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# Background

At the end of 2004 the third generation partnership project (3GPP) Standardisation Forum started to evaluate a new radio technology as a successor for wideband code division multiple access (WCDMA). This work was called long term evolution (LTE) and is nowadays the radio interface name used in most official publications. Inside 3GPP the newly developed radio access network is called the evolved UMTS terrestrial radio access network (E-UTRAN) to indicate the path from the global system for mobile communications (GSM)/Enhanced data rates for global evolution (EDGE) radio access network (GERAN) via the GSM/general packet radio service (GPRS)/EDGE to UTRAN [WCDMA/high-speed packet access (HSPA)] and finally to E-UTRAN (LTE). In parallel to the work on a new radio interface 3GPP initiated a study to evolve the 2G/3G packet core network (known as the GPRS core) in order to cope with the new demands of LTE. This core network study was called system architecture evolution (SAE) and it was documented in the 3GPP technical report (3GPP TR 23.882). The final outcome of this work was a new packet core design in Release 8 documented in (3GPP TS 23.401) and (3GPP TS 23.402), called the evolved packet core (EPC). 3GPP Release 8 was officially completed in March 2009 and the world's first commercial LTE network was opened in December 2009 by TeliaSonera.

3GPP Release 8 introduces major advances in mobile networks. For the subscriber, it means higher access rates and lower latency on the connection, while for the mobile communication service provider, LTE radio technology provides lower cost per transmitted bit thanks to more efficient use of radio network resources and delivers excellent voice spectral efficiency, as described in Chapter 7. The technology also offers more flexibility in frequency allocation, thanks to the ability to operate LTE networks across a very wide spectrum of frequencies. LTE also minimises the power consumption of terminals that are used 'always on'. 3GPP Release 8 also introduces major advances in the core network that improve service quality and networking efficiency, leading to a better end user experience. GPRS technology has already introduced the always on concept for subscriber connectivity and 3GPP Release 8 mandates this ability, with at least one default bearer being always available for all subscribers. This allows fast access to services as well as network initiated services such as terminating voice calls and push e-mail. The connection setup time for person to person communication is also minimised with always on bearers.



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But considering the fact that LTE is an all-internet protocol (IP) technology we can get to the conclusion that the voice service will have to be delivered in a different way as circuit switched voice will not be possible. So there is a need for a voice solution on top of LTE. Voice in this IP world, would be implemented as voice over Internet protocol (VoIP). The 3GPP-specified way to support VoIP is the IP multimedia subsystem (IMS). It is an access-independent and standard-based IP connectivity and service control architecture that enables various types of multimedia services to end users using common Internet-based protocols. 3GPP has worked with the IMS since 2000 and there exist thousands of pages, in different specifications, that cover IMS related functionalities. In the meantime, a sophisticated architecture and feature set has been developed. Moreover, 3GPP has specified multiple, different ways to complete single functions (e.g. authentication, session setup, supplementary service execution, bearer setup) which increases complexity of the IMS.

While 3GPP has specified all of the 'ingredients' needed to implement IMS-based voice over long term evolution (VoLTE) – such as session initiation protocol (SIP) registration, signalling compression, call set up and supplementary services – it has left it up to communication service providers and vendors to decide which of the numerous alternative implementation options to use. This is frankly a recipe for a chaotic and fragmented rollout of IMS-based VoLTE since there is no way to guarantee that different industry players will opt for the same 'ingredients' that their competitors' choose for their own implementations. It goes without saying it was not a model for success.

Unsurprisingly, in the absence of a clear-cut approach to VoLTE, alternatives emerged, most notably 3GPP specified circuit switched fallback (CSFB), in which an communication service provider uses its legacy 2G/3G network to handle voice calls. In this scenario, when an LTE terminal initiates a voice call or receives one from the legacy circuit-switched network, it downgrades any ongoing LTE data session to 3G or HSPA speeds for the duration of the voice call. If the voice call 'falls back' to a 2G network, the LTE data session will likely be suspended altogether, as 2G data speeds are not sufficient for broadband data applications. In either case, the impact on customer experience can be obvious.

Another emerged alternative for IMS-based VoLTE was VoLTE via generic access (VoLGA) promoted by the VOLGA Forum.

All major network and handset vendors compete aggressively for the biggest possible slice of network communication service providers' business. But at the same time, their business is an interconnected business, where equipment interoperability, especially between handset and network is the key to ensuring that they can all play together. For communication service providers voice have been the killer application and it is going to be big source of revenue for years to come. When there were three different voice solutions (IMS-based VoIP, CSFB, VoLGA) there was rightfully serious concerns whether LTE would come with voice anytime soon. So the situation in year 2009 was equally challenging for both communication service providers and vendors. This is why, from time to time, serious rivals come together to agree on technical cooperation that is designed to help smooth the way forward for the common good of the telecoms market. On 4 November 2009 the One Voice initiative was published by AT&T, Orange, Telefonica, TeliaSonera, Verizon, Vodafone, Alcatel-Lucent, Ericsson, Nokia Siemens Networks, Nokia, Samsung and Sony Ericsson. These 12 companies announced that they have concluded that the IMS-based solution, as defined by 3GPP, is the most applicable approach to meet their consumers' expectations for service quality, reliability and availability when moving from

existing circuit switched telephony services to IP-based LTE services. The companies in One Voice then set about to create a solid foundation for securing the smooth introduction of standards-based VoLTE. They evaluated the different alternative 'ingredients' specified by 3GPP in order to settle on a minimum set of essential handset and network functionalities and features that communication service providers would need to implement basic, interoperable VoLTE service. These agreed mandatory set of functionalities for the user equipment (UE), the LTE access network, the EPC network and the IMS functionalities are contained in the 'technical profile' published by One Voice, available for use by anyone in the industry. In a sense, the technical profile gives all industry stakeholders a level playing field on which to enhance their VoLTE service as they see fit, but most importantly a level playing field that enables the basic working, and interworking, of VoLTE across the entire industry landscape.

15 February 2010 marks the second important milestone in VoLTE ecosystem development. On that date, the Global System for Mobile Association (GSMA) announced it has adopted the work of the One Voice initiative to drive the global mobile industry towards a standard way of delivering voice and messaging services for LTE (GSMA) and Next Generation Mobile Networks alliance (NGMN) delivered communication service providers' agreement to ensure roaming for VoLTE by recommending to support CSFB in all LTE voice devices and networks (NGMN). The GSMA's VoLTE initiative was supported by more than 40 organisations from across the mobile ecosystem, including many of the world's leading mobile communication service providers, handset manufacturers and equipment vendors, all of whom support the principle of a single, IMS-based voice solution for next-generation mobile broadband networks. This announcement was also supported by 3GPP, NGMN and the International Multimedia Teleconferencing Consortium (IMTC). Following the announcement, work progressed very quickly; and already in March 2010 the GSMA permanent reference document (IR.92) on IMS profile for voice and short message service (SMS) was published containing an improved version of the One Voice profile. In September 2010 GSMA agreed to freeze the content of the permanent reference document (IR.92). A global baseline for commercial VoLTE deployments was finally stabilised.