White Paper

Examining the Case for VoLTE & Rich Media Communications

Prepared by

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VoLTE: A Demanding Application

Voice over LTE (VoLTE) is, perhaps, one of the ultimate applications for 4G-LTE networks. The stringent requirements of mobile voice communications present new challenges for all-IP mobile networks, and VoLTE's extension into real-time video – and related rich media and collaboration services – only serves to emphasize the importance of advanced features, such as quality of service (QoS), call admission control and session management, inherent to the LTE system architecture.

The purpose of VoLTE is not to be a technical marvel, however. The intent is to create new services that will enable communication and collaboration in ways that are not possible, or practical, using today's mobile technologies. VoLTE is a core component, and a practical starting point, for a new set of foundation services being defined for all-IP networks in the smartphone era. The objective is to make these services as ubiquitous and accessible as voice and SMS are today, yet also open to interaction with Web and Internet applications.

In more down-to-earth terms, it is unthinkable that future mobile networks will not support reliable voice and messaging. VoLTE is a foundation that is essential to the future of operator business models and to vital services, such as emergency calling, that the industry has a responsibility to develop and maintain.

For a large number of Tier 1 mobile operators, it is no longer a question of whether they should implement VoLTE and associated rich media communications, but rather of when, where and how to implement VoLTE.

A Technical & Commercial Challenge

Undoubtedly, VoLTE is a technically and financially challenging process and, given these constraints, many operators are rightly cautious about the pace of investment. This white paper aims to provide operators and other industry participants with a status update on VoLTE that will contribute to an understanding of the technical viability of the service and provide guidance on industry timelines for network trials and commercial launches.

Commercially, we expect services to launch in 2012, led by North American operators with a CDMA heritage, and perhaps some advanced South Korean operators. Extensive field trials are already underway, and initial results are promising in terms of technical performance and end-user service quality. For operators with a UMTS heritage, we expect commercial launch starting in 2013. These operators will typically want in-call handover from LTE to 3G, which brings additional technical challenges that are eased by a new generation of device chipset that is currently sampling to handset makers, enabling them to produce test devices.

In the core network, the mobile industry has aligned on IP Multimedia Subsystem (IMS) technology to deliver VoLTE service and is working to tightly integrate this with LTE access to improve reliability, network efficiency and service quality. To use a sporting analogy, the industry is now putting in the hard yards of winter training needed to achieve success and glory later. The upside of this for fast-follower operators is that the best practice around VoLTE and IMS implementation will start to percolate through the ecosystem, enabling them to launch rapidly and with less technical and commercial risk than today's pioneers.

It many senses, VoLTE is a community project – albeit one with definite commercial objectives – that no single actor can develop and deliver alone. In this sense, it embodies the best of networking industry practice, in that collaboration between vendors and operators will create the foundations for a long-lived and competitive mass market in advanced communications services.

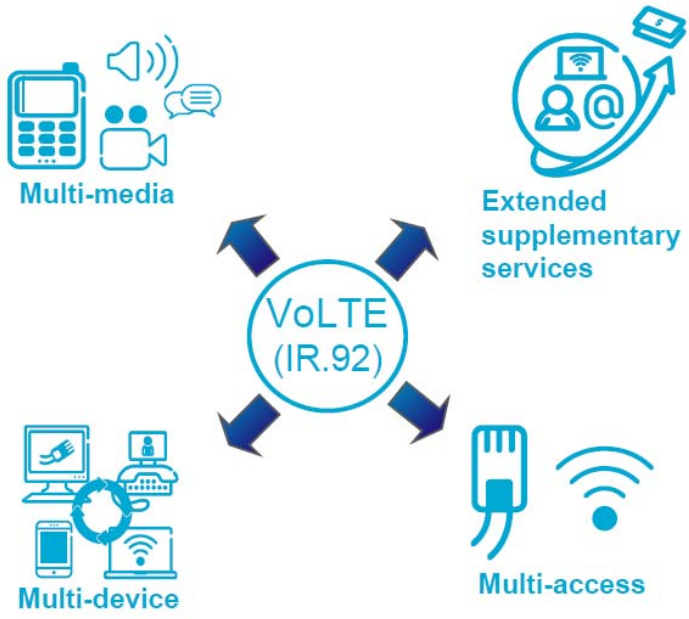
Service Extension: To Video & RCS

VoLTE in its simplest form specifies a minimum experience that is intended to match the features offered by today's 2G/3G circuit-switch domain. This service set was defined in document IR.92 by the GSMA and was kept intentionally simple to aid deployment and interoperability. In essence, to get a complex technology operational and released into the market, it was simplified to its bare essentials.

Even basic VoLTE will deliver high-quality services. Call setup times in VoLTE are less than 1 second, against more than 3 seconds in UMTS systems, and initial reports from drive tests suggest that voice quality in VoLTE systems is favorable. This is partly due to the adoption of the wideband codecs, but also because VoLTE tightly links voice service to management of mobility, resources and sessions in the network.

VoLTE is not only a replacement for circuit-switch services, however; it is also intended to be extensible and evolve to rich media services that can be delivered over multiple access networks to many different devices.

Figure 1: VoLTE as a Foundation for Service Extension



Source: Ericsson

The more obvious examples will be extension into video-calling and related Rich Communications Suite (RCS and RCS-e) services defined by the GSM Association and other industry bodies. It is not restricted to this, however.

A strength of well-defined, interoperable communications technologies such as VoLTE and RCS is that they can be used to underpin applications developed by third parties, that are then free to focus their efforts on things that matter more to their particular service. Rich voice and messaging, for example, could be built in to a consumer application or a high-end enterprise collaboration service without the third party having to develop this functionality itself. The two services would look and perform very differently, but would use the same underlying technology.

Alternatives: CSFB & OTT

In one sense – because there is no other well-specified, well-supported solution on offer – operators have no alternative to VoLTE. There are, however, a number of interim methods to support voice in LTE devices that are useful to operators wanting to start selling smartphones before VoLTE is ready for their market or use-case. These would typically use the existing circuit-switch 2G and 3G network, but may also be pseudo over-the-top (OTT)-style services.

Figure 2: Positioning VoLTE

SERVICES		VOLTE	CSFB	OTT
Standards	Global Roaming	✓	✓	✖
	Interoperability	✓	✓	✖
	QoS & Regulatory (e.g., Emergencies)	✓	✓	✖
Rich Media	Path to IP-Based Rich Communications	✓	✖	✓
	Simultaneous 4G LTE Data & Voice	✓	✖	✓
	Extensible for IP Service Innovation	✓	✖	✓
Evolved Voice	HD, Web/App Integration	✓	✖	✓
	KPIs (Reliability, Billing, Security, etc.)	✓	✓	✖
	2G/3G Integration/Fallback	✓	✓	✖

Source: Alcatel-Lucent, Heavy Reading

Circuit-Switch Fallback (CSFB) and the dual-radio solutions used by CDMA operators (sometimes in the form of Simultaneous Voice-and-LTE, or SVLTE) are useful in that the existing telephony service is retained. The issue is that they do not evolve easily and are not, at root, LTE solutions. OTT options are appealing because they run over IP and can support richer experiences, but at the expense of crucial features, such as emergency calling, interoperability, 2G/3G integration/handover and broad ecosystem support.

This paper will not address these options in detail, but suffice to say that over the medium and longer terms both solutions may struggle to compete with well-implemented VoLTE services. Nevertheless, the CSFB and dual-radio devices in the market today are proving useful, and have clear value. The operators that have been first to adopt these interim approaches have done so because of near-term need, and they are often the same operators that will lead on VoLTE services.

Timeline & Commercial Launch

The first commercial VoLTE services are expected to launch in the U.S., and South Korea in 2012. This first wave of advanced operators will be followed by another wave of progressive operators launching in 2013, with the technology and ecosystem then pushing into the mainstream from 2014 onward.

Figure 3: VoLTE Launch Phases by Region

REGION	VOLTE LAUNCH	VIDEO, RCS	SERVICE CONTINUITY	EMERGENCY CALLING
US CDMA	Mid 2012	At VoLTE launch	Not needed	Using CS initially, then VoLTE
US UMTS	2013	At VoLTE launch	Yes, SR-VCC	Using VoLTE
Advanced Asia/Pacific	2H12	At VoLTE launch	Yes, SR-VCC	Not known
Europe	2013-2014	RCSe begins in 3G – 1H12	Yes, SR-VCC	Using VoLTE

Source: Alcatel-Lucent, Heavy Reading

Device Capability & Availability

Commercial VoLTE introduction is determined primarily by device capabilities and availability. There are other factors at work – notably coverage, implementation of advanced LTE QoS features, the existence and maturity of IMS core networks, and commercial strategy – but it is availability of devices that is the determining factor.

Device capabilities are tightly linked to the handset operating system and the need to embed the IMS stack and user-interface elements related to rich media video and messaging services. Devices are also dependent on VoLTE-optimized chipsets. Newer-generation products are able to integrate VoLTE functionality into the baseband to improve call quality and perform the radio measurements needed to deliver low-latency 2G/3G handovers more quickly and accurately.

First-generation chipsets are already shipping in mass-market LTE devices and can support VoLTE with QoS, but without emergency calling and in-call handover to 2G/3G. Second-generation chipsets that will support these features will ship in volume from mid 2012, which will mean device availability from early 2013.

Early VoLTE Launches (With Video & QoS)

There is always uncertainty about exactly when operators will launch new services, which tend to be closely guarded secrets. Nevertheless there are at least four operators that have made public statements to the effect that they will aim to launch VoLTE in 2012: Verizon Wireless, MetroPCS and C Spire Wireless in the U.S. and LG U+ in South Korea.

Not coincidentally, these are all CDMA operators that currently use dual-radio CDMA-LTE devices. They also have ambitious LTE coverage rollouts that mean they

can launch VoLTE service without the need to support handover to 2G/3G during a call. For these operators, a VoLTE service using the QoS capabilities of LTE and wideband codecs should be possible by mid 2012. Devices are already available and are being tested in live networks with positive key performance indicators (KPIs). Because handover is not needed, the existing generation of chipsets should suffice for these first devices.

It is also likely that services will launch with a video option. With QoS implemented in the LTE network, it should be possible to provide good quality, IP-based video calling with performance that is usable and desirable.

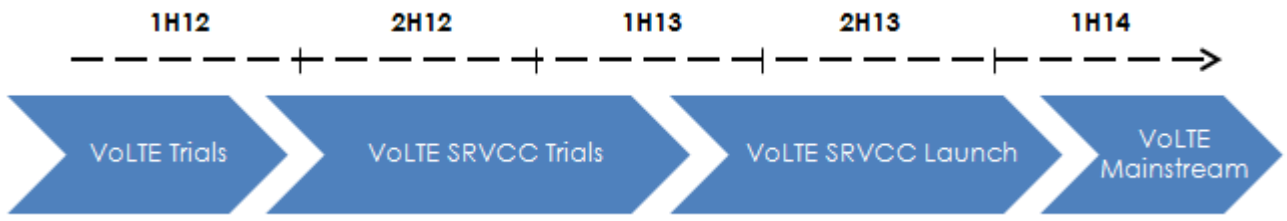
The outstanding question for these early launches is how to provide emergency calling services, which of course need to be reliable and, in some markets, notably the U.S., are subject to strict regulatory requirements. For the initial launches, therefore, these operators will continue to rely on the CS domain for emergency calling via the CDMA radio in the device.

VoLTE Launch With Handover

Operators that require VoLTE with in-call handover (and emergency calling support) will deploy in a later phase – probably from early 2013 onward. For UMTS operators this is likely to be the mainstream scenario. As noted, CDMA operators have interim emergency calling procedures that can be used alongside VoLTE.

This timeline is shown in **Figure 4**. It is representative of UMTS operators and indicates that VoLTE launches will occur through 2013, 2014 and beyond. This aligns well with the mass of LTE network deployments expected over the next few years as new spectrum is released. The advantage these fast-follower operators have is that the ecosystem and best-practice expertise will be in place for rapid VoLTE service launch from the start of their commercial LTE activities.

Figure 4: VoLTE Launch Phases (With SR-VCC & Emergency Calling)



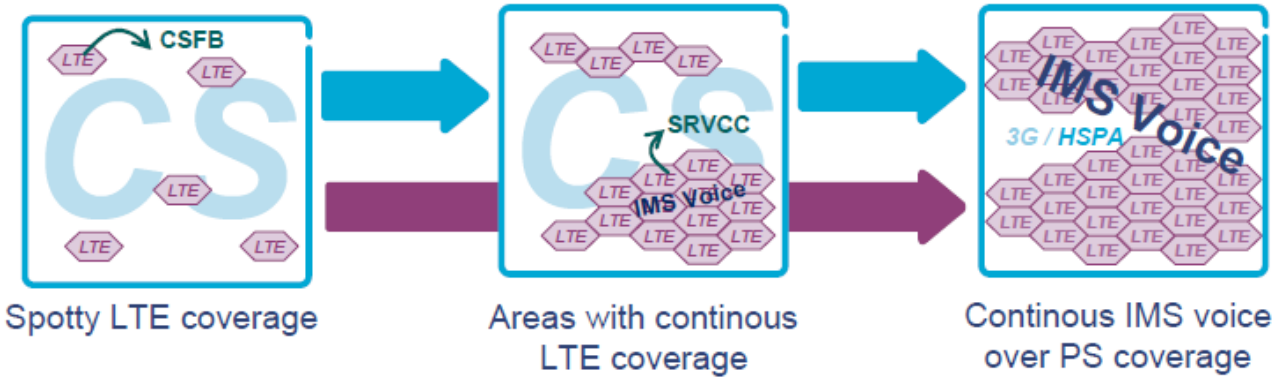
Source: Heavy Reading

For in-call handover using Single Radio Voice Call Continuity (SR-VCC), the main challenge is secure low enough latency to be tolerable for commercial services. The newer generation of chipsets should improve this considerably, as they will have more granular control over the radio and will be better able to fine-tune the radio measurements required to optimize the handover process. These chipsets are already sampling and will enable handset makers to deliver the first devices to operators in the first quarter of 2012 for initial testing. Chipsets should be shipping commercially from mid 2012 to enable larger-scale trials in live networks, with a view to launching possibly at the end of 2012, but more likely in 2013.

Impact of LTE Coverage on Voice Strategies

The LTE coverage an operator is targeting will have a direct impact on the choice of voice strategy – in fact, is one of the most influential factors. **Figure 5** shows how the relationship between coverage and voice may evolve.

Figure 5: VoLTE & in Network Coverage Scenarios



Source: Ericsson

In the first phase, where LTE coverage is spotty, it is appropriate to use CSFB (or dual-radio devices), because the amount of time a device will be in LTE coverage will be low. Moreover, this would probably be in the early phases of launch, meaning customer numbers would also be low. Where LTE is deployed in traffic hotspots as capacity relief for dongles, MiFis and similar services, then a voice solution is not needed.

In the second phase, when LTE coverage is good but not ubiquitous, it makes sense to move to VoLTE to enhance the user experience and competitive positioning against other service offerings. This is where SR-VCC-based handover is required – although the expectation is that handovers become less and less frequent as coverage is built out. Target performance of an SR-VCC handover is on the same level as an ordinary IRAT handover, and newer chipsets and optimized networks should bring this down to less than 300ms (per 3GPP 22.278), making it suitable for a flagship service.

Some operators (for example, in Europe) are considering whether to launch a VoLTE + Video service without handover when they have decent but not perfect coverage. The logic is to provide a rich experience alongside the basic CSFB solution to differentiate against the competition and OTT providers. At the time of writing we do not believe operators have committed to this path, but it is notable that it is being considered, pending further work on SR-VCC.

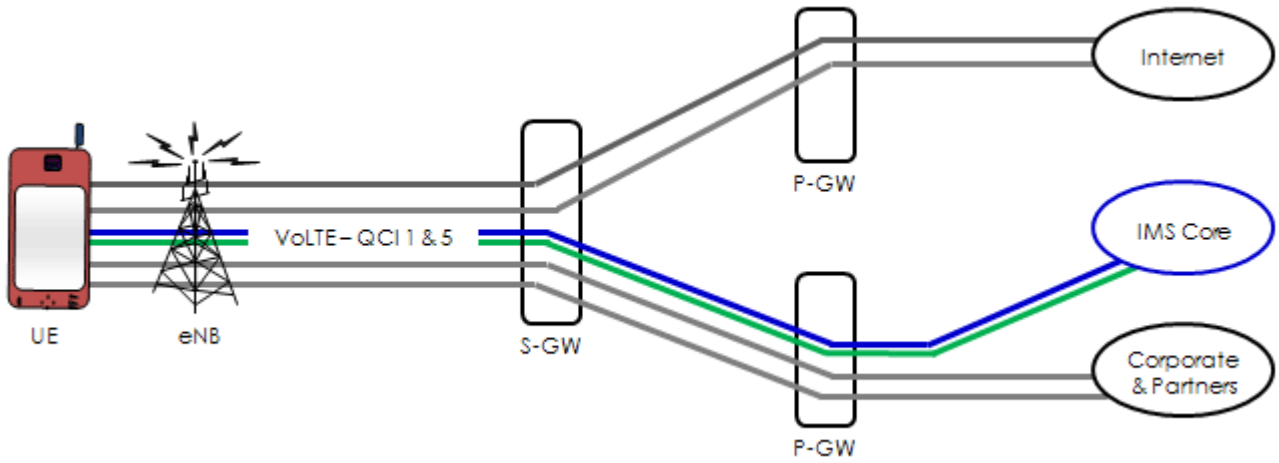
In the third phase, LTE coverage is very good. Handovers will be very few and, combined with optimized packet-switch handover, it may become attractive to offer IMS-based VoIP and video services over the 3G access network as well as over LTE. This will give operators the capability to deliver a common IP-based service set across access networks and, for end users, will offer a ubiquitous, high-end experience.

Network Implementation

One aim of VoLTE is to provide a service that is at least as reliable as the current cellular voice experience, but to do so over an all-IP infrastructure in a shared-resource environment.

To set up and maintain a VoLTE call requires tight integration across the network. Devices, the radio network, packet transport, the Evolved Packet Core (EPC) and the IMS-based service core all have to be aligned. The network must reserve bandwidth of sufficient performance across the call path using LTE QoS mechanisms. This takes the form of specific logical bearers with defined bit rate, packet loss and delay attributes described by QoS Class Indicator (QCI) values. In **Figure 6**, these are shown in blue for the call itself (QCI 1) and green for the SIP signaling bearer (QCI 5).

Figure 6: LTE Bearer Model & QoS



Source: Heavy Reading

Radio Access Network

The performance of the radio network is critical. To run carrier-grade voice services, operators and vendors must implement the Allocation, Retention and Priority (ARP) mechanisms used for call admission control in radio base station equipment. This is of particular utility when a VoLTE call needs to be prioritized in a loaded cell over, say, best-effort Internet traffic. A small number of operators have implemented ARP in live networks, and more will do so in the coming year. ARP should be well supported by the major LTE RAN vendors, but even in these cases it needs to be tested and integrated with the rest of the architecture – for example, as ARP relates to the bearer setup, PCRF actions and the IMS core.

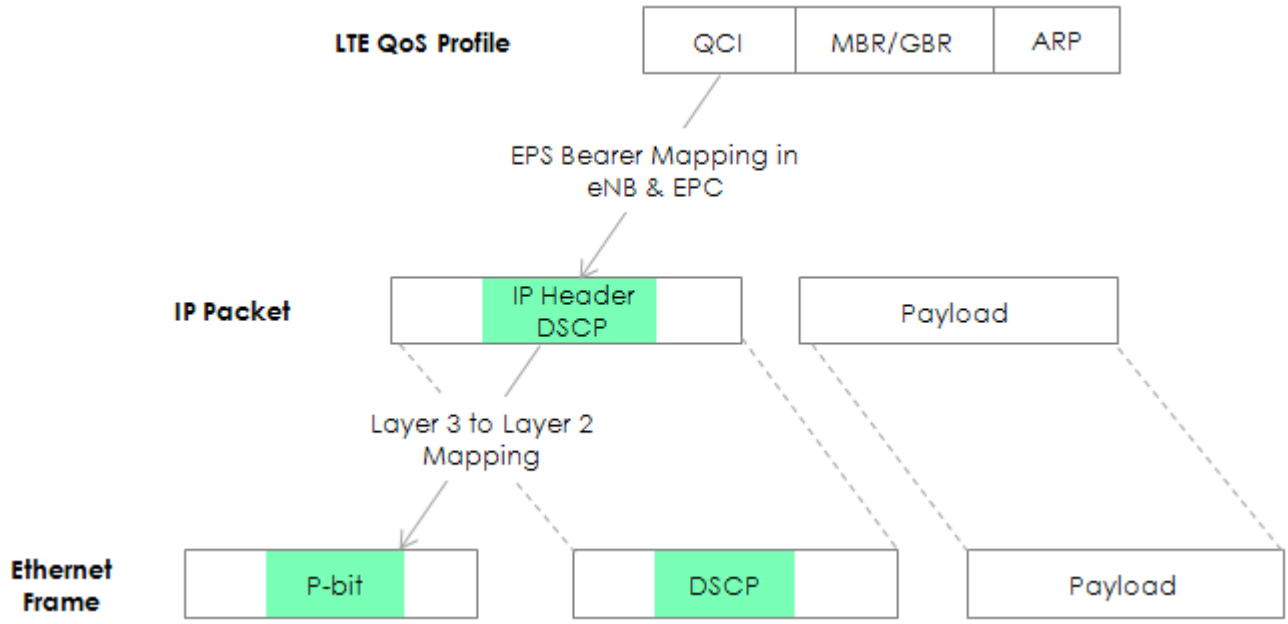
Another important factor is the impact on scheduler performance of the mixed packet sizes that VoLTE will create. Radios designed and configured for large data packets may perform well in throughput tests, but cell efficiency could suffer when smaller voice packets are part of the traffic mix. The scheduler is critical to overall system performance, and this must be a key evaluation for the operator when planning to introduce VoLTE.

Packet Transport & EPC

The transport network will, in general, have been upgraded to support packet services for the introduction of LTE. Historically, voice has proven a challenge for packet backhaul as the delay requirements, SLAs, troubleshooting tools, etc., have either not been mature enough, or operators have not been familiar with them. This has evolved over the past couple of years to the point where progressive operators have transitioned to IP RAN for 2G/3G and are now running voice and data over pure packet infrastructure. Verizon Wireless is on record as saying its packet backhaul is good enough to support VoLTE today and that latency is within the demanding tolerances needed for voice (and related signaling).

There are some specific requirements for LTE voice. First, operators will need the ability to map QCI values to IP DiffServ code points and Ethernet priority bits, so that voice calls and signaling can be treated to higher priory than best-effort Internet in the transport network.

Figure 7: Mapping QCIs to IP & Ethernet to Support VoLTE Service



Source: Heavy Reading

In addition to ensuring end-user service quality, this should also generate efficiencies in the transport domain, as the operator will not have to provide Grade A service to all of its traffic – just to those services that merit it. Typically operators use up to four classes of service in packet backhaul networks, with the highest priority reserved for signaling and voice.

There is also the prospect of operators wanting to route VoLTE bearers to specific locations in their network – be that a specific P-GW and/or a specific site where the IMS core, media gateways, session border controllers, interconnect points, etc., are located. This again has implications for packet transport, which must be flexible enough to support this type of routing and re-configuration of the network.

Service Core (IMS)

Operators need to have an IMS core deployed to offer VoLTE service. Ideally the IMS core would be in their own physical network, although in some cases it may be possible for operators with multiple operating properties to host this centrally, as is the case with some IMS-based fixed-line services, or the RCS services set to emerge in 2012.

Until recently, mobile operators had been reluctant to make the investment needed in IMS cores. Now with a combination of VoLTE and RCS (along with the RCS-e variant), many Tier 1 mobile operators have largely taken the decision to deploy, at least conceptually, and some are now deep into the evaluation and deployment phases.

IMS technology is now well proven in fixed line, but implementation in the much more dynamic mobile environment is not yet well practiced. Integration with the EPC and business support systems, and interaction between the core and devices and clients, are examples of where specific mobile requirements need to be addressed and optimized in IMS.

An IMS system configured for voice service only and 1 million subscribers at 1 BHCA per subscriber must support 2x(28M messages/ 3,600) ≈ 16,000 messages per second

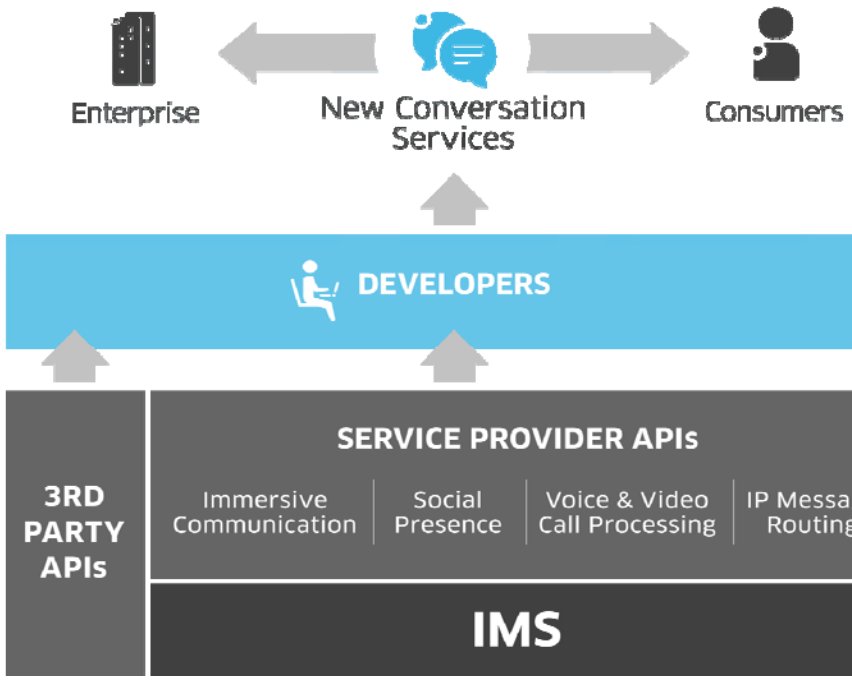
An example of how tighter integration between EPC and IMS can help comes from a study by Cisco. It states that the P-CSCF and S-CSCF must each process 28 SIP transactions for a voice call, which when modeled to represent a real-world VoLTE deployment, configured for voice service only and 1 million subscribers, would mean the IMS elements would need to support 16,000 transactions per second. This is a demanding performance requirement, and especially so when scaled up to larger networks.

Broadly speaking, larger operators are now more positive on IMS because they see it as a critical enabling technology for all-IP networks, and with VoLTE (and to some extent RCS) they see an application that has the commercial potential to justify the capital and operational investment demanded by IMS. For example, in North America and some progressive European and Asian markets, mobile IMS core networks are now being tested and deployed with a view to broad commercial service in 2012 and 2013.

Third-Party Integration

While VoLTE initially may be about meeting a base level of features and capabilities, it is conceptually much more than that. It is also a first step toward enabling a broader set of Internet-based services. From the most sophisticated enterprise collaboration applications to the lowliest, hacked-together chat/IM applications, there is potential to leverage the capabilities that come with VoLTE, IMS and open EPC network technologies and services.

Figure 8: IMS & Third-Party APIs



Source: Alcatel-Lucent

While VoLTE is viewed as a defense against OTT providers, many operators also wish to act as enablers for third-party applications and, in the context of IMS and VoLTE especially, those that have a communications component. The view is that by providing APIs that allow access to network functions, operators will contribute to developers' success and to the end-user experience. This should also generate R&D efficiencies for developers and allow them to focus on consumer-facing functions of their services. IMS could provide a standards-based interconnect mechanism between different third parties that will grow the overall communications services market in the best traditions of the telecom and mobile industries.

Of course, there remain challenges for third-party developer strategies for IMS core networks, but there is a growing acknowledgement that it represents a useful, and potentially commercially rewarding, way forward. Ultimately it is likely that the IMS environment will play the same role as the PSTN does today in terms of being the interconnect of last resort – one that users and developers can rely on.

Conclusion

Voice is essential to mobile networks. It has great economic value and the industry has a responsibility to support reliable, interoperable services.

The stringent requirements of mobile voice communications present new challenges to IP-based LTE networks. After extensive evaluation, the industry has now aligned on VoLTE using IMS as the preferred, common solution. For a large number of Tier 1 mobile operators, it is no longer a question of whether they should implement VoLTE and associated advanced communications, but rather when, where and how.

We expect progressive operators to launch commercial VoLTE service in 2012 and 2013. The market will be led by North American operators with a CDMA heritage, and perhaps some advanced South Korean operators. For operators with a UMTS heritage, we expect commercial launch from 2013 as chipsets and devices allow.

To set up and maintain a VoLTE call requires tight integration across the network. Devices, the radio network, packet transport, the EPC and the IMS-based service core all have to be aligned. The industry is now putting in the hard work needed to deliver consistent, reliable services. A consequence of this is that fast-follower operators will benefit from a well-developed ecosystem from 2014 onward that should enable them to launch VoLTE rapidly after commercial introduction of LTE.

It many senses, we view VoLTE as a community project – albeit one with definite commercial objectives – that no single actor can develop and deliver alone. In this sense, it embodies the best of networking industry practice, in that collaboration between vendors and operators will create the foundations for a long-lived and competitive mass market in advanced communications services.

Background to This Paper

Original Research

This *Heavy Reading* White Paper was commissioned by Light Reading as part of its Voice-over-LTE Industry Initiative program sponsored by Alcatel-Lucent, Anritsu, Cisco and Ericsson. It is based on independent research and opinions expressed in the report are those of *Heavy Reading.*

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Brown's coverage at *Heavy Reading* focuses on wireless data networking technologies, including WiFi, 3G/HSPA and LTE, with reference to how these technologies impact the wider mobile data services market. Brown has covered the wireless data industry since 1998. Before moving to *Heavy Reading*, Brown was Chief Analyst of the monthly *Insider Research Services*, published by *Heavy Reading*'s parent company *Light Reading*.

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