Abstract— Long Term Evolution (LTE) is the next step forward in cellular 5G services. Expected in the 2020 time frame, LTE is a 3GPP standard that provides for an uplink speed of up to 50 megabits per second (Mbps) and a downlink speed of up to 100 Mbps. LTE will bring many technical benefits to cellular networks. Bandwidth will be scalable from 1.25 MHz to 20 MHz. This will suit the needs of different network operators that have different bandwidth allocations, and also allow operators to provide different services based on spectrum. LTE is also expected to improve spectral efficiency in 5G networks, allowing carriers to provide more data and voice services over a given bandwidth. This technical paper provides an overview of the LTE physical layer (PHY), including technologies like voice calling over VoLTE.

I. INTRODUCTION

The 3GPP Long Term Evolution (LTE) represents a major advance in cellular technology. LTE is designed to meet carrier needs for high-speed data and media transport as well as high-capacity voice support well into the next decade. It encompasses high-speed data, multimedia unicast and multimedia broadcast services. Although technical specifications are not yet finalized, significant details are emerging. This paper focuses on the LTE physical layer (PHY), Over-the-top (OTT) communication solutions, such as Skype and FaceTime, have driven user adoption of more advanced service behavior based on VoIP, video-calling and messaging services in combination. However, a fully satisfactory user experience cannot be provided by OTT solutions, as there are no QoS measures in place, no handover mechanism to the circuit-switched network, no widespread interoperability of services between different OTT services and devices, and no guaranteed emergency support or security measures. Consequently, the adoption of OTT clients is directly dependent on mobile-broadband coverage and the willingness of subscribers to use a service that lacks quality, security and flexibility. Operators have started to launch nationwide commercial VoLTE services for voice and video calling over LTE, including seamless service continuity with circuit-switched networks. In addition, continuity with Wi-Fi networks for residential use is also starting to be available on the market. With native support in smartphones and networks, a seamless high-quality experience is a given with VoLTE, and the service reach can also be extended outside LTE coverage and to additional device types. Mobile-broadband networks will evolve into their fifth generation (5G) starting around 2020. VoLTE technology is a natural fit within 5G; VoLTE will therefore also serve as the foundation for telecom-grade voice and video calling services in future 5G networks.

II. IMPLEMENTATION DESIGN

A. How VoLTE Works

Although MMTel forms the basis of the VoLTE solution, EPC (with IP flow and bearer management) and LTE (with conversational radio bearers) are integral parts of it. Together, they secure interoperability on all interfaces between devices and networks.

B. VoLTE Support in Smartphone

The VoLTE device ecosystem has developed to support large-scale deployment plans with a wide set of devices from all major vendors. Devices are built using VoLTE capabilities integrated into chipsets supporting HD voice, video calling and Single Radio Voice Call Continuity (SRVCC), among others. Key VoLTE features to deliver high-quality voice and efficient capacity for the combined voice and data services are supported. Devices have been designed to adapt to radio conditions for seamless mobility, optimized battery consumption and call latency.

C. Natively Integrated Wi-Fi Calling

Natively integrated Wi-Fi calling in devices has recently been introduced by major device vendors. Operators can now extend VoLTE service reach into homes with limited cellular coverage. Seamless handover of calls from LTE to Wi-Fi is supported to ensure service continuity. The phone will use the local Wi-Fi access point and automatically connect to the operator-provided voice service via any internet connection. The native phone dialer of the smartphone is used to make
regular calls, still using the SIM-based mobile phone number and without the need to use a separate app in the phone. Video calls are used in the same way.

Wi-Fi calling needs to be enabled both in the device and in the network. New integrated functionality in the EPC, with the Evolved Packet Data Gateway (ePDG), is needed to allow for untrusted non-3GPP accesses to interwork with the EPC and connect to the IMS network. The ePDG provides security mechanisms such as IPsec tunneling of connections with the device over untrusted non-3GPP access to ensure seamless handover of an ongoing VoLTE call to the user’s home Wi-Fi. The service is still anchored in the operator network via the ePDG.

Wi-Fi calling builds on IMS/MMTel and offers the same service capabilities as VoLTE, with a few differences regarding how location-dependent services are handled. VoLTE uses network mechanisms to make the service predictable and independent of load from other services, while for Wi-Fi calling, the service quality will be dependent on the local environment and load from other users connected to the same access point. Thus, Wi-Fi calling is recommended for residential usage and smaller enterprises, while larger enterprises are recommended to use 3GPP-based small cell solutions to guarantee high-quality real-time voice and video calling services.

D. Voice Call

Mobile broadband has created a world of opportunities and opened up new revenue streams for operators. Opportunities are often coupled with challenges, and mobile broadband tests the position of communication services, such as voice, which today account for around 60 percent of operators’ annual revenue – about USD 600 billion in 2014 – globally. The crucial question is how to take advantage of mobile-broadband opportunities, while at the same time maintaining and increasing revenues from communication services for consumers as well as for business users.

LTE networks can deliver mobile broadband with greater data capacity and lower latency. However, as there is no circuit-switched voice domain in LTE, the mobile industry has adopted a globally interoperable IP-based voice and video calling solution for LTE, known as VoLTE, which also enables development of new innovative communication services.

Over-the-top (OTT) communication solutions, such as Skype and FaceTime, have driven user adoption of more advanced service behavior based on VoIP, video-calling and messaging services in combination. However, a fully satisfactory user experience cannot be provided by OTT solutions, as there are no QoS measures in place, no handover mechanism to the circuit-switched network, no widespread interoperability of services between different OTT services and devices, and no guaranteed emergency support or security measures. Consequently, the adoption of OTT clients is directly dependent on mobile-broadband coverage and the willingness of subscribers to use a service that lacks quality, security and flexibility.

Operators have started to launch nationwide commercial VoLTE services for voice and video calling over LTE, including seamless service continuity with circuit-switched networks. In addition, continuity with Wi-Fi networks for residential use is also starting to be available on the market. With native support in smartphones and networks, a seamless high-quality experience is a given with VoLTE, and the service reach can also be extended outside LTE coverage and to additional device types.

Mobile-broadband networks will evolve into their fifth generation (5G) starting around 2020. VoLTE technology is a natural fit within 5G; VoLTE will therefore also serve as the foundation for telecom-grade voice and video calling services in future 5G networks.

E. Video Calling Over LTE

The GSMA profile for IMS conversational video [5] caters for video calls over LTE based on VoLTE with the addition of video capability, providing users with synchronized full-duplex voice and video streams, as shown in Figure 4. Users can make one-to-one or one-to-many video calls, switch to video at any point during a call, and drop video at any point to continue with just voice. During call establishment, all devices involved declare their video-availability status, and the results are displayed on all devices. Users can either choose one-way video call ("see what I see") or invite users to two-way video calls.

![Figure 2. Video calling over LTE end to end communication view.](image)

CONCLUSION

Although incomplete, the LTE specifications do contain a great deal of useful information. It is entirely possible to construct a reasonably accurate picture of the LTE physical layer at this time. This discussion has hopefully provided the reader with a reasonably complete description of the LTE PHY. In some cases, material has been omitted for the sake of brevity. In other instances, the LTE specifications do not contain much detail at this time. As mentioned above, work on the 3GPP LTE specification is ongoing at this time and will not be complete before late this year or possibly early 2008.

References


