VOLTE: VOICE OVER LTE - CONSIDERATIONS AND DEPLOYMENT IN 4G NETWORKS

G Kumar
Dean R&D NRI group institutions Bhopal
seetharam.kumar03@gmail.com

Abstract

For all the mobile network operators, voice and short message service (SMS) have consistently been major sources of revenue. Optimum support of these conventionally circuit switched services in data-oriented LTE is essential. LTE was specified by the 3rd Generation Partnership Project (3GPP) in release 8 and further updates are also in progress. LTE is designed as a pure packet switched system. This implies that support of voice within LTE has to be done with voice over IP. This paper discusses various alternatives to accommodate voice during migration period

Keywords:-4G, VOLTE, IMS,SMS

I. OVERVIEW

Supporting voice over IP in a cellular communication system throws in a lot of new challenges. Mainly the Subscribers expect the same quality of service they know from circuit switched voice services, like in GSM networks.

Voice support in LTE requires the right mechanisms and architecture in radio and core networks, to guarantee quality of service and a good user experience. Nnationwide LTE coverage can hardly be achieved from day one onwards. Hence subscriber mobility between LTE and legacy GSM, UMTS and CDMA networks is also a key requirement.

When it comes to voice support in LTE, the IP Multimedia Subsystem (IMS) is the key technology. IMS provides a framework for supporting IP based services and requires new IMS-specific network elements as part of the dedicated core network architecture. The first version of IMS was standardized in 3GPP release 5, with many enhancements specified in subsequent releases.

In the early days of LTE standardization, it had been assumed that IMS would be commercially available when the first LTE networks were deployed. Voice support was also considered as being addressed by IMS. However, rollout of IMS was slower than expected, with the result that voice support in LTE had become a real challenge for many network operators.

Alternatives and intermediate solutions for supporting voice services in LTE were investigated more deeply. The most important and commercially relevant one is the circuit switched fallback which basically provides subscribers with voice services via the existing networks GSM, or CDMA. The users "fall back" to one of these technologies as soon as they initiate a voice call within LTE coverage or if they accept a terminating voice call.

The first LTE networks are already using CSFB for voice support. CSFB is also supporting a variety of roaming scenarios, ensuring that existing circuit switched roaming agreements can be met.

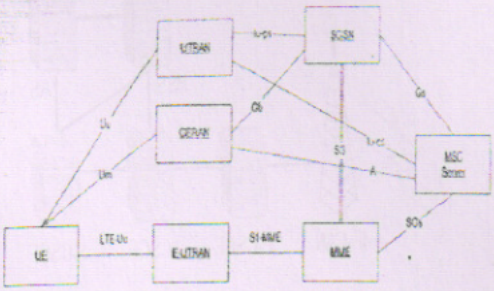
A closely related topic to support of voice is the support of SMS as another key circuit switched service. SMS is a huge revenue driver for network operators worldwide. A non-IMS based solution for SMS was specified by 3GPP, the "SMS over SGs" solution for GSM and UMTS networks, where SGs is the name of a core network internal interface. SMS over SGs allows network operators to support SMS as a circuit switched service within LTE.

In the long run, support of voice and messaging in LTE over IMS remains the major target. A related industry initiative is VoLTE (Voice over LTE). It was formally announced in February 2010 [3] by the network operator organization GSMA (Global System for Mobile Communications Association). VoLTE has developed the framework for optimum support of voice and SMS over IMS in LTE, including roaming and interconnect issues. VoLTE is based on existing IMS multimedia telephony (MMTel) concepts.

II. CIRCUIT SWITCHED FALLBACK (CSFB)

CSFB is the mechanism to move a subscriber from LTE to a legacy technology to obtain circuit switched voice service. This function is only available if LTE coverage is overlapped by GSM, or CDMAT coverage.

CSFB was already specified in 3GPP release 8, with further enhancements defined in 3GPP release 9. A number of different CSFB mechanisms are available, and there are also differences depending on the radio technology the subscriber falls back to.

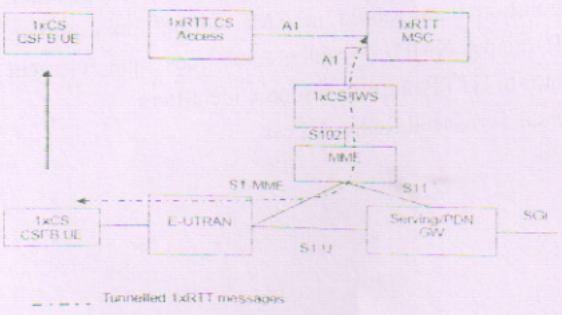


III. CIRCUIT SWITCHED FALLBACK TO GERAN OR UTRAN

CSFB affects the radio and the core networks. 3GPP technical specification (TS) 23.272 [5] is the stage 2 specification of CSFB, providing an overview of the architecture and procedures used. Figure 1 taken from TS 23.272 shows the Evolved Packet System (EPS) architecture for CSFB. It includes the interfaces between the different radio access network types and the core network entities. UTRAN is the UMTS terrestrial radio access network, GERAN is the GSM/EDGE radio access network, and E-UTRAN is the evolved universal terrestrial radio access network of LTE. To support circuit switched services, a connection to the mobile switching center (MSC) server has to be established. The mobility management entity (MME) of the evolved packet system interfaces to the MSC server via the SGs interface. The CSFB mechanism is implemented using this SGs interface.

IV. CIRCUIT SWITCHED FALLBACK TO CDMA

For CSFB to 1xRTT, the UE can establish voice service by falling back from E-UTRAN to the CDMA network. Figure shows the reference architecture for CSFB to 1xRTT [5]. It includes the S102 reference point between the MME and the 1xCS IWS (circuit switched fallback interworking solution function for 3GPP2 1xCS). The S102 reference point provides a tunnel between the MME and the 1xCS IWS to relay 1xCS signalling messages.



V. SMS OVER SGs

SMS over SGs is a mechanism to transmit circuit switched SMS over the LTE radio network. It is based on circuit switched infrastructure and is a transition solution before SMS over IMS is deployed. SMS over SGs was specified in 3GPP release 8. The SGs is the reference point between the MME of the evolved packet system and the MSC server. The protocol used to connect an MME to an MSC server is SGsAP. The protocol for transferring signalling messages is the Stream Control Transmission Protocol (SCTP).

The SGs is used to handle mobility management and paging procedures between EPS and the CS domain and for SMS, to deliver both mobile originating and mobile terminating SMS.

SMS over SGs is independent from CS Fallback; meaning it does not trigger CS Fallback to UTRAN or GERAN. As no fallback takes place, SMS over SGs does not require overlapped coverage of LTE and already existing technologies.Supporting SMS over SGs is mandatory for UE, MME and MSC entities supporting CS fallback. However, entities supporting SMS over SGs are not required to support CS fallback.

VI. SUPPORT OF VOICE AND SMS VIA IMS

The IMS is an access-independent and standard-based IP connectivity and service control architecture. It provides the framework for IP-based multimedia services in a mobile network and is an ideal choice to offer voice over IP services. IMS was first specified in 3GPP release 5 and enhanced in the following 3GPP releases to a powerful feature set supporting a wide range of multimedia applications.

Today, the mobile industry considers IMS as the major solution for supporting voice and SMS services in LTE. A Voice over IMS profile was defined that only contains those network and terminal features that are considered essential for launching IMS based voice. The "One Voice" alliance of several major network operators and manufacturers published their 3GPP-compliant Voice over IMS profile recommendations already. Complying to this profile is the prerequisite for interoperability of different manufacturer's terminal and network implementations.

"Using IP Multimedia Subsystem specifications developed by 3GPP as its basis, GSMA have expanded upon the original scope of One Voice work to address the entire end-to-end voice and SMS ecosystem by also focusing on Roaming and Interconnect interfaces, in addition the

interface between customer and network. GSMA VoLTE will develop the function and technical definitions for the way in which Voice and SMS will work in the future, and will define the interfaces for an end-to-end calling structure that will take into account interconnect and roaming."

Proper consideration of the roaming and interconnect issues will be key to the success of voice over IMS in LTE. From experience with legacy technologies, subscribers are used to seamless service availability and worldwide access to voice and messaging services. GSMA published the IMS profile for Voice and SMS (GSMA Permanent Reference Document IR.92, based on the profile specified by the One Voice alliance. Only the essential set of terminal and network features for supporting voice and SMS services via IMS is listed; the required IMS functions, supplementary services, media characteristics and radio and packet core capabilities. At a later point, more features may be added to terminals and networks. Compatibility between early VoLTE implementation and later releases shall always be ensured.

The first LTE networks are unlikely to offer nationwide coverage. Therefore, the continuity of voice calls needs to be guaranteed by handover to a legacy technology such as GSM. This is achieved by a feature called single radio voice call continuity (SRVCC).

VII. OVERVIEW OF THE IMS FRAMEWORK

The IMS reference architecture provides entities for session management and routing, service support, data bases, and interworking. For LTE, the IP connectivity access network (IP-CAN) as shown in Figure would be composed of the EPS and the E-UTRAN.

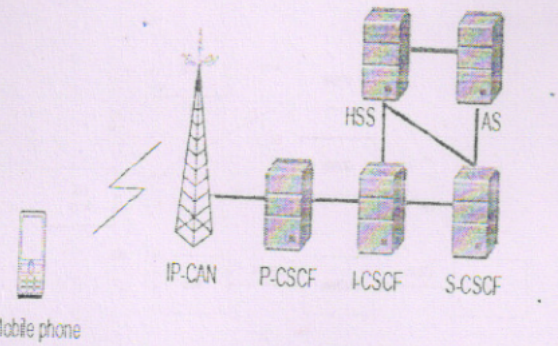
The call session control functions (CSCF) are the core components of the IMS.

There are three CSCF:

Proxy-CSCF (P-CSCF): The P-CSCF is the first point of contact for a user. The PCSCF behaves like a proxy, i.e. it accepts requests and forwards them on.

Interrogating-CSCF (I-CSCF): The I-CSCF is the entry contact within an operator's network for all connections destined to a subscriber.

Serving-CSCF (S-CSCF): The S-CSCF is responsible for handling the registration process, making routing decisions, maintaining sessions, and downloading user information and service profiles from the HSS.



The **home subscriber server (HSS)** is the master database for a user. It is comparable to the home location register in a legacy mobile radio network. The HSS contains the subscription-related information required for the network entities actually handling calls/sessions. For example, the HSS provides support to the call control servers to complete the routing/roaming procedures by solving authentication, authorisation, naming/addressing resolution, location dependencies, etc.

The **application server (AS)** provides specific IP applications, e.g. messaging.The purpose of the IMS architecture and the different CSCF entities becomes clear in the case of roaming: Network providers are unwilling to disclose their internal network structure and want to prevent any access to their own user databases. Since a UE always communicates with the local P-CSCF in the accessed network, this P-CSCF must be denied access to the HSS. The I-CSCF is in charge of hiding the network architecture from other providers. IMS uses a set of internet-based protocols.

The Session Initiation Protocol (SIP) as a text-based protocol for registration, subscription, notification and initiation of sessions

The Session Description Protocol (SDP) as a text-based protocol for negotiating session parameters like media type, codec type, bandwidth, IP address and ports, and for media stream setup.

The Real-Time Transport Protocol (RTP) and RTP Control Protocol (RTCP) for transport of real-time applications (e.g. audio)

The Extensible Markup Language (XML) Configuration Access Protocol (XCAP)

XCAP allows a client to read, write and modify application configuration data, stored in XML format on a server. XCAP maps XML document sub-trees and element attributes to HTTP uniform resource identifiers

Universal Terrestrial Radio Access

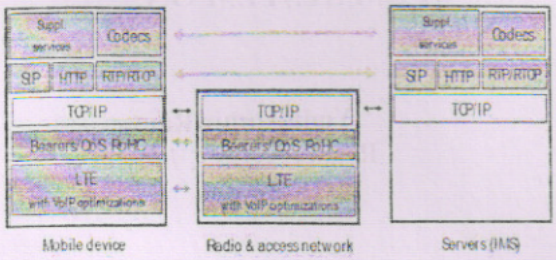


Figure : Depiction of UE and network protocol stacks in IMS Profile for Voice [14]

VIII. CONCLUSION

Efficient support of voice and SMS is a key requirement for LTE networks. Different techniques to support these services in LTE are introduced in this white paper, from circuit switched fallback to IMS-based solutions. Thorough testing of terminal implementations is a must to verify the proper functioning and performance of the new protocol procedures.

IX. REFERENCES

[1] Long Term Evolution – A concise introduction to LTE and its measurement requirements, Christina Gessner, Rohde & Schwarz, ISBN 978-3-939837-11-4

[2] NGMN Alliance Delivers Operators' Agreement to Ensure Roaming for Voice over LTE, 15 February 2010, www.ngmn.org

[3] GSMA VoLTE Initiative,http://www.gsmworld.com/our-work/mobile_broadband/VoLTE.htm

[4] 3GPP TS 22.173 V9.5.0 (2010-03): "IP Multimedia Core Network Subsystem (IMS)' Multimedia Telephony Service and supplementary services; Stage 1 (Release 9)".

[5] 3GPP TS 23.272 V9.6.0 (2010-12): "Circuit Switched Fallback in Evolved Packet System; Stage 2 (Release 9)".

[6] 3GPP TS 36.300 V9.6.0 (2010-12): "Evolved Universal Terrestrial Radio Access (EUTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2 (Release 9)".

[7] 3GPP TS 36.306 V9.3.0 (2010-09): "Evolved Universal Terrestrial Radio Access (EUTRA); User Equipment (UE) radio access capabilities (Release 9)".