On Interaction between Services Implemented on Different Service Platforms

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Abstract. To distinguish themselves from the competitors, mobile network operators offer value-added services based on Customized Application for Mobile Enhanced Logic (CAMEL) technology. It is usual for network operators to deploy these services implemented on different vendor-specific service platforms. The increased requirements of the subscribers for more services and the desire of network operators to reuse the existing infrastructure as far as possible impose integration of existing services. CAMEL allows only one service logic instance for a specific call segment at a time. To allow several service logic instances Service Capability Interaction Manager (SCIM) can be applied. In the paper the use of SCIM for this purpose is explained and verified by examples. Different service interaction scenarios are investigated and the required functionality of service interaction manager is synthesized.

I. Introduction

Network operators and service providers being hard pressed by the competition and the increased subscriber needs for more communication alternatives are forced to offer attractive valueadded services. While the new Internet protocol (IP) based technologies appear as promising platform for service provisioning, there exist legacy circuit switched solutions which must be reused as much as possible.

In legacy mobile networks, value-added services are implemented on vendor-specific switching platforms and generally support CAMEL interfaces. CAMEL stands for Customized Application for Mobile Enhanced Logic and implements intelligent network concept in mobile networks.

Figure 1 shows the reference CAMEL architecture as defined in standards where call and connection control is done in gsmSSF, service logic is executed in the gsmSCF, and the gsmSRF takes care of special user interactions. A CAMEL service is executed in the home network of a subscriber, but gsmSSF where the service is triggered may be in the visited network for outgoing calls or in the interrogating network for incoming calls. In such networks services are usually implemented on different platforms. The increased requirements of the subscribers for more services and the desire of network operators to reuse the existing infrastructure as far as possible impose integration of existing services. CAMEL allows only one service logic instance for a specific call segment at a time. To allow several service logic instances Service Capability Interaction Manager (SCIM) can be applied. The functional component SCIM is defined in standards [1] mainly in the context of Internet Protocol multimedia services and plays an important role in avoiding conflicts when interaction between services occurs.

SCIM generally include a protocol mapping function in addition to a triggering and routing function. SCIM functionality is also used to combine existing CAMEL-based services and to allow introduction of new ones.

The variety of SCIMs available on the market [2,3,4] is mainly supporting service interactions by following standards. However, there is a subset of specific service implementations in the mobile operators' domains that imposes requirements to SCIM fulfilled only partly by SCIM. As far as the process of migration to IP-based services is a continuous process which must be conducted seamlessly, there is a need of research on requirements concerning signaling about those mobile operator specific services.

The paper presents a study on the requirements for SCIM that may be used to integrate CAMEL services. Different service interaction scenarios are investigated and the required functionality of SCIM is synthesized. The paper focus is on interaction between two well known services with specific implementation.

II. Service Interaction Overview

Service Capability Interaction Manager (SCIM) is required functional component for interaction between services implemented on different service provider's platforms. We study the interaction between Pre-paid and HomeBox services.

The Pre-paid service [5] allows subscribers to pay in advance a predefined amount of money which is permanently monitored and decreased during a call using on-line charging functionality. The Pre-paid service features include originating user prompter, announcements and call gapping

The HomeBox service [6] allows fixed-mobile substitution and provides subscribers with fixed telephony service i. a mobile network) and Internet. A HomeBox subscriber can place and receive calls only if he or she is in his/her preliminary defined home zone. The HomeBox service features include mobile icoation screening, black/white list screening and announcements Any contradictory service feature like call forwarding must be prohibited by administrative means.

We presume that SCIM supports CAMEL Application Part (CAP) and Mobile Application Part (MAP) protocols. SCIM communicates with the following network elements:

• Service Control Point that hosts the Pre-paid service logic (SCPpre-paid) via CAP interface.

¹ The research is conducted with support of Bulgarian Mobile Operator Mobiltel



Figure 1. CAMEL architecture



Figure 2. Network architecture for service interaction

• Service Control Point that hosts the HomeBox service logic (SCPhomebox) via CAP interface.

• Service Switching Points (SSPs) represented by Gateway Mobile services Switching Center via CAP.

• Home Location Register (HLR) via MAP interface in provisioning Unrestricted Supplementary Service Data features.

Figure 2 shows possible network architecture.

The CAMEL subscription information (CSI) contains the trigger detection point list, SCP address, service key and default call handling. In case of service interaction, the CSI stored in the

visited network contains the service key of the service which is to be invoked first. SCIM stores the CSI for the service that has to be invoked next. When a subscriber places or receives a call, the SSP in the visited network checks the CSI criteria set for this subscriber and sends Initial Detection Point (IDP) message to SCIM in order to trigger the first service. SCIM activates the first service. On receiving instructions from the SCP of the first service to connect the call, SCIM activates the second service. Having two possibilities for first service triggering, two alternatives for interaction between the Pre-paid service and HomeBox service are possible:

Interaction with leading HomeBox service (the CSI in visited network contains the service key of the HomeBox service and the CSI stored at SCIM contains the service key of the Pre-paid service).
Interaction with leading Pre-paid service (the CSI in visited network contains stored at SCIM contains the service key of the HomeBox service). Both alternatives are examined for the following use cases:

• Originating call from a Pre-paid HomeBox subscriber who is in his/her home zone.

•Originating call from a Pre-paid HomeBox subscriber who is not in his/her home zone.

•Terminating call to a Pre-paid HomeBox subscriber who is in his/her home zone.

•Terminating call to a Pre-paid HomeBox subscriber who is not in his/her home zone. •Call gaping.

•Special call handling based on the called number.

III.Service Interaction with Leading Service HomeBox

In this type of interaction the first triggered service is the HomeBox service. The CSI in the visited network contains the service key of the HomeBox service and the address of SCIM. SCIM needs to have some logic for triggering the Pre-paid service.

For originating calls from a Pre-paid HomeBox subscriber, the SSP activates the HomeBox service according to the Originating-CSI (O-CSI). The O-CSI related to the Pre-paid service is stored at SCIM. For terminating calls to a Pre-paid HomeBox subscriber, the SSP activates the HomeBox service according to Terminating-CSI (T-CSI). For all terminating calls SCIM does not activate the Pre-paid service logic.

A. Originating Call from a Pre-paid HomeBox Subscriber who is in his/her Home Zone

When a Pre-paid HomeBox subscriber dials any national mobile number, he or she dials a special prefix in front of the called number and is presented with his/her mobile number. When the subscriber dials any other number he or she is presented with his/her fixed number.

Figure 3 shows the signaling flow when a Pre-paid HomeBox subscriber with sufficient credit in his/her pre-paid account places a call to a fixed or international mobile number. The procedure for this is as follows:

1.A Pre-paid HomeBox subscriber dials a fixed or international (mobile and fixed) number.

2.SSP finds that the subscriber has O-CSI that requires CAMEL treatment and the SSP starts O-BCSM (Originating Basic Call State Model). O-CSI contains trigger for the HomeBox service at the Collect_info Detection Point (DP). The SSP encounters in the O-BSCM this DP and sends an IDP message to SCIM. The most important message parameters include calling party MSISDN, dialed number, service key, and Cell-ID. The Cell-ID parameter is used to indicate the location of the calling Pre-paid HomeBox subscriber.

3. SCIM stores the parameters of the original IDP message. SCIM triggers the HomeBox service at the SCPhomebox by sending the original IDP message.

4. The service logic in SCPhomebox ascertains that the subscriber is in his home zone by comparing the Cell-ID received in the IDP message with the ID of his/her preliminary defined location area and determines that special charging has to be applied. SCPhomebox sends furnishChargingInformation (FCI) message to SCIM pointing out the charged party ID and a call type.

5. For originating calls to fixed or international mobile numbers, the SCPhomebox determines that the subscriber should be presented to the called party with his/her fixed number. SCPhomebox sends Connect message to SCIM including Generic number parameter which is equal to the fixed number of the Pre-paid HomeBox subscriber.

6. SCIM has the O-CSI related to the Pre-paid service for the subscriber. SCIM determines which SCP has to contact with and formulates a new IDP message. The value of the called party parameter in the new IDP message is the called party number returned in the Connect message from the SCPhomebox, and the service address parameter corresponds to the SCPpre-paid. The other parameters in the new IDP message are retrieved from the original IDP message. SCIM involves in the new IDP message the Generic number parameter pointing at the calling party presentation number.

7. The Pre-paid service logic checks the current credit of the subscriber's prepaid account and determines the amount of time which the call is allowed. The SCPpre-paid instructs SCIM to monitor for called party answer (O_answer) and calling party disconnect (O_disconnect) events and to report on the event occurrence by sending requestReportBCSMEvent (RRB) message.

8.SCPpre-paid sends charging instructions to SCIM by sendChargingInformation (SCI) message.

9. The SCPpre-paid sends applyCharging message to SCIM requesting charging control and reporting after the call completion.

10. The SCPpre-paid instructs SCIM to allow the call to proceed for a limited amount of time by sending Connect message.

11. SCIM sends FCI message which is received from SCPhomebox.

12. SCIM requests the SSP to monitor for answer and disconnect events and to report the events.

13. SCIM sends the charging instructions to SSP according to instructions sent by the SCPpre-paid.

14. SCIM sends instructions to the SSP to control charging and to report after the call completion as requested by the SCPpre-paid.

15. SCIM orders the SSP to connect the call according to instructions sent by SCPpre-paid.

16. The O-BCSM starts a timer and completes the call. When the called party answers, the SSP reports the event to SCIM by sending eventReportBCSMEvent (ERB) message.

17. SCIM reports the "answer" event to the SCPpre-paid.

18. Upon the call release the SSP reports the event to SCIM.

19. SCIM forwards the event report to the SCPpre-paid.

20. The SSP reports charging information after call completion indicating the cause.

21. SCIM forwards the charging report to the SCPpre-paid. SCPpre-paid updates the credit.

In case of insufficient credit, the SCPpre-paid sends instructions to connect the call to intelligent peripheral for playing announcement and to release the call. SCIM relays instructions for playing announcement. SCIM overrides the instructions sent by the SCPhomebox to connect the call and sends instructions to release the call as required by the SCPpre-paid. The call is cleared.

Originating subscriber location screening feature is applied as a part of HomeBox service logic. SCIM does not activate the Pre-paid service logic.

B. Terminating Call to a Pre-paid HomeBox Subscriber

For all terminating calls SCIM does not activate the Prepaid service logic. The call handling is according to the processing logic of the HomeBox service. When a called Pre-paid HomeBox subscriber is not in his her home zone an announcement is played to the calling party and the call is released

IV. Service Interaction with Leading Service Prepaid

In case of leading Pre-paid service the CSI related to the Pre-paid service is stored at the SSP. The O-CSI ochtains the Pre-paid service key and the address of SCIM. SCIM needs to have some logic for triggering the HomeBox service.

For originating calls form a Pre-paid HomeBox subscriber, the SSP activates the Pre-paid service as to 0-CSI. The 0-CSI related to the Pre-paid service is stored at SCIM.

For terminating calls to a Pre-paid HomeBox subscriber, the SSP activates the HomeBox service as to T-CSI. For all terminating calls to a Pre-paid HomeBox subscriber, SCIM does not activate the Pre-paid service logic.

When the SSP generates the IDP message to trigger the Pre-paid service logic, it must include the information element Cell-ID of the calling party because the HomeBox service logic needs it.



Figure 3. Originating call from home zone with leading HomeBox service

A. Originating Call from a Pre-paid HomeBox Subscriber who is in his/her Home Zone

Figure 4 show the signaling flow when a Pre-paid HomeBox subscriber who is in his/her home zone places a call, but his/her current credit gets insufficient.

1.A Pre-paid HomeBox subscriber places a call.

2.The SSP finds that the subscriber has O-CSI that requires CAMEL treatment and starts O-BCSM. O-CSI contains trigger for the Pre-paid service at the Collect_info DP. The SSP in the O-BSCM encounters this DP and sends IDP to SCIM. The most important parameters of the IDP message include MSISDM of the originating Pre-paid HomeBox subscriber, dialed number service identifier, and the Cell ID of the calling party.

3. On receiving the IDP message SCIM stores the messag parameters. If the called party number is with the specific prefi for national mobile number then SCIM removes the prefix an triggers the Pre-paid service in SCPprepaid.

4. The service logic at the SCPpre-paid determines that special charging has to be applied. The Pre-paid service logic checks the current credit of the subscriber's prepaid account and determines the amount of time for which the call is allowed. The SCPprepaid sends charging information to SCIM.

5. The service logic at the SCPprepaid orders to connect the calling party.

6. The SCPpre-paid instructs the SCIM to apply charging mechanisms to control the call duration.

7. The SCPpre-paid instructs SCIM to monitor for called party answer and calling party disconnect events and to report on the event occurrence.

8.0n receiving instruction to connect the call, SCIM retrieves the parameters of the original IDP message and formulates a new IDP message using the parameters of the original IDP message and the HomeBox service key. SCIM includes in the IDP message the Cell-ID of the Pre-paid HomeBox subscriber. SCIM determines the SCPhomebox address and triggers the HomeBox service logic.

9. The HomeBox service logic determines that special charging has to be applied. The SCPhomebox provides information for charging to SCIM. The information includes the call type and the charged party ID.

10. The SCPhomebox sends instructions to connect the call. The service logic at the SCPhomebox determines the calling party identification that is to be presented to the called party.

11. SCIM forwards the FCI message to the SSP.

12. SCIM instructs the SSP to apply call duration control.

13. SCIM orders to connect the call.

14. SCIM requests from the SSP to monitor for answer and disconnect events and to report the event.

15. SCIM sends charging instructions to the SSP.

16. The O-BCSM starts a timer and completes the call. When the called party answers the SSP reports the event.

17. SCIM reports the answer event to the SCPpre-paid.

18. Upon expiration of allowed time, the SSP sends another trigger (timer expired) to SCIM.

19. SCIM forwards the notification to the SSP.

20. The SSP reports charging after time expiration.

21. SCIM forwards the report to the SCPpre-paid.

22. The SCPpre-paid updates the credit and checks again whether the remaining credit is sufficient. If the credit is insufficient, the SCPpre-paid sends instructions to establish connection to intelligent peripheral by establish TemporaryConnection (ETC) message.

23. SCIM forwards the instructions to the SSP. The SSP connects to an announcement machine.

24. The intelligent peripheral requests playing instructions from the SCPpre-paid.

25. The SCPpre-paid instructs the intelligent peripheral to play a recorded message to the subscriber by sending playAnouncement (PA).

26. The intelligent peripheral reports that the announcement has been played.

27. The SCPpre-paid requests the connection to intelligent peripheral to be disconnected by sending disconnectForwardConnection (DTC) message.

28. SCIM forwards the message to the SSP.

29. The SCPpre-paid sends instructions to release the call by releaseCall (RC) message.

30. SCIM forwards the message to the SSP.

31. The call is released.

B. Originating Call Screening

A pre-paid HomeBox subscriber who is not in his/her home zone places a call. On receiving the original IDP message from SSP, SCIM activates the Pre-paid service logic as to previous scenario. In case of sufficient credit, the SCPpre-paid sends instructions to connect the call. SCIM triggers the HomeBox service logic next. On receiving instructions from the SCPhomebox, SCIM overrides the instructions sent by the SCPpre-paid to connect the call and sends instructions to the SSP to release the call.

V. Summary of Requirements to SCIM

When O-CSI and T-CSI at SSP contain the HomeBox service key, SCIM needs to store the O-CSI with the Pre-paid service key. The O-CSI and T-CSI at SSP contain the address of SCIM. This case is referred as leading HomeBox service.

When the O-CSI at SSP contains the Pre-paid service key and the T-CSI at SSP contains the HomeBox service key, SCIM needs to store the O-CSI with the HomeBox service key. The O-CSI and T-CSI at SSP contain the address of SCIM. This case is referred as leading Pre-paid service. In this case the information element Cell-ID must present in the original IDP sent by SSP and in the new IDP generated by SCIM when triggering the HomeBox service logic.

The original IDP sent by SSP is received by SCIM. On receiving original IDP, SCIM needs to store the message parameters. These parameters are to be used in case of formulating the second IDP message.

In case of leading Pre-paid service and the dialed number is with a prefix that is specific for the HomeBox service, SCIM must remove the prefix when triggering the Pre-paid service logic.

SCIM must have some logic in order to trigger the second service, if the first activated service has sent instructions to connect the call. SCIM should not trigger the second service, if the fist triggered service has sent instructions to release the call.

In formulating the second IDP message. SCIM must use the stored parameters of the original IDP message. If the Genero number parameter is returned in the first Connect message it is parameter is included as mandatory parameter. In formulating the second IDP message, SCIM has to use the service +e, of the second service that is to be triggered.

SCIM must send a Connect message to SSP based on the Connect message, sent by the service logic that is triggered as a second service.

SCIM must send a Release call message to SSP f an, of the services sends Release call message. For example cagapping is a feature provided by the Pre-paid service to decrease the number of calls to be processed at the SCP. In case of leading service Homebox and applying call gapping feature, SCIM must override the instructions sent by the SCPhomebox to connect the call and must send instructions to release the call as required by the SCPpre-paid.

In case of terminating calls to a Pre-paid HomeBox subscriber, SCIM should not activate the Pre-paid service logic.

SCIM must have some logic for special call handling in



Figure 4. Originating call from home zone with leading Pre-paid service

case of dialing of predefined numbers. Emergency calls are to be served irrespectively of the subscriber's location or the subscriber's account. Calls to the Call center require special handling too.

SCIM need to support MAP communications related to USSD. A Pre-paid HomeBox subscriber dials a special number when he or she wants to re-charge his/her pre-paid account or when makes an enquiry about the credit via USSD. The subscriber must be able to recharge the account irrespectively of his/her location.

SCIM must resolve any feature interactions concerning attempts of activating the contradictory service features for Prepaid HomeBox subscribers.

In case of leading Pre-paid service the SSP dialog with the SCPpre-paid remains open from the beginning to end of the call.

VI. Conclusion

CAMEL does not allow multiple points of control. In CAMEL it is possible only one service logic instance to control a call segment at a time.

Service Capability Interaction Manager is required functional component in case of interaction between different services. SCIM is responsible to trigger different service logic instances based on the initial request for instructions sent by SSP. SCIM allows several service logic instances to control the same call segment at a time. This means that SCIM must possess means to arbitrate between service logic instances that try to execute incompatible requests.

In managing interaction between services implemented on different service platforms, SCIM needs to consider the specifics of service implementation.

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