)
   - FurnishChargingInformation

Continue

Mobile subscriber is attached to the Circuit Switched Core Network Domain, and the call is terminated.
Location Update (M-CS I not present)

- With the M-CS I, CS Core Network Domain Attach and Detach procedures can be reported to the gsmSCF, too. In the CAMEL Phase 3, however, Inter System Change between the 2G-MS C and the 3G-MS C, is not visible to the gsmSCF. (Net01f)

- Figure is based
Conclusions (1/2)

- The service control experiences a real evolution: more players in the field, new technologies (terminal, radio access, core network), network operators must open their networks for other companies (wholesaling), new value chain models, new business models, multiple service scenarios. The most important concept is the VHE.

- The IN shall have a role in the future mobile networks; but the role of the IN changes from the sole technology to just one technology alternative in 3G service creation and control. The most important benefits of the IN are safe and secure solution and standardized, open interfaces. The biggest drawback is that all IN based solutions are quite expensive for the network operator.
Conclusions (2/2)

- The CAMEL Phase 3 architecture affects the R99 UMTS network by introducing INCM entities (SSFs) in the core network. The utilized protocols are CAP and MAP that increase SS7 signalling load of the network. The most important service is Prepaid. The Prepaid concept may be later enhanced towards m-Commerce and different micro-billing scenarios. The main purpose of the CAMEL is to give roaming support for subscribers moving outside HPLMN area.

- The CAMEL Phase 3 core network signalling can utilize APIs, such as OSA and Parlay API, for more flexible service control between the network and the service layer. By the help of the APIs, the service layer devices do not have to know the details of the core network at all. This makes possible more flexible and rapid service and application development especially for the 3rd parties. The CAMEL and APIs together create more value for all participants within the 3G product value chain: operators and application developers get more revenue and a mobile subscriber is entitled to
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