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The Alignment of IN and GSM

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I. Introduction

The secret of wealth can no longer be described as land, raw material and money. It is intelligence and information, and the ability to use it.

Today's telecommunication market is shifting from providing basic telecommunication services towards the use of value added services through multiple networks. Competition and deregulation cause a growing demand of operators and providers to increase their service offerings to gather additional revenue. This may be achieved by differentiating and enlarging the offer of personalized services to end-users.

After the Global System for Mobile communication (GSM, [Mou92]) started its triumphal march from the old continent became obvious that mobile communication is a market with a gigantic subscriber potential. In 1996 there were 153 GSM networks installed in 91 countries worldwide, [Sei97]. One of the most fascinating features of these GSM networks is the possibility for the subscribers to roam between countries always being reachable under the same directory number.

The visions of globally accessible supplementary services and integrated networks are shared by most telecommunication companies in the world. However, the telecommunication world needs to cooperate for the provision of sophisticated services.

Moreover, telecommunication network users become more demanding in terms of functionality. Their common slogan is “any service, anywhere, any time”. Therefore new methods of service provisioning are urgently needed, but the provision of sophisticated communication functionality within the GSM system cannot be solved that easily. This has been identified by the European Telecommunication Standards Institute (ETSI) and measures have been taken to evolve the GSM architecture towards the standard of an Intelligent Network (IN). Therefore, a feature which answers to the name Customized Applications for Mobile networks Enhanced Logic (CAMEL) has been standardized by ETSI. In particular this CAMEL feature will help GSM network operators to provide their subscribers with Operator Specific Services (OSS) even when roaming outside their home networks. This is the most critical issue, because the possibility to roam is achieved with a strict standardization of the network interfaces.

II. Integration of IN and GSM

The number of IN services offered by Public Network Operators (PNOs) is currently increasing. While IN services prove their usefulness in the PNOs networks, a demand to extend these new telecommunication capabilities globally arise, but up to now these services are available only in fixed networks. To provide IN services within a mobile network like GSM means to supply a mobile subscriber with the addition of personal and terminal mobility called universal mobility or total mobility, [Geu93, Har96].

Personal mobility allows a user to access telecommunication services through different terminals. Calls directed to the subscriber should be presented to him/her at the terminal he/she is currently using. The UPT service is a personal mobility service allowing the subscribers to be reachable in multiple networks under a unique Personal Telecommunication Number (PTN). However, the GSM system has been designed without consideration of the IN standard. The separation of the switching layer from the mobility and service layer at the visited switch does not exist.

Future systems will deliver common supplementary services for customers roaming globally across a number of underlying transport networks (cellular, fixed and cordless), see figure 1.

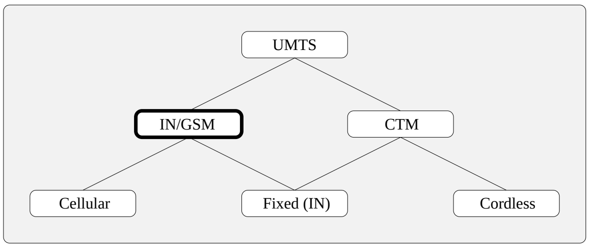

Figure 1: Integration scenario

For GSM Phase 2+ there is a standardization issue called CAMEL under discussion. It is more and more seen as a way to introduce IN into GSM. CAMEL is described in the following chapter.
Besides IN and GSM there is a third telecommunication system currently booming. This is Digital Enhanced Cordless Telecommunication (DECT). The DECT standard was defined by ETSI to serve a range of applications that include residential and business systems, public cordless access systems (telepoint), wireless data access systems (LAN) and evolutionary systems (cordless access to cellular) [Pan95]. Furthermore, an IN service called Cordless Terminal Mobility (CTM) is defined by ETSI, [613-2]. This service involves the ability of cordless terminals to be mobile within and between networks. CTM is the attempt to integrate cordless telecommunication systems like DECT into an IN.

III. CAMEL

CAMEL is undoubtedly one of the most interesting new developments within the GSM framework. It is currently discussed in ETSI's SMG 1 and 3 for GSM Phase 2+. In order to support the growing need for service differentiation the item 'Support of PLMN specific services when roaming' was defined by SMG in 1993. In 1994 the title of the work item was changed to CAMEL together with an enhancement of its scope to an IN-like SSF-SCF interface between PLMNs, and the SSF being implemented in the MSC/VLR or GMSC.

Network Feature

It is important to notice that the CAMEL feature is a network feature and not a supplementary service [02.78]. It is a tool which helps PNOs to provide GSM end-users with OSS also when roaming outside their home network. It will result in a modification and extension of the MAP protocol and should introduce IN within GSM.

IN will add value to the GSM network. This will be done by having a stronger differentiation between networks with IN services and by the IN capabilities for fast and economic service creation and deployment etc. When references are made to IN standards the CS-1 recommendation Q.121x series is used. Although it is obvious that CAMEL becomes more and more the evolution of GSM towards IN, up to now CAMEL is not foreseen to support capabilities for interworking between IN-structured fixed networks and GSM, but that might change in the future.

The network model for the introduction of CAMEL is depicted in figure 2 below.

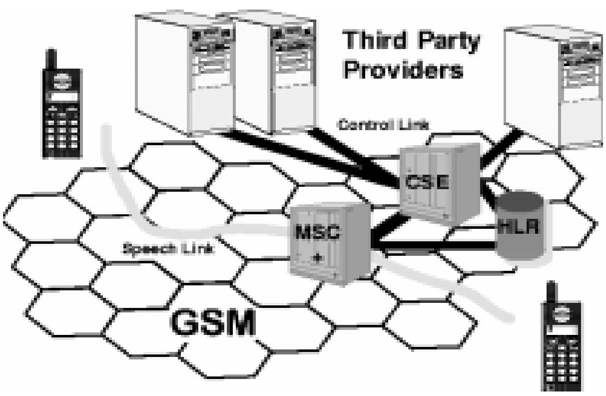

Figure 2: The principle of introducing CAMEL into GSM

The IN SCF function is mapped to a PE called Camel Service Environment (CSE). This PE acts as a central target node for all CAMEL specific signalling. It is located in the subscriber's home network and thus provides service execution that is controlled in the home provider domain also for end-users who roam outside their home network. So these end-users are able to use OSSs outside their home network.

When certain service events are detected in a GSM network the gsmSCF may be informed of the events that have been encountered. A point in call at which such an information flow to the home network may occur is called Detection Point (DP). Whenever a DP is met, the call or service control may possibly be transferred to the gsmSCF in the CSE. A DP may be armed in order to inform the gsmSCF in the home network of the encountered event. If a DP is armed, and the criteria associated with the DP are met, the gsmSCF may be informed of this in a service control relationship [Adr95].
In contrast to the traditional IN concept, there are at least two further DPs which have to be introduced: location update and IMSI detach. However, the impact of roaming and handover on the CSE and SSF have to be accurately investigated for non-call related services, which will be defined in CAMEL Phase 2, and if more mobility related DPs are appropriated.

However, the CAMEL feature allows the separation of service logic from the MSC. With the help of CSEs OSSs can be offered to customers. The service logic of these OSS could be held totally within the CSE, or within the domain of a Third Party Provider (TPP), or partially in the CSE and partially in the domain of a TPP. This could be achieved through the IN reference points O, P, Q or with the help of an SMF. If the interface is realized with an IN reference point P or Q, which means that the TPP has only SDF functionality, there will be no distribution of service logic possible. In that case the whole service logic will reside within the CSE. Assuming that the CSE is under control of the network operator, the network operator is able to scale the control of a TPP. [03.78] gives the possibility that the CSE and the home network are controlled by different operators. This means that a TPP can also have his own CSE, implying security threats. Another problem is that up to now for each CAMEL subscriber there can only be one CSE addressed, which signifies that the mobile user can merely use services of one specific TPP.

Mobile Originating Calls

If an active originating CAMEL dataset is found in the VLR during the call set up of a MS, the Visited SSF (VSSF) sends an InitialDP message to the gsmSCF and the Visited MSC (VMSC) suspends the call processing. The InitialDP shall always contain the service key, called and calling party number, calling party's category, location number, bearer capability, event type BCSM, location information and the IMSI, [03.78]. After the service logic processing, the CAMEL-specific service logic is initiated from the gsmSCF, see figure 3.

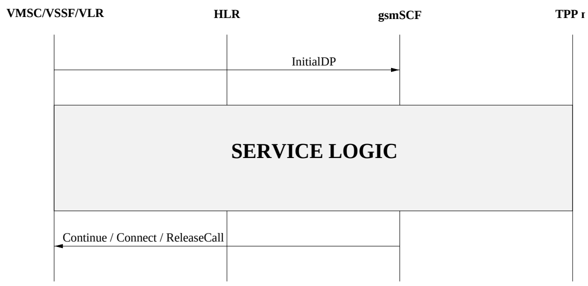

Figure 3: Signalling procedures for originating calls

Mobile Terminating Calls

In the case of a mobile terminating call, the GMSC in the interrogating network identifies the HLR of the called party with the help of the MSISDN. Then the GMSC sends a RoutingInformationRequest to the HLR. The HLR checks the CAMEL dataset of the called party and sends the information stored in the subscriber record back to the GMSC. Now, the GMSC acts according to CAMEL information. If the terminating CAMEL dataset is active the trigger criteria of a DP is fulfilled and the call processing is suspended. An InitialDP message, which shall always contains the service key, called party number, event type BCSM and the IMSI is sent to the CSE and the service logic execution is started. Thereafter CAMEL specific handling is initiated, see figure 4 below.

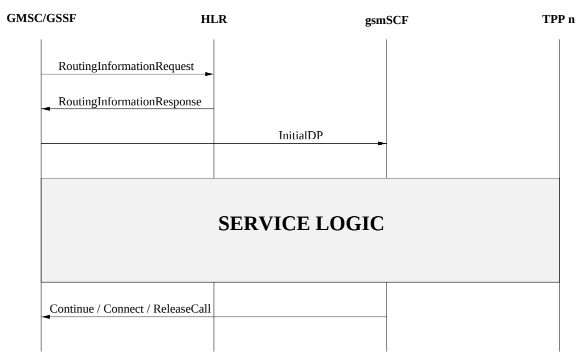

Figure 4: Signalling procedures for terminating

IV. Performance of CAMEL

In order to get a clear opinion about the feasibility of enhanced service provisioning methods a GSM network similar to german GSM network operator Mannesmann Mobilfunk, which is the largest private GSM network in the world, has been investigated. Furthermore, it has been assumed that the nodes and the links work under normal load (70%) and high load (84%), which is normally not the case. Finally, it should be mentioned that the number of calls is kept constant in this analysis.

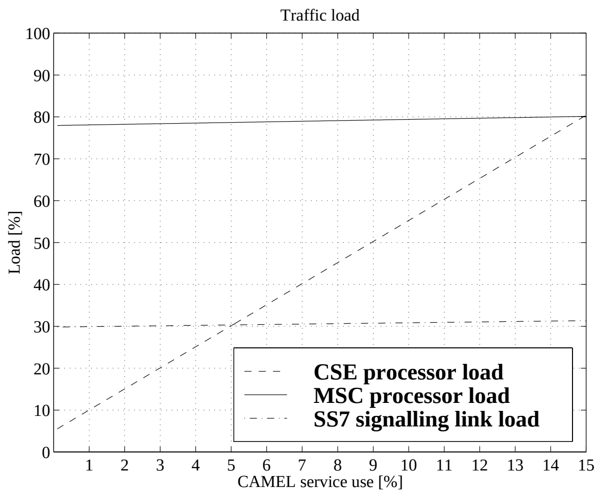

Figure 5: Processor and link load (high load)

Figure 5 shows the increase in the MSC processor load and CSE processor load as well as the increase of the link load when using CAMEL services. Whereas the MSC and the SS7 links are already working under normal load, the CSE processor is merely charged through idle load (5%). Obviously, it is the CSE anyhow which will first reach capacities problems when using only one CSE in the evaluated network configuration.

The SS7 activity covered here take place between two MSCs, between an MSC and the CSE, or between an MSC and an HLR.

Figure 6 shows the relative increase in the MSC load and link load. The additional MSC load starts at round about 4%, because with the introduction of CAMEL every call respectively subscriber has to be checked if she/he/it needs CAMEL support.

The analysis showed that the impact of the evaluated methods on the signalling links is nearly negligible. The increase of signalling link load is less than 4%, given that up to 10% of all calls use a CAMEL based service.

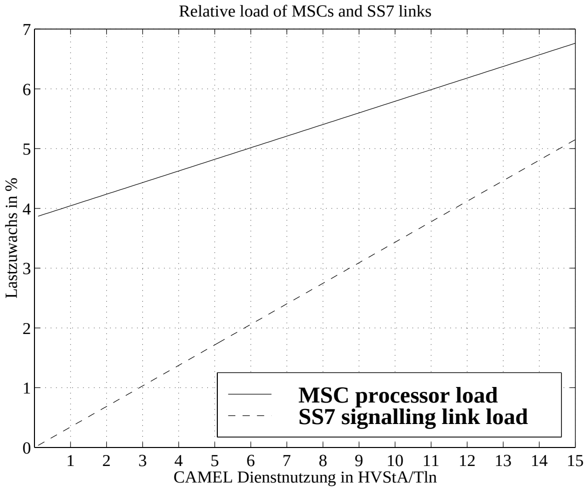

Figure 6: Rrelative load of MSCs and SS7 links

Service Logic Times

The service logic time is the additional delay in the chain of actions in the SSF, the SCF and in STPs plus the propagation time of the channel. The mean service logic time of the CAMEL feature is illustrated in figure 10 in dependence of the MSC processor load and on the use of CAMEL based services. This graphs shows explicitly that the mean service logic time can be controlled through the MSC processor load.

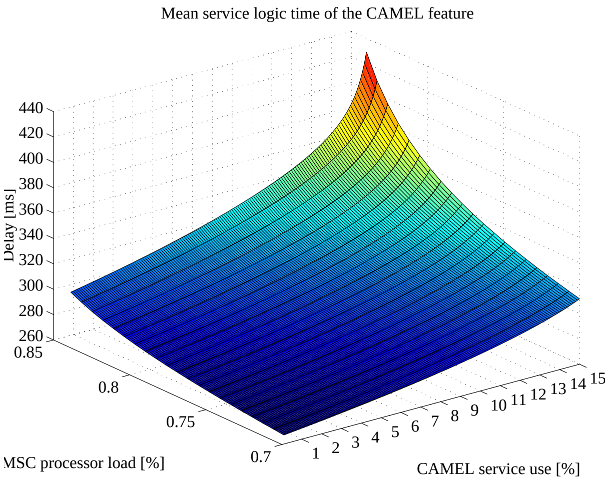

Figure 7: Service logic time dependent on service use and processor load

V. Conclusion

The ETSI GSM Phase 2+ standardization work item CAMEL supports the provision of operator specific services when roaming within the GSM service area by introducing IN technology to GSM. Thus, CAMEL strengthens GSM service delivery capabilities and reduces the mobility impact on the switching layer by separating it from the mobility and service layer.

For the evolution of GSM towards UMTS, the CAMEL mechanism aligns with the IN SSF-SCF model (IN reference point N), because establishing a further new technology, architecture and protocol makes no sense. Both MAP and INAP use the SS7 MTP/SCCP/TCAP platform and can easily “co-exist”. Nevertheless, CAMEL specifications should only complement, not duplicate IN standards and therefore provide mainly a transport mechanism for the required information exchange between GSM networks and also between GSM and other IN-structured networks. CAMEL Phase 1 uses a subset of the ETSI Core INAP protocol stack.

The CAMEL description does not prohibit the CSE (physical location of the gsmSCF) to be located in the domain of a TPP. TPPs are necessary, because the mobile environment becomes more competitive. Moreover, real user demands can better be taken into account and service differentiation is easier to realize with TPPs. Taking into consideration a division of service logic and data between the CSE and a TPP a detachment of SCF and SDF functions would cause additional signalling overhead. Anyhow, this does not represents a risk for the signalling network. However the services with multiple transactions, for example several user interactions and rerouting procedures, produce a noticeable increase on the signalling links.

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