Consultation Paper on Voice Services to LTE users (including VoLTE and CS Fallback) by CPA Himmatnagar

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Introduction :

With the fast deployment of LTE networks and the high penetration rate of smart phones, the mobile networks operators are facing the challenge which is the pure IP based structure of the LTE network which couldn't support transferring of the traditional voice services. The expected increase of data services revenue shares, compared to the voice services forecasted trend is showing that the traditional voice services will have slight degradation in the revenue shares, but it will not be killed completely, as it will be kept as the main demand for many mobile subscribers.

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In early launches of VoLTE, either in the form of market trials or commercial availability, the need to ensure a good user experience is paramount. Given the trend toward data-rich applications, voice now represents a smaller fraction of total device usage. It does, however, remain an essential capability, and user expectations for voice are very high. If voice services do not deliver the necessary level of quality and reliability, users will revert back to existing circuit-switched options or, in some cases, simply rely on over-the-top solutions. Clearly, the performance of the User's Experience will play an even greater role for services provided over packet-switched networks than over circuit-switched.

For reasons including improved cost effectiveness, spectrum use, and service quality, wireless operators are actively deploying VoLTE (voice over LTE), to support voice as another application on the data network, similar to over-the-top (OTT) VoIP applications. To ensure high service quality to end users, VoLTE relies on specialized support in both ends devices and network architecture, as well as dedicated radio resources during the voice call, to achieve an ambitious goal of completely replacing the legacy call in the long term.

VoLTE deployment by Indian operators is still at an early stage, but it is important to empirically understand its

performance from the perspective of mobile end users, especially compared to legacy call and OTT VoIP call.

Issues for Consultation :

1. **Whether prescribed QoS parameters, as per existing QoS Regulations, are sufficient to effectively monitor QoS of VoLTE/CSFB calls? Please provide suggestions with justifications.**

Comments :

Existing QoS parameters as per existing QoS Regulations are not sufficient to effectively monitor QoS of VoLTE/CSFB calls, because :

1. Key differences between VoLTE and Legacy voice for the network is :
   * Legacy voice has its dedicated path for signaling and user planes.
   * VoLTE shares its user and signaling paths with packet switched traffic (i.e. Large volume of internet traffic)
   * VoLTE signaling is carried inside a data user plane.
2. Long term Evolution (LTE) was designed for the data transfer and also as a packet switched all – IP system. It does not contain any circuit switched domain for the

purpose of providing with the regular Voice and SMS services.

3. Study reveals that in the current VoLTE deployment, call reliability is still not competitive with legacy calls. Call failure ratio, including setup failure and unintended call drop, is almost 5 x higher than the legacy call, which is a known problem to severely impair user experience and is a common problem seen in all the network. It is clearly imperative for operators to address the VoLTE call reliability challenges as soon as possible.
4. The major challenge of VoLTE in the early development is the inadequate LTE coverage compared with 2G/3G, which affects VoLTE call's reliability under undesired network condition and in the mobility case.
5. VoLTE doesn't guarantee superior audio quality all the time considering the lack of cooperation among VoLTE service providers in the current stage of VoLTE deployment.
6. VoLTE may affect by back ground traffic and degrade quickly with increasing upload traffic rate, which may be caused by the buffering on the device and in the network.
7. The reliability in both stationary and mobility cases is not satisfactory comparable to legacy call, especially in

mobility scenario. The root cause is the immature LTE coverage, ultimately significantly increase in call drop.

8. Over The Top (OTT) such as Skype or Google Talk provided either free of charge or is relatively inexpensive. Mobile operators might use OTT when they do not want to invest too much on deployment a very expensive IMS. There is no guaranteed QoS and no service continuity using this method, especially when user end moves outside an LTE coverage area. Call drop and call failure is always possible using this method .

9. Three types of problems of the deployed VoLTE service are identified:

(i) A lack of coordination between device-originated and network- originated events, which leads to consistent VoLTE call setup failure in some cases;

(ii) Incorrectly ordered inter-dependent actions , which lead to a high VoLTE call drop rate;

(iii) A lack of coordination in cross layer interactions , which results in extremely long muting during VoLTE calls.

These problems are all temporary in the early deployment, but such problems may always exist as long as we are in a heterogeneous network environment.

2. If existing QoS parameters are not sufficient to monitor QoS of VoLTE/CSFB calls, then what new parameters can be introduced? Please provide details with justifications.

Comments :

Customers mind service quality, not network performance

In order to guarantee minimum quality of service (QoS) requirements for its service delivered to the end user and then to improve his perception, we should defined a number of QoS class identifiers, each of which is used for bearers with specific priority an attributes. Different levels of QoS should be provided for different services, achieving a QoS guarantee on VoLTE calls. VoLTE QoS requires strict design for all network nodes to achieve the required QoS KPIs like :

(i) Packet loss rate

(ii) Mouth to ear delay

(iii) Availability of wireless resources and

(iv) Retainability of these resources.

End to End (E2E) QoS requires the cooperation of mobile terminals, access networks and core network to establish an E2E

voice signaling and bearer channel. This can provide higher QoS guarantee for voice services and improve subscriber experience.

An efficient QoS assessment for VoLTE is structured in main areas to be analyzed and managed as per below:

- Mean Opinion score (MOS):

  Is a standard values to measure the Quality of voice.

- Mouth to Ear delay:

  It is the end to end (E2E) delay which represents the time taken from processing speech starting from the UE VoLTE device including encoding/ decoding process until reaching on the called UE ,

- Packet Loss Rate (PLR):

  Ratio of lost packets to total transmitted packets, and Jitter which is the difference in response time between different packets received in the destination side.

There are other factors affecting the customer QoE (Quality of Experience), like the wireless coverage and the subscriber status whether he is in a high mobility mode or in a fixed mode state.

@ For service providers, Voice over LTE is the first and possibly most important service that requires full implementation of QoS on bearer level, IP and Lower level.

@ Consistent traffic marking and treatment required.

@ Measurement and monitoring of Voice service quality in LTE is much more important than in legacy network, and can be more difficult.

Quality of Experience measurements :

- ♣ Quality of Experience (QoE) measurements should always be completed as surveys and the results should dependant on perceptions and expectations.
- ♣ In practice, expectations of quality would likely have a big impact on QoE results.

Capturing the End-user Experience :

HOW : Terminals & test cases as per real subscriber behavior

WHEN : Test should be focused on peak hours, no empty network testing

WHERE : Independently selected dense population areas & landmarks

In short: How and how much the services improved in the LTE network should be measured.

Quality of Service (QoS) criteria

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The performance of Voice over LTE can be measured with the help of various criteria. The major focus should lie on the following four of the major criteria.

♣ Quality of experience measurement :

Quality of experience (QoE) measurement of VoLTE should be done in the handset and network also. There are known solutions to carry out such QoS measurements already on the market

♣ For VoLTE QoS measurements made on the handset, the concepts used should be similar/same as legacy voice QoS measurements – each handset/terminal measures the relevant KPIs and incoming stream quality.

♣ VoLTE QoS measurements made on the network should be done somewhat differently to legacy voice due to the different architecture.

- QoS measurements should be made on a large number of users.
- Streams in both directions should be measured

VoLTE QoS related Key performance Indicator (KPIs) :

- (KPIs)/KQIs associated with VoLTE QoS are typical to voice services:
  - Voice Quality

  - Call success rate
  - Call setup success rate
  - Call drop rate
  - Call setup time
- Other KPIs relevant to VoLTE are:
  - SRVCC (Single Radio Voice Call Continuity) handover success rate
  - SRVCC handover voice interruption time
  - RTP packet loss
  - RTP jitter
  - IMS KPIs (e.g. Initial Registration Success Rate)
  - EPC KPIs (e.g. Bearer Establishment Success Rate)

QoS measurement issues

Following Key issues should be considered in LTE QoS measurements :

- Deciding where to measure and how to measure (defined by what the measurements are targeted to do)

- Real network is not just LTE, but also 3G and 2G (take into account legacy network & architecture)
- Sheer volume of traffic (effective filtering required)
- Relatively low amount of VoLTE traffic (effective filtering required)
- Correlating the QoS results to ensure the final results provide an accurate representation of the actual network performance

Mean Opinion Score (MOS):

MOS is a well established metric and grading system that is used for the measuring of the quality of a voice call. It is usually graded by the user with the scale of 1 to 5, which means bad to excellent. This particular score is determined by few of the factors such as :

1. End to end delay,
2. Jitter and
3. Packet loss.

The following **Table 1** shows the standard and the ideal quality values for the Mean Opinion Score (MOS).

Table 1: MOS standard.

MOS	Quality
5	Excellent
4	Good
3	Fair
2	Poor
1	Bad

End to end delay:

End to End Delay is the time taken for a voice packet to be transmitted from the source UE to the destination UE across the LTE network. In simple words, it can be explained as the difference in the time between the sending and receiving of the packet. It basically takes place due to the performance of the network and the distance that exists between two of the nodes. This parameter is crucial so as to receive more information on the

voice of a real time. There would be difficulty in having the effective communication in case of too much delay.

Packet loss:

Packet Loss can be defined as the number of the transmitted packets that are failed to reach its destination. It can also be described as the particular rate in which the packets that are being sent do not reach at the receiving end. The real time communications are based on the UD protocols. This protocol is usually without any connections and it cannot be send again if the packet is lost. The loss of the packages can also take place by removing all those packets that do not arrive to the end of the receiver on time. It becomes problematic whenever the loss of packet takes place in a bulk. The highest rate of packet loss so the voice can be heard with enough quality must be 1%.

The following **Table 2** shows the average and the ideal quality values for the Packet Loss during Voice over LTE session.

Packet loss rate	Quality
<1%	Ideal
<2%	Average

Jitter:

The ITU-R has recommended 25 ms jitter as an acceptable value for the delay variation

3. How to define instance of silence/voice mute? How many such instances may be accepted during voice call? Whether existing parameters like packet loss, jitter, latency, end-to-end delay are sufficient to identify or measure silence/voice mute or some other parameters are also need to be factored to measure it? Please provide details with justifications.

Comments :

How to define instance of silence/voice mute ? How many such instances may be accepted during voice call ?

The main cause is the network type change happening during the muting, which may cause codec changes or switching between different audio decoder modules. The potential cause of long audio muting is lack of coordination in cross layer interaction.

Incoming voice can be sampled as byte streams in real time using the android audio record and problem can be monitor by sample buffering. For example, the pattern of a muting problem can be defined as consecutive zero buffers presenting in the sampled byte stream and parameters can be configured as the sampling period and threshold value of reporting a problem. Over 10 second muting should be considered intolerable according to the standard.

According to the standards, over 10 second muting is considered intolerable but configuration of the parameters to make audio quality responsive to muting over one second can also capture problem such as intermittent audio. This detection algorithm can also distinguish problematic muting from silence, since there are still non–zero bytes received during silent period.

- To ensure privacy, the audio quality monitor doesn't record any audio and only monitor a sample buffer that flushes frequently.
- Using the audio quality monitor, we can capture various telephony audio problems such as muting, intermittent audio and garbled audio besides call setup failure and unintended call drop.

Nuisance Silent Call :

1. As per the **Analysis of Silent calls Summary Report** published by **Ofcom,** " Financial companies are responsible

for knowingly using silent calls whilst the chasing of debt as a tactic to put pressure on consumers."

2. Over seas organizations or entities are also responsible for generating significant volumes of silent calls.

Silent and abandoned are usually made to consumers by companies using automated calling systems (ACS), also known as predictive dialers, to make outbound calls. If the called party answers the call and no agent is available, then the call is disconnected, which results in the consumer receiving an abandoned call. If no recorded information message is played upon disconnection, then the call will be silent. Silent and abandoned calls can cause annoyance, inconvenience and anxiety to consumers, especially to vulnerable groups. Sometimes the caller's number (the Calling Line Identification, the CLI) is withheld, which means that the consumer is unable to find out who made the call.

Generating such calls is a form of persistent misuse of an electronic communication network or service. Authority has the power to take action if it has reasonable ground to believe that persistent misuse has taken place.

Both service providers (Fixed and Mobile) should be advised to support their consumers who may be the victim of nuisance and malicious calls.

Whether existing parameters like packet loss, jitter, latency, end-to-end delay are sufficient to identify or measure silence/voice mute or some other parameters are also need to be factored to measure it? Please provide details with justifications.

Comments :

Yes, existing parameters like packet loss, jitter, latency, end-to-end delay are sufficient to identify or measure silence/voice mute. Some other parameters are mentioned above.

4. **How to measure report and evaluate network or service from perspective of silence/voice mute problem? Which ITU measurement tools can be used to prepare framework for measurement of silence/voice mute problem? Please provide details with justifications.**

Comments :

No Comments. Technical question.

5. **Whether certain range of timers and constants are required to be prescribed which may affect VoLTE call quality assessment? If yes, which may**

be those timers and constants and what may be the suggested ranges of timers and constants? Please provide details with justifications.

Comments :

No Comments. Technical question.

6. What parameters like Post Dialing Delay (PDD) may be introduced to measure performance of users being served voice via CSFB? What may be the threshold? How to measure report and evaluate? Please provide details with justifications.

Comments :

As per the international guidelines.

7. Any other issue which is relevant to this subject?

Comments :

VoLTE is still at its early phase for global rollout. It is natural to suffer from easy-to-fix mistakes during this period. However, we seek to sort out the fundamental issues beyond simple bugs and errors. Bearing the telecom-based design mindset, VoLTE calls for substantial upgrades on the infrastructure side (complex functions in the core), and device updates as well. VoLTE can be

exploited to launch attacks against both the network operator (thus benefiting mobile users) and an individual user. The user may gain free and high-priority data access by abusing the VoLTE signaling bearer to carry data packets. (S)he may also suffer from voice/data DoS attacks due to spamming over the voice/signaling bearer. Two lessons can be learned :

First, VoLTE operates on both control and data planes. Its signaling and data are implemented in both software and hardware at the device, and carried by distinctive radio bearers within LTE. Consequently, to secure both planes, the solution calls for concerted effort between the network infrastructure and the end host, as well as the software and the hardware at the device.

Second, VoLTE leverages the high priority services (compared with the low-priority, best-effort delivery) in mobile networks to ensure quality calls. The priority services supplemented by the LTE network may serve as an implicit side-channel to leak confidential information. As the voice solution becomes compatible with the Internet design, it is prudent to add more intelligence at the device and the network, to address the double-edged, security side-effects of PS and IP.

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