Overcoming VoLTE: Deployment Challenges

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1   Business Drivers for VoLTE

With the emergence of mobile broadband and smartphones, subscribers increasingly started to use OTT applications like WhatsApp, LINE, Viber, etc. instead of services offered by MNOs. Revenue from mobile voice and messaging decline steadily, forcing MNOs to focus their investment on their network where growth is possible—mobile broadband—even to a greater extent.

To maximize revenues from their most precious asset—the radio frequency spectrum—to its fullest potential, MNOs are investing more efficient radio access technologies like LTE and 5G. As an undesired consequence, the rapid rollout of LTE networks and its increasing coverage have accelerated the erosion of revenues for mobile voice. Customers of OTT providers stand to benefit from the improved speed and low latency in LTE, bringing the experience in voice closer to what MNOs provide. In effect, MNOs are on the brink of becoming data pipe providers for third parties, who run their services on top of their network, without incurring any costs. Whereas they must maintain two expensive sets of infrastructures, one mainly for voice and the other for data, while complying with regulatory obligations of the country they reside in.

The major reason for MNOs to invest in VoLTE is the need to decommission the legacy 2/3G circuit switched domain to enable a full spectrum refarming to LTE and 5G for broadband data usage. On the feature level VoLTE services are similar to those in 2/3G and do not compete with OTT, but their goal is to leverage the biggest

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advantage the MNOs have over OTTs—seamless user experience between all access networks without disruption even in case of network congestion.

Central element of VoLTE is the IP Multimedia Subsystem (IMS), standardized by 3GPP. The IMS core together with Application Servers (AS) enable the service execution for native voice and messaging services in packet switched networks.

Originally IMS was designed access agnostic and it had a natural place in the core of the network as the voice production platform for multiple services, irrespective of access technology. Enhancements to enforce quality of service in mobile packet switched networks and interworking towards legacy 2/3G networks were developed much later. In terms of Fixed Mobile Convergence (FMC) strategy, IMS enables operators to converge LTE and Fixed VoIP offerings into the same core, causing substantial savings on operations. Beyond this, IMS allows MNOs to leverage infrastructure beyond their premises by enabling voice and text services via any Wi-Fi access. This functionality is called Voice over Wi-Fi (VoWi-Fi). Integration between MNOs cellular voice service and Wi-Fi calling is an emerging trend in the market as technology entrée barriers are low and user acceptance is high. With VoWi-Fi MNOs need to deploy less small cells to provide their services in buildings with poor coverage, as customers take on the task to build their own indoor networks.

2   Challenges in the Deployment of VoLTE

The deployment of VoLTE is most challenging task since the introduction of GSM 25 years ago. Complexity and technical barriers are high; implementation efforts, timeline and costs are often underestimated.

Of particular importance for VoLTE is the capability to allow voice call continuity, even when leaving LTE coverage and handover to 2/3G is required. This feature is called Single Radio Voice Call Continuity (SR-VCC). Though this feature sounds very useful it has several downsides:

- Complexity related to integration effort towards legacy 2/3G networks.
- Costs and time to implement both on network, as well as IT side, as it requires correlation of charging data records in VoLTE and 2/3G.
- User experience is in reality only "almost" seamless, as there are speech disruptions related to access technology swap every time when used.

Providing seamless handover between all networks is one of the most technically ambitious tasks. Especially in areas with poor LTE coverage, many inter-radio handovers are expected to occur. In the early deployment phase of VoLTE, users are likely to experience higher call drop rates and call setup failures and will see this as a degradation compared to service quality in 2/3G networks. Reaching maturity of SR-VCC takes time and requires additional effort. However, costs and effort spend in SR-VCC will become void, once LTE achieves the same or a bigger footprint as 2/3G.

For the same user experience as in legacy networks, operators tend to deploy the same fully blown feature set, e.g. ring back tone, call completion and multi SIM. This is referred to as "2/3G feature parity". Technical implementation challenges are not considered and often no calculation on the business case to do it is made—as features are dictated by marketing. This requires a complex and a costly integration of Intelligent Networks (IN), which is the service execution area in 2/3G. What is often forgotten is that once the LTE-only status of an MNO is achieved, a transfer of the service execution to the AS becomes the only sensible option for having one service delivery platform. The deployment of VoLTE should be seen as an opportunity to retire non-profitable and no longer needed features. Similar features like in 2/3G can easily be setup on AS layer, setting these up here right in the beginning reduces the effort once a full transition from IN to AS is required.

Other aspects impacting the costs and timeline for a VoLTE deployment are maturity of both the IMS solution and the handsets, as well as virtualization and interworking between IMS and AS components. In the past vendors have developed their solutions at the MNOs premises transferring a lot of the costs related to testing on the MNOs. Interworking between IMS components of different vendors has proven to be a challenge, as 3GPP standards have often been interpreted differently, causing components not to work with each other at initial phases of the deployment. High amount of testing and additional effort was required by the MNOs, who considered to deploy VoLTE early, causing delays until commercial launch of several years and additional costs.

MNOs taking on late the challenges that arise with VoLTE should leverage from lessons learned by choosing experienced vendors. Especially prior to selecting vendors for IMS and AS interoperability tests should be performed. Also taking the same vendor for the new VoLTE components has proven to benefit the timeline and costs of the deployment.

3   Reasons Against a Quick Deployment of VoLTE

In mature markets, large MNOs have deployed VoLTE trying to prove their technology leadership. The truth is that their customers have not even noticed, as their experience is at launch at best the same as in legacy, but it can be worse. A similar statement could be "others have it" that is why "I need it too".

The way many MNOs are often marketing the fact that they deployed VoLTE is amusing at best: typically a short statement in a local newspaper and a bit longer article in specialized press. The first one completely ignored due to almost identical user experience and the second reaching only a very limited group. The total outcome is having bragging rights on telco conventions. Hence, technology leadership nor "others have it and our customers will run away" should not be the reason behind VoLTE investment.

Beside a very complex deployment of VoLTE with interworking towards 2/3G networks, there are other options for mobile voice services in the future:

- Wait for LTE-2/3G coverage parity, turn on VoLTE and start planning decommissioning of 2/3G networks. This avoids a very costly IN and SR-VCC integration between VoLTE and 2/3G.
- Deciding never to upgrade to VoLTE, if revenues of voice are dropping very quickly. Let them die with 3G or partner with OTT providers to cover the leftovers of voice services.

When the above simplest solutions are not fit for the MNO, then several other aspects should be considered when making the decision. The right time to make the transition strikes a point of balance between:

- The costs of VoLTE, especially SR-VCC and IN integrations and changes in those costs related to maturity of VoLTE solutions,
- Need for spectrum refarming for broadband data usage,
- 2/3G end of life dates and possible savings on maintenance costs and
- Savings on having a single voice production for fixed and mobile, if applicable.

MNOs that decide to launch VoLTE late, benefit from innovations over the last years. Nowadays, a great number of VoLTE handsets is available from multiple vendors, with prices steadily declining, lowering the entry barriers especially in emerging markets, where device costs are of major concern. Out-of-the-box VoLTE solutions composing IMS core and AS will become available to greater extent, reducing the number of interfaces to be integrated.

4   Reasons for a Quick Deployment of VoLTE

Brownfield operators should notice that there is only one set of circumstances, which justifies a quick rollout of VoLTE, i.e. access networks are already or close to congestion and a relevant part of the spectrum is blocked by voice on circuit switched technology. Spectrum refarming to LTE and 5G is required to increase the service offering of mobile broadband. It is likely that such an operator could create a strong positive business case on VoLTE today.

For Greenfield MNOs the situation is different. This is because almost every smartphone is LTE-enabled, making it easy to embrace a large number of customers. Unfortunately, this does not imply VoLTE handset compatibility and subscribers will use OTTs for voice in data only networks. A deployment of VoLTE should therefore be considered in relation to the availability and costs for VoLTE handsets. Also waiting too long may also make it difficult of taking services back from OTTs.

5 Overcoming the Complexity of VoLTE by an Agile Like Deployment Approach

The introduction of VoLTE significantly differs from any deployment of fixed and mobile services and technologies in the past. For technologies like public switched telephone network (PSTN), 2G and even 3G the implementation of new features for voice services was limited by the speed of their development by standardization bodies, which was rather slow. Additionally, the nature of changes in technology, on the example of 2G to 3G, was only enhancing the previous solutions. Thus, the complexity of building the 3G voice solution with value added services (VAS), as we know it today, was spread over many innovation cycles and years.

A waterfall based VoLTE deployment assuming 2/3G parity and seamless hand-over between packet switched LTE and circuit switched 2/3G has proven to be very complex, as it requires creation of a new voice service delivery platform and its integration into many legacy systems. In effect, proceeding with a complete requirements-to-design mapping done in a single step, has turned out to be impossible. In previous technologies, changes were incremental and operators had time to learn how enhancements were to be integrated, whereas the knowledge on how to integrate the entire VoLTE solution needs to obtained first. Unfortunately, this is not something a person fully comprehends after reading design guidelines and standards. It takes months of trial and error to understand all its aspects in conjunction with its interworking towards legacy systems.

To streamline the introduction of VoLTE and to allow learning during the project, an agile like deployment approach of VoLTE is of advantage, which divides the complex task of deploying VoLTE into several steps. By applying this approach, the MNO only needs to have a basic understanding of his VoLTE scope and target architecture at the beginning of the project, while only in the steps, detailed requirements are defined and in a design, integration and testing phase the solution is build. Each step builds on top of previous steps concluding with a friendly user trial in production and a go to market decision. With this iterative approach, learning becomes an integral part of the process allowing constant improvement and hand-over of responsibilities from design, through build to run. The following steps are big enough to make them sub-projects but small enough to be fully understood during requirements-to-design mapping, resulting in a solid project and resource planning:

- The first step will enable basic VoLTE to VoLTE calling functionality.
- The second step will provide connectivity to other networks, i.e. to allow VoLTE call to and VoLTE to be called from the operator's 2/3G network, PSTN and fixed IMS as well as other operators.
- The third step will enable SR-VCC for seamless handover during voice calls from LTE to 2/3G, when moving out of LTE coverage. (This step can be omitted in case of LTE-2/3G network coverage parity.)
- The fourth step will enrich the user experience by enabling features known from 2/3G like conference, call waiting and introduce billing.
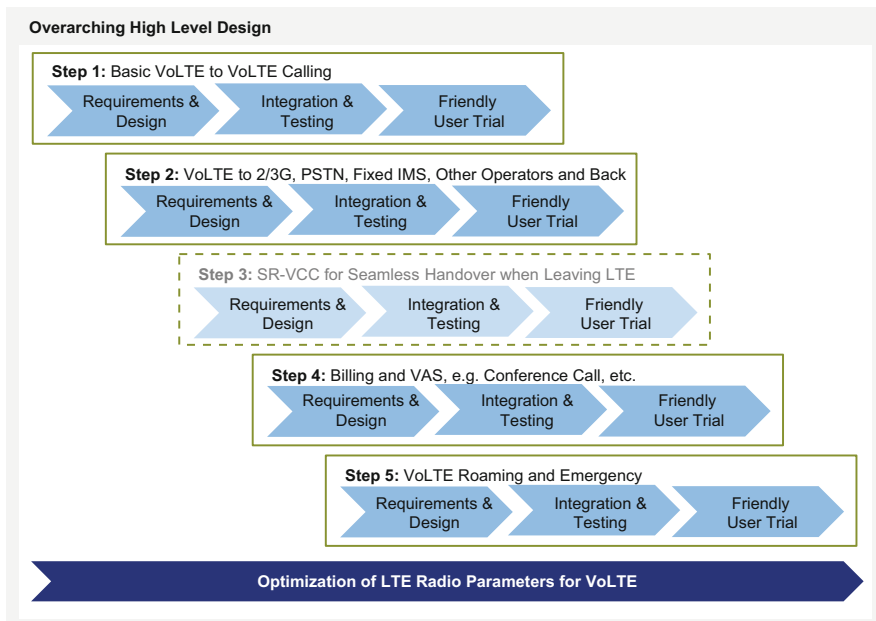
Fig. 1 Agile-like VoLTE deployment approach, comprising of five steps

- The fifth step focuses on the deployment of latest features standardized in 3GPP, which are VoLTE roaming and VoLTE emergency functionality with location information.

Due to fact that all steps conclude with a friendly user trial in production, radio fine-tuning can be started early in the deployment. This has shown to benefit the overall deployment timeline in reaching 2/3G-like quality of VoLTE services, whereas in a one shot scenario it requires additional effort and time that is seldom considered.

The figure shows the described agile like VoLTE deployment approach (Fig. 1).

6   How Does Virtualization Fit to the Picture of VoLTE?

IMS is one of the main systems impacted by the idea of Network Function Virtualization (NFV) and both IMS and AS can be introduced as virtualized (today) or containerized (soon) solutions. This enables MNOs to benefit from:

- Using commercial off-the-shelf hardware and simple expansions,
- Reduced time to market, by having less specialized elements of the network, making the purchasing process simpler and less risky

- Simplified operation, by automated re-configuration and moving network workloads onto spare capacity and
- Optimizing the network configuration and/or topology in near real time.

In a virtualized setup, the entire VoLTE solution may be cheaper when considered individually, especially in a small-scale deployment. The reason being that in a joint hardware and software based deployment, the capacity could be multiple times too big for the needs of a small MNO, while a big chunk of the cost will be this dedicated hardware. On the other hand, the price of a license based only virtualized solution will scale according to usage. Additionally, savings on having multiple test and production systems on a single platform can be substantial, if done right.

All the above is theory. Practice has shown that virtualized software also brings challenges, that are not obvious to an MNO unexperienced with cloudified and purely software based solutions.

The biggest issue is the hardware platform itself. Even though the off-the-shelf sounds easy and cheap, the reality could not be farther from the truth. There are multiple companies in the world that spent a very considerable effort into building their own "telco clouds". Very few were as successful as they expected to be. Most were not able to do it by themselves and ended up spending considerable amounts on support of external companies and training of their own people. Which is not a problem when virtualization becomes a strategic initiative, but becomes an issue when it is only planned to be done for IMS and AS.

Another issue that is critical for success of virtualization, is that the software that the cloud must carry cannot be written like it was for huge hardware equipment. Especially redundancy and deployment mechanisms must be completely software based, which changes how many things will be measured and executed. That work needs to be done both in the MNO as well as on vendor sides.

6.1 Utilizing Public Clouds for Telco Services

One could say that the MNO should outsource the cloud problem completely and use what is available on the market. There are many public cloud providers and some of them even able to introduce what was considered "telco specific"—hardware acceleration. The idea seems good, unfortunately there are many limitations. The availability of the public cloud is not the same across the world, also very often particularities of telecommunications law might be a blocker of using the public cloud. Still, the public cloud option should at least be considered if the limitations are not present and capabilities, skills and approaches should be understood and sensibly copied from them as IT has gone through this cloudification process a while back already and it is easier to find people with related skillset.

6.2   Building a Telco Cloud

There is of course the possibility that the telco creates its own cloud, for its internal purposes. Although that is costly, for multiple reasons. First one is the inherent daily variation of usage, that makes the cloud as big as the peak usage, while it is used on average a lot less. Which means, that the economy of scale is less pervasive but there are other "costs".

One of the key learnings of big strategic virtualization initiatives is that it is not enough to just "get a couple of programmers". It requires competence in areas of: data center networking, virtualization/containerization, continuous integration/delivery/deployment, very fine-grained monitoring of everything and much stricter software-like requirements management enabling automated testing. Those skills are not easy to find and build-up. And that is just the technology side. The topic requires a fundamental shift of the company values, methods and organization. Especially, telco management needs to understand that the divide and control methodology that could be easily applied to standardized networks is just not effective with clouds. It is critical to think end-to-end. That is indeed a learning to be made, and a big obstacle at the beginning.

6.3   Virtualized IMS: Cheaper or …?

The goal of having a "cheaper" IMS will not be easy to achieve based on the cloud. The general return on investment is big, but not when considering it as an IMS only initiative. Operations and testing automation that can be done will have a huge impact on the cost side, but only when spread out across all of the services and not without a huge investment at the beginning of the cloud journey.

What is even more business impactful is that it is possible to have and IMS that is built better, more customer oriented, with a friendlier payment model, and easier to manage, maintain and change. That can be achieved by giving chances to new entrants into the NFV market, allowing to create some ferment in the rather stable telecom vendor industry. Cloudification will require a lot of work both on the MNO as well as those new suppliers, but it will be done as software development, where the needed investment is not as big as it used to be, when telco equipment was uniquely huge hardware pieces with complex tightly coupled software on top. Production of such complex products required a huge risk to be taken and that set the pricing levels. Thus, one may say that the general goal of the IMS in the cloud is to make risk for every participant of the market smaller.

7   Conclusion

This article presented mistakes and challenges during the deployment of VoLTE in the past. As one of the most important lessons learned it was highlighted, that technology leadership should not be the driver to invest in VoLTE. The deployment

of VoLTE should only be driven by the need of spectrum refarming for LTE and 5G and the need to decommission 2/3G networks. If revenues of voice are dropping very quickly, it can also be a rational to never invest in VoLTE and become a pure broadband data provider. MNOs deciding to invest in VoLTE late benefit from mature technology, greater interoperability, lower costs for VoLTE handsets and more experienced vendors. It was pointed out, that reaching 2/3G-LTE coverage parity prior to deploying VoLTE benefits the business case, as no spending in a complex and interim solution for seamless handover from LTE to 2/3G (SR-VCC) is required. Finally, this article concluded with a new, agile like VoLTE deployment approach. With this approach, learning becomes an integral part of the deployment by delivering little by little of the entire VoLTE solution and streamlines the timeline as cumbersome radio optimization can be started early. The article also showed consideration points for virtualization, that should allow for a plan to be made related to IMS virtualization as part of a fundamental, value-increasing transformation to a cloud based provider.