SERVICE CONTINUITY FOR TODAY'S VOICE OVER LTE SUBSCRIBERS

ENSURING VOICE SERVICE WITH SINGLE RADIO VOICE CALL CONTINUITY (SR-VCC)

TECHNOLOGY WHITE PAPER

Subscribers' expectations for mobile data services are continuing to increase. Mobile operators are responding to this demand by deploying 4G Long Term Evolution (4G LTE) networks, which provide a better mobile data service at a more attractive cost. Based on the initial commercial success of 4G LTE, mobile operators are preparing to launch Voice over LTE (VoLTE), which unlocks all-IP communications in the 4G LTE network. However, current 4G LTE service is not as geographically widespread as 2G/3G, and subscribers are demanding the confidence that their voice calls will not be dropped when they move out of 4G LTE coverage.

Mobile operators are therefore relying on a VoLTE technology called Single Radio Voice Call Continuity (SR-VCC). With safe, rapid launches enabled by SR-VCC, service providers can secure subscribers' confidence in their voice services while simultaneously unlocking 4G LTE's all-IP communications with enriched voice, many forms of video, IP messaging and social communications.

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1. INTRODUCTION

The sudden and spectacular popularity of 3G data services observed in recent years is rapidly overloading current 3G networks. Operators need to find new ways to simultaneously boost the capacity of their mobile networks while optimizing operating costs. Third-Generation Partnership Project (3GPP™) 4G LTE™ is the perfect mix of technological innovations that solve these needs. Today, 4G LTE is recognized as the technology of choice for wireless network evolution. As of March 2012, 57 operators have launched 4G LTE networks in 32 countries, and a further 59 operators in 14 additional countries are engaged in trials, tests or studies. [12]

4G LTE provides more bandwidth, less latency and Quality of Service (QoS) for the delivery of data-intensive applications, such as mobile TV, over a simple, flat IP architecture. 4G LTE offers mobile service providers an avenue to profitably deliver next-generation wireless broadband services. Everyone agrees that 4G LTE is the way to go for data. But how is voice service delivered to 4G LTE subscribers?

3GPP has standardized two methods for providing voice services in 4G LTE:

- Circuit Switched Fallback (CSFB), in which voice calls are provided by the 2G/3G Circuit Switched (CS) network. CSFB requires the User Equipment (UE, such as a smartphone) to fall back from 4G LTE to 2G/3G as soon as the subscriber originates or receives a voice call (unless the subscriber rejects the incoming voice call).
- VoLTE [10], in which voice calls are provided by the all-IP 4G LTE network, including IP Multimedia Subsystem (IMS).

This document examines the VoLTE technology used to ensure that a stable voice call is preserved when a subscriber moves out of 4G LTE coverage. This loss of 4G LTE coverage may occur in:

- 4G LTE networks whose coverage is not yet as geographically widespread as that of 2G/3G. For example, a subscriber moves out of 4G LTE coverage while traveling.
- 4G LTE networks that operate at very high frequencies, such as 2.6 GHz, with line-of-sight transmission characteristics. For example, a subscriber moves out of 4G LTE coverage when moving, even on foot or in a room.

In either situation the subscriber could lose their 4G LTE signal during a voice call. The voice call is dropped unless it is gracefully handed over from 4G LTE to 2G Global System for Mobile Communications (GSM) or 3G Universal Mobile Telecommunications System (UMTS), also referred to as 3G Wideband Code Division Multiple Access (W-CDMA). Such a graceful handover gives subscribers confidence in their voice service, and it distinguishes the mobile operator's VoLTE service from over-the-top (OTT) providers.

The VoLTE technology for this graceful handover is SR-VCC. A version called enhanced SR-VCC (eSR-VCC) applies for international roaming. Both are standardized by the 3GPP as the means to ensure Voice Call Continuity (VCC) when a subscriber moves out of 4G LTE coverage to 2G/3G CS voice coverage. Both SR-VCC and eSR-VCC ensure that the handover's interruption of the voice call is less than 300 ms. The interruption occurs when the UE transfers from 4G LTE to 2G/3G CS voice and the IMS reconnects from the Evolved Packet Core (EPC) to the 2G/3G CS voice core. By keeping the voice interruption to less than 300 ms, the effect on the subscriber is minimized. [2]

The next update of the 3GPP standards (3GPP Release 11) will standardize the reverse handover from 2G/3G CS voice to 4G LTE VoLTE. This is called Reverse SR-VCC (rSR-VCC) and is not covered in this document. The value of rSR-VCC is to provide 4G LTE data service for a subscriber who enters 4G LTE coverage during a 2G/3G CS voice call (not to preserve a stable voice call because 2G/3G service is far more geographically widespread than 4G LTE).

This document does not address voice service consistency across 4G LTE, 2G and 3G networks. The value of voice service consistency is to ensure that a subscriber's voice services work similarly across all three mobile access networks. [9]

Section 2 describes SR-VCC, including principles relative to basic and emergency calls, and the network implementation. Section 3 describes eSR-VCC, including why an enhanced version is necessary, principles relative to basic calls and the network implementation.

2. ENSURING VOICE CALL SERVICE CONTINUITY

In this section we describe the SR-VCC procedure, examine the functions that take place in the mobile network and IMS domain, address the network implementation and discuss how emergency calls — such as a subscriber's call for help to police, fire or ambulance — are assured if the subscriber moves out of 4G LTE coverage during the call.

2.1 SR-VCC definition and overview

The 3GPP standard for SR-VCC, TS 23.216 [3], provides the following definition of Single Radio Voice Call Continuity (SR-VCC): Voice call continuity between IMS over Packet Switched (PS) access and Circuit Switched (CS) access for calls that are anchored in IMS when the UE is capable of transmitting/receiving on only one of those access networks at a given time.

There are two interesting points in this definition:

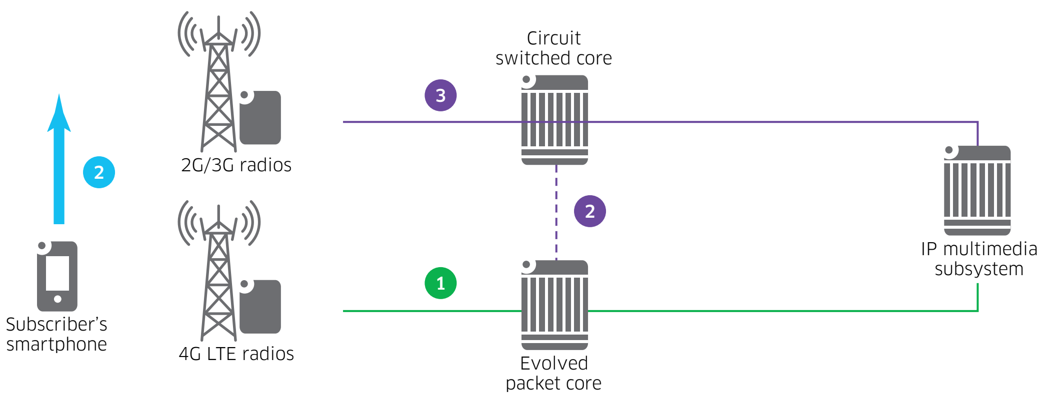
- Single radio: The UE is in either 4G LTE or 2G/3G coverage but it cannot connect or listen to the two types of radio access networks at the same time. Therefore, when the UE moves from 4G LTE to 2G/3G, the UE is disconnected from 4G LTE and reconnects to 2G or 3G. When this happens during a voice call, SR-VCC defines the procedures. Outside of a voice call, SR-VCC does not apply: instead, cell reselection procedures are used.[7]
- The call must be anchored in the IMS domain: The voice call is controlled by the IMS in the subscriber's home network. To provide this control, both incoming and outgoing calls are anchored in IMS. The call may be Voice over IP (VoIP) or CS voice.

SR-VCC is defined by 3GPP standards TS 23.216, TS 23.237 [4] and TS 24.237 [6]. We first describe the high-level SR-VCC procedure and then examine the mobile and IMS components in Section 2.2.

As shown in Figure 1, the high-level SR-VCC procedure is:

1. Green line: The subscriber is in the midst of a stable VoLTE call.
2. Dashed purple line: The subscriber moves out of 4G LTE coverage, triggering the SR-VCC mechanism. The EPC communicates with the specific Mobile Switching Center (MSC) in the CS core that will receive the handover. The MSC triggers the handover of the voice call from the 4G LTE radio to the 2G/3G radio. At the same time the MSC triggers the IMS to perform a session transfer, establishing a new access path with the MSC.
3. Solid purple line: The voice call is reestablished over the 2G/3G radio and the CS core. The voice call remains under control of the IMS.

Figure 1. General SR-VCC procedure



1. Subscriber is in a VoLTE call.
2. Subscriber moves out of 4G LTE coverage, initiating an SR-VCC handover.
3. Subscriber is now in a CS voice call.

The SR-VCC procedure relies on the following components:

- UE, which must include an SR-VCC client
- Mobile network, with:
  - Evolved UMTS Terrestrial Radio Access Network (eUTRAN) (radio part)
  - EPC, particularly the Mobility Management Entity (MME)
  - CS core (only a few MSCs need to be upgraded with new software to support the SR-VCC procedure)
  - IMS domain, particularly the Service Centralization and Continuity Application Server (SCC-AS) and the Home Subscriber Server (HSS)

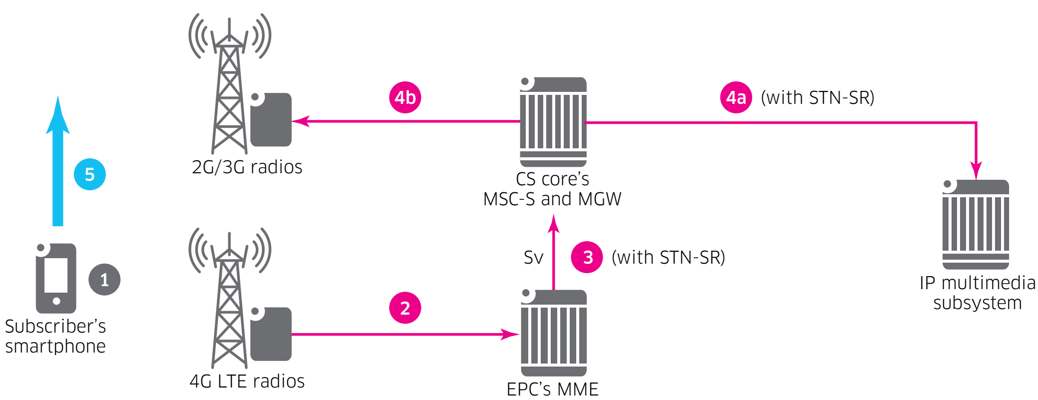
2.2 Voice Call Continuity

As previously described, when a subscriber moves out of 4G LTE coverage during a VoLTE call, the SR-VCC procedure initiates a handover that resumes the voice call over 2G/3G CS access. Therefore, two handovers take place simultaneously: one in the mobile network and one in the IMS network.

2.2.1 Handover on the mobile side

Figure 2 shows a high-level view of the EPC and CS core mechanisms involved when a subscriber moves from 4G LTE to 2G/3G CS access.

Figure 2. SR-VCC procedure on the mobile side



On the mobile side, handover of a call from 4G LTE to the 2G/3G CS core comprises the following steps:

1. Based on reports sent by the UE to the Evolved Node B (eNodeB) on radio conditions, the eNodeB decides that a handover must take place.
2. The eNodeB sends a request for handover to the MME, with an indication that it is an SR-VCC handover.
3. The MME triggers the SR-VCC procedure with the MSC server (which must have the SR-VCC software). The Sv reference point uses the UE's Session Transfer Number for SR-VCC (STN-SR) information to uniquely identify the particular subscriber. The STN-SR is a unique identifier per subscriber and is stored in the HSS.
4. The MSC server then:
   a. Initiates the session transfer procedure with IMS
   b. Coordinates the IMS session transfer with the CS handover procedure to the target 2G/3G cell
5. The target 2G/3G radio sends a message to the MSC server to accept the handover. The MSC server sends the PS-CS handover response to MME, including the necessary CS handover command information for the UE to access the 2G/3G radios.

If the target MSC server that supports the specific 2G/3G radios the subscriber is moving to is different from the MSC server enhanced with SR-VCC software, the SR-VCC MSC simply uses normal MSC-to-MSC handover procedures to complete the transfer.

The initial eNodeB handover message to the MME indicates whether the handover is CS-only or if the handover is CS + PS. If the UE is engaged in a data session at the time of the voice call handover, the PS data session is handled by the MME with the PS bearer splitting function. Based on the handover message received from the eNodeB, the MME starts the handover of the data session in parallel with the SR-VCC procedure. The handover of data PS bearer(s) is done according to the inter Radio Access Transfer procedure defined in 3GPP TS 23.401. [5] The MME coordinates the Forward Relocation Response from the SR-VCC and the PS handover procedure from 4G LTE to 3G PS.

2.2.2 Handover on the IMS side

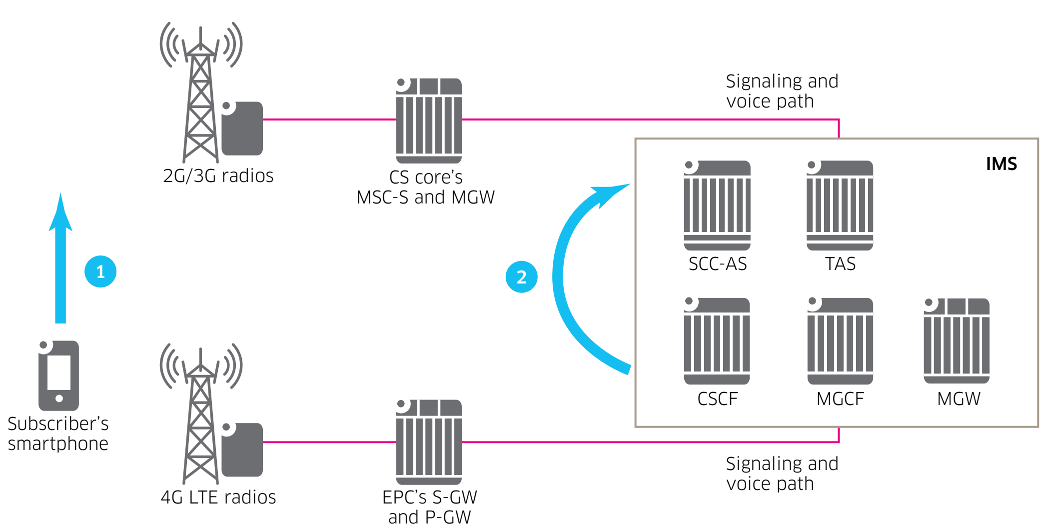
The SR-VCC feature is intrinsically defined with IMS anchoring, ensuring IMS control for both originating and terminating voice calls:

- Originating calls: VoLTE calls originating in 4G LTE are naturally handled by the IMS. If the subscriber is originating a call over 2G/3G CS access, the 2G/3G MSC and Home Location Register (HLR) handle the call as a 2G/3G CS voice call, and IMS anchoring is not needed or used. For the related topic of consistent services in 2G/3G CS voice and 4G LTE VoLTE, see Service Consistency for Today's VoLTE Subscribers. [9]
- Terminating calls: For VoLTE subscribers, the incoming voice call is always routed to the IMS, where it is anchored. When a subscriber is in 4G LTE coverage, the VoLTE call is naturally handled by the IMS. When a subscriber is in 2G/3G CS voice coverage, IMS anchoring ensures that the IMS provides terminating features.

In the VoLTE network, the 3GPP-defined SCC-AS is always inserted in the path of an IMS voice call. The SCC-AS is triggered in the subscriber's home mobile network. It is the first AS used on originating calls and the last AS used on terminating calls. Because of this sequencing, when an SR-VCC handover from 4G LTE to 2G/3G CS voice is triggered, the SCC-AS is informed and provides the IMS session transfer procedure. The SCC-AS takes care of all impacts related to the UE's mobility so that other IMS elements in the call are unaffected by SR-VCC.

Figure 3 shows the high-level view of IMS mechanism involved when the VoLTE subscriber moves from 4G LTE coverage to 2G/3G CS voice access.

Figure 3. SR-VCC procedure on the IMS side



On the IMS side, the procedure for handing over a VoLTE call from 4G LTE to the 2G/3G CS core comprises the following steps:

1. The subscriber moves out of 4G LTE coverage, and from the mobile side the MSC server triggers the IMS to perform a session transfer. The MSC server passes the STN-SR identification to the SCC-AS, uniquely identifying the UE that is moving out of 4G LTE coverage.
2. The IMS SCC-AS triggers a session transfer from the EPC to the CS core. A new voice path is established to the CS core media gateway (MGW), and the old voice path to the EPC is released. The MSC then coordinates handover of the UE to the target 2G/3G radio.

The SR-VCC handover procedure moves one stable voice call. If the VoLTE subscriber has multiple voice sessions, only the active voice call is handed over. The other calls, such as a call on hold, are released.

2.2.3 Implementing SR-VCC in the UE and the network

The use of an SR-VCC handover implies that the 3G UTRAN does not support VoIP. Otherwise, a simple Inter-Radio Access Technology (IRAT) PS handover from 4G LTE to 3G UTRAN would occur, and the voice handover would not need to rely on the CS domain and the SR-VCC mechanism.

This section and Table 1 describe SR-VCC's network implementation.

UE

The subscriber's device must support SR-VCC and indicate to the 4G LTE network, at the time of radio attachment, that SR-VCC is to be used for handovers to the 2G/3G CS network.

eUTRAN

In addition to VoLTE optimizations [10], the eUTRAN receives the radio reports from the UE and instructs the MME when a handover is needed.

HSS

The HSS provides the STN-SR, which uniquely identifies the subscriber's UE. The STN-SR is downloaded from the HSS to the MME when the UE attaches to the eUTRAN radio. The HSS also informs the MME when the STN-SR is modified or removed.

The HSS also supports the Terminating Access Domain Selection (T-ADS) parameter, which identifies the types of access supported by the UE. The T-ADS information takes into account the access network's capabilities, UE capabilities, IMS registration status, CS status, existing active sessions, user preferences, and operator policies such as access network-specific voice domain preferences.

In addition, the HSS manages failure cases — for example, when it does not receive the T-ADS from the MME and therefore cannot provide the T-ADS to an AS. In this case, the HSS sends an indication to the SCC-AS that the IMS Voice over PS session support is unknown.

MME

The MME distinguishes voice from the data PS bearers, initiates the SR-VCC handover procedure to the target MSC over the Sv interface and, if a data PS session is handed over simultaneously with the voice session, coordinates the CS and PS handovers. With the HSS, the MME also processes the T-ADS. The MME also builds the mobility tracking area (TA) list to ensure the consistent support of VoLTE in the EPC and IMS.

MSC
The MSC server must be upgraded with the Sv interface. The MSC coordinates the SR-VCC handover and initiates the session transfer procedure. Upon successful handover, the MSC server also registers the UE with the 2G/3G HLR.

Not all MSC servers located in the 4G LTE area need to be upgraded to support the Sv interface. Only the MSC servers that receive the handover need be upgraded. If the target MSC that supports the 2G/3G radios does not have the SR-VCC software, the SR-VCC MSC simply performs a standard MSC-to-MSC handover to conclude the SR-VCC handover.

SCC-AS
If not already present, the SCC-AS is introduced in the IMS network. Some networks have already deployed the SCC-AS to support IMS call anchoring services, such as those used for single number services across fixed and mobile. The SCC-AS provides the SR-VCC function, shielding other IMS elements from the procedure. The SCC-AS interworks with the HSS for the T-ADS selection of access networks.

Table 1. SR-VCC network implementation

NODE	SR-VCC CAPABILITY
UE	• Addition of SR-VCC and IMS clients • Provides SR-VCC capability information to the MME at the time of radio attachment • Handover between VoLTE and 2G/3G CS voice
eUTRAN	• Receives radio reports from the UE • Signals the need for a handover to the MME
HSS	• STN-SR provisioning and error handling • T-ADS processing query
MME	• Sv interface • Checks IMS roaming agreement with the home mobile network • T-ADS processing query • Builds TA list that matches VoIP support
MSC server	• Sv interface • SR-VCC handover processing • Session transfer initiation • Required only on a subset of MSCs
SCC-AS	• Session transfer control • T-ADS control

2.3 VCC during emergency calls

In addition to the general voice calls described in Section 2.2, mobile operators must support subscribers' emergency calls for help from police, fire and ambulance. Such calls must be assured to work, even if a subscriber moves out of 4G LTE coverage during an emergency call. This paper examines the VoLTE situation. Alternatively, an operator can support LTE subscribers' emergency calls using 2G/3G CS voice, but this situation is not covered because it does not use SR-VCC.

2.3.1 Emergency calling

In this section, we provide a high-level description of emergency calling and then examine SR-VCC.

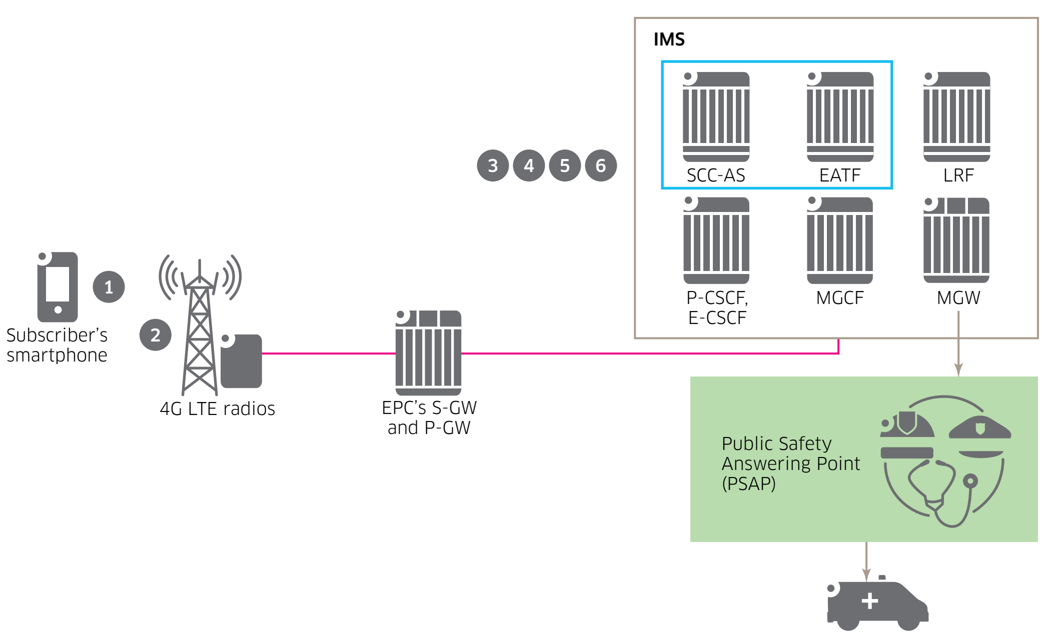
Emergency calls are handled differently from normal calls to reduce call setup time, determine the subscriber's location, identify the correct Public Safety Answering Point (PSAP) and allow emergency calls even if the device is not provisioned for service. For emergency call processing, two functions are added to the IMS: the Emergency Call Session Control Function (E-CSCF) and the Emergency Access Transfer Function (EATF). In an emergency call, the E-CSCF triggers the EATF. The EATF handles aspects related to mobility, which shields other IMS components.

These procedures apply to the home network service. When roaming, emergency calls — including the EATF — are supported by the visited network.

As shown in Figure 4, a VoLTE subscriber's emergency call comprises the following standard steps:

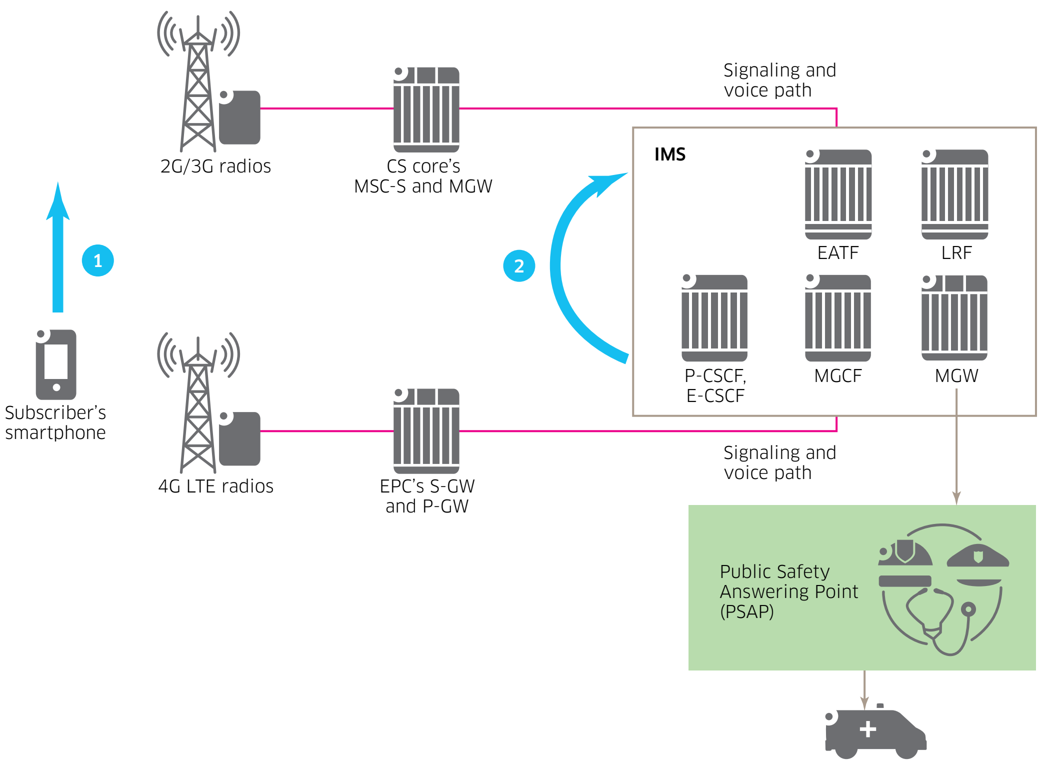
1. The UE initiates the emergency call.
2. The eUTRAN sets up emergency service radio bearers.
3. The IMS Proxy CSCF (P-CSCF) recognizes the emergency call and routes it to the E-CSCF.
4. The E-CSCF triggers the EATF for mobility processing. Because of the similarity with the SR-VCC SCC-AS, these two functions are conveniently combined into one network element, as indicated by the rectangle surrounding them.
5. The E-CSCF queries the Location Routing Function (LRF) to identify the correct PSAP for the mobile UE's location.
6. The E-CSCF routes the call to the PSAP using the MGCF and MGW.

Figure 4. SR-VCC and emergency calling



Focusing on SR-VCC, emergency calls must be supported even if the subscriber moves out of 4G LTE coverage during the call. The process for this support is similar to that of the SR-VCC procedure on the IMS side (see Figure 3, steps 1 and 2), except the SCC-AS role in a normal SR-VCC handover is instead provided by the EATF (see Figure 5).

Figure 5. SR-VCC handover of an emergency call



The operators' investment in emergency calling is therefore leveraged for the VoLTE subscribers. For example, VoLTE subscribers receive faster call setup and routing to the correct PSAP, as previously noted. Their calls are prioritized and preserved even if a subscriber moves out of 4G LTE coverage during an emergency call — a situation that was not a concern for 2G/3G CS voice's geographically widespread access but is a concern for 4G LTE's initial deployments. Even after an SR-VCC call handover to 2G/3G CS voice, such emergency features as PSAP auto callback (in case of a disconnection) continue to function.

3. ENSURING VCC WHEN ROAMING BETWEEN NETWORKS

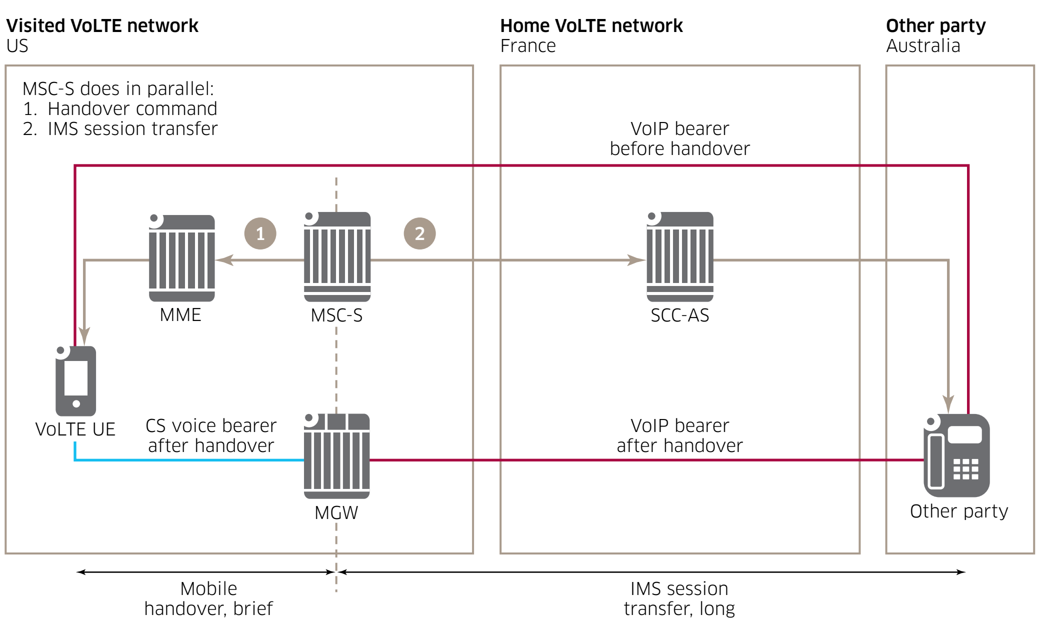
VoLTE roaming enables subscribers traveling to or from other networks to enjoy the all-IP 4G LTE service even when they travel. Some operators plan to launch home network VoLTE ahead of VoLTE roaming (in which case they use CSFB for 4G LTE roaming) and some operators plan to launch at the same time as VoLTE roaming. VoLTE roaming is expected in one to two years, so operators must consider their roaming strategy. As previously described, an SR-VCC voice handover is composed of a mobile part and an IMS part. As discussed next, an IMS enhancement ensures that the international roaming VoLTE call's handover is also a brief duration.

3.1 Challenges for subscribers who roam internationally

When a subscriber roams from the home VoLTE network to a visited VoLTE network on a different continent, the transport delay increases the duration of the voice interruption during an SR-VCC handover. This is caused by the additional distance between the visited VoLTE network's SR-VCC MSC server and the home IMS network's SCC-AS. If both parties in a VoLTE call were to roam to visited VoLTE networks, the effects would be additive. As noted in Section 1, the SR-VCC voice interruption must be kept to less than 300 ms.

Figure 6 shows a roaming example. The European VoLTE user is roaming abroad to the United States (US) and calls a person in Australia. When the VoLTE subscriber who is roaming in the US undergoes an SR-VCC handover, the voice interruption will be too long. Note that a VoLTE calling party's VoIP bearer is not required to route through the home network in the GSMA's "CS Copycat" roaming method. [10]

Figure 6. SR-VCC handover of an international roaming call



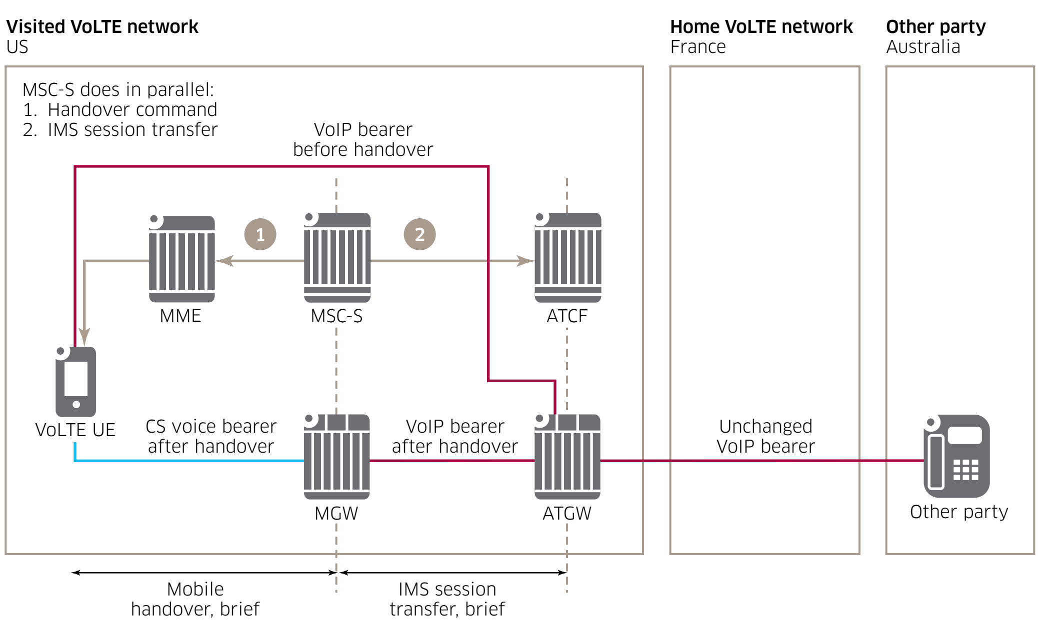
3.2 eSR-VCC definition and overview

The 3GPP defined the eSR-VCC mechanism [1] [4] [6] to reduce the duration of the voice interruption, thereby solving the international roaming problem described in Section 3.1. Emergency calling is not a concern for eSR-VCC because emergency services are provided by the visited network, not the home IMS network.

The duration of the voice interruption is caused by the lengthy IMS session transfer shown in Figure 6. It is reduced by moving the IMS anchor point closer to the roaming VoLTE subscriber. This is accomplished by two functions: Access Transfer Control Function (ATCF) and Access Transfer Gateway (ATGW), both shown in Figure 7. The ATCF is inserted in the path at the time of the UE's radio attachment and IMS registration. The ATCF sends an STN-SR address (pointing to the ATCF) to the MME. During the SR-VCC procedure, when the MME sends the STN-SR to the MSC server (see Section 2.2.1, Step 3), subsequent processing uses the ATCF and ATGW located in the visited VoLTE network, not the home VoLTE network.

The call is therefore anchored in the visited VoLTE network. Regardless of the distance between the two UEs and the distance between the VoLTE UE (which is moving out of 4G LTE coverage) and the home VoLTE network, the handover duration is always that of a local, in-country handover.

Figure 7. eSR-VCC handover of an international roaming call



3.3 Enhanced VCC

3.3.1 Handover and implementation on the mobile side

In the mobile network, eSR-VCC functions the same as SR-VCC, described in Section 2.1. Both methods require the same network functions, described in Section 2.2.3. If SR-VCC is already deployed into the mobile network, the eSR-VCC method is available.

3.3.2 Handover and implementation on the IMS side

As described in Section 3.2, the eSR-VCC mechanism introduces the ATCF and ATGW. Located in the visited VoLTE network, the ATCF anchors IMS signaling and the ATGW anchors IMS media. Typically the ATCF is combined with the P-CSCF and the ATGW is combined with the border's media element, providing better performance at a lower cost.

The ATCF is inserted in the IMS signaling path during the IMS registration procedure. During IMS registration, the ATCF provides an STN-SR (pointing to itself) and forwards it to the SCC-AS. The SCC-AS is enhanced to update the HSS with the ATCF STN-SR.

The HSS is enhanced to use this updated STN-SR and forward it to the MME. As noted in Section 3.3.1, the MME is not affected by the eSR-VCC method, but it does use the ATCF STN-SR when invoking subsequent voice call handover.

The visited network's ATCF and the home network's SCC-AS act in cooperation to perform the actual eSR-VCC voice call handover.

4. CONCLUSION

Operators such as AT&T [11] are preparing for the imminent deployment of VoLTE. Because most operators' 4G LTE access does not initially extend to their entire 2G/3G geographical coverage, the SR-VCC method provides essential VCC for subscribers who move out of 4G LTE coverage during a voice call. For operators who expect international VoLTE roaming, the eSR-VCC method ensures that their subscribers also enjoy minimal interruptions in their voice calls.

VoLTE is a serious engineering undertaking, and service providers need a partner who can help them follow a safe, profitable path. Four operators have contracted Alcatel-Lucent for commercial service, and we have over 13 trials covering all regions of the world. Alcatel-Lucent is implementing VoLTE, including SR-VCC and eSR-VCC, as part of the Alcatel-Lucent 4G Consumer Communications solution [8]. This solution assures subscribers of global roaming, service interoperability and performance.

Alcatel-Lucent implements the new functions in proven products, which enables cost-effective deployment and improves reliability:

- The SCC-AS of Figures 3, 4 and 6 and the emergency service's EATF of Figures 4 and 5 is implemented in the Alcatel-Lucent 5420 Services Continuity Gateway, which is already commercially deployed for voice call continuity services.
- The roaming service's ATCF of Figure 7 is implemented in the widely deployed Alcatel-Lucent 5450 IP Session Controller and the Alcatel-Lucent 5060 IP Border Controller (both are co-located along with the P-CSCF), which ensures the roaming subscriber's QoS is extended from the home network to visited networks.
- The roaming service's ATGW of Figure 7 is implemented in the Alcatel-Lucent 7510 Media Gateway (MGW), which is widely deployed for IP border and IP-to-TDM media gateway services.

By accelerating VoLTE's launch with the performance of SR-VCC and eSR-VCC, operators can use VoLTE to innovate and extend mobile voice beyond a traditional call. Voice can become a feature of other services, such as navigation, e-commerce, social networking, status updates and augmented reality applications.

With safe, rapid launches enabled by Alcatel-Lucent's implementation of SR-VCC and eSR-VCC, service providers can secure subscribers' confidence in their voice services while simultaneously unlocking 4G LTE's all-IP communications.

5. ACRONYMS

2G	Second-generation wireless, such as GSM
3G	Third-generation wireless, such as UMTS/WCDMA
3GPP™	Third Generation Partnership Project
4G	Fourth generation, such as LTE
ATCF	Access Transfer Control Function
ATGW	Access Transfer Gateway
CS	Circuit Switched
CSCF	Call Session Control Function
CSFB	Circuit Switched Fallback
E-CSCF	Emergency CSCF
eUTRAN	Evolved UMTS Terrestrial Radio Access Network
EATF	Emergency Access Transfer Function
eNodeB	Evolved Node B
EPC	Evolved Packet Core
EPS	Evolved Packet System
eSR-VCC	Enhanced Single Radio Voice Call Continuity
GSM	Global System for Mobile Communications
HLR	Home Location Register
HSS	Home Subscriber Server
IMS	IP Multimedia Subsystem
IP	Internet Protocol
IRAT	Inter-Radio Access Technology
LRF	Location Routing Function
LTE	Long Term Evolution
MGCF	Media Gateway Control Function
MGW	Media Gateway
MME	Mobility Management Entity
MSC	Mobile Switching Center
MSC-S	Mobile Switching Center- Server
OTT	over-the-top
P-CSCF	Proxy CSCF
PS	Packet switched
PSAP	Public Safety Answering Point
QoS	Quality of Service
RoHC	Robust Header Compression
rSR-VCC	Reverse SR-VCC
SCC-AS	Service Centralization and Continuity Application Server
SPS	Semi-Persistent Scheduling
SR-VCC	Single Radio Voice Call Continuity

STN-SR	Session Transfer Number for SR-VCC
T-ADS	Terminating Access Domain Selection
TA	tracking area
TAS	Telephony Application Server
TTI	Transmission Time Interval
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
VoIP	Voice over IP
VoLTE	Voice over LTE
W-CDMA	Wideband Code Division Multiple Access

6. REFERENCES

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