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The 5G Voice Transition: Managing the Complexity

Published: April 2023

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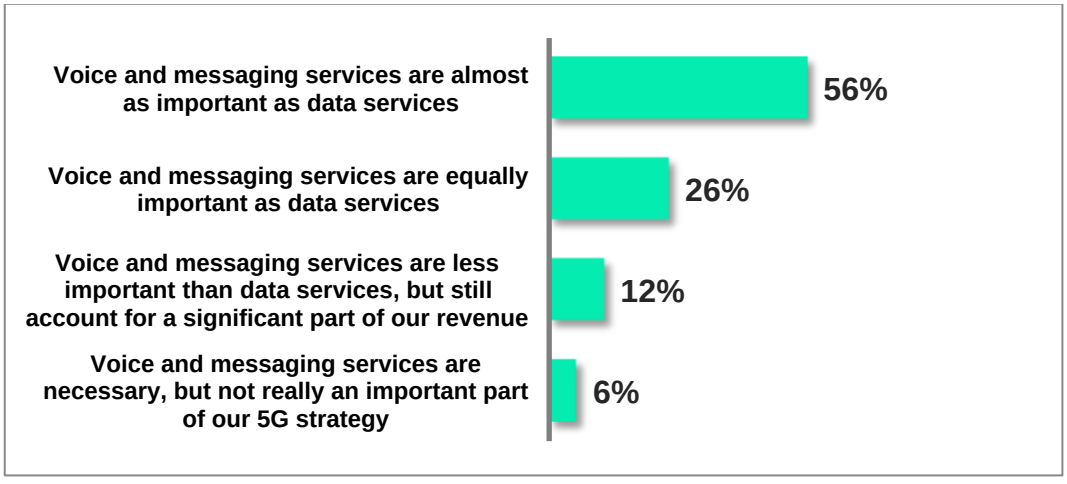
1. Introduction

Voice traffic carried over mobile networks has both been the mainstay of the telecom industry and at the same time, its most underappreciated or overrated, depending on the individual's perspective. The history of voice communication over telecom networks has a long and storied history, starting with Alexander Graham Bell and ending with today's smartphones that are the most sophisticated things we own – but which we still use for classic voice calls. Voice communication is fundamental and taken for granted by consumers and enterprise users. Those users are generally willing to accept best efforts connectivity to the Internet but hold voice communications to a higher standard.

To this day, carrier voice remains the most reliable voice channel despite increasing competition from web-based voice services. Voice communications are also central to most regulators' definition of telecom services and are designated core services in licensing agreements for communication service providers (CSPs). As a result, carrier voice will remain a mandatory capability in 5G networks even as service providers introduce innovative, higher-margin services. Mobile voice is still a priority for carriers, as a survey carried out for this report shows.

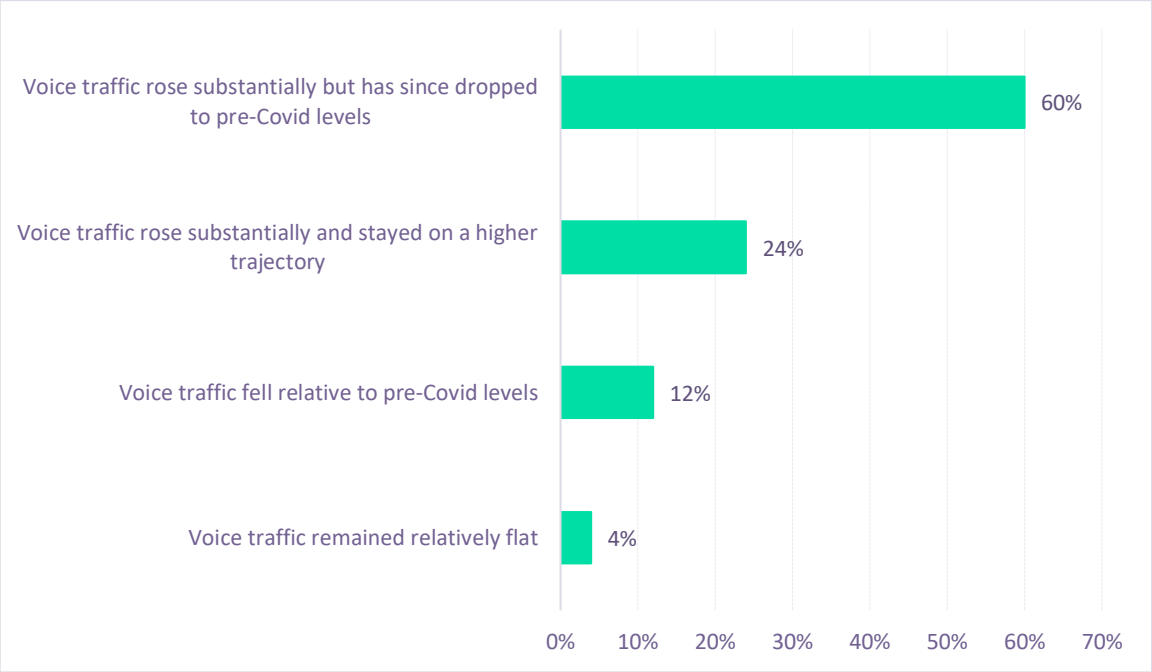
When thinking about your 5G priorities, how do voice and messaging services compare to data services in terms of importance?



(n=50 throughout this report unless noted otherwise)

Carrier voice has also retained its importance through the COVID-19 pandemic. Many CSPs faced a surge in voice traffic as customers were homebound through lockdowns and travel restrictions. Over 60% of the carriers surveyed indicated that voice traffic had risen substantially through COVID-19 but then dropped back to “normal” levels, while 24% indicated that traffic has stayed on the higher trajectory. Most of that higher-traffic segment is in the Middle East and Africa. One possible reason is due to the high proportion of migrant labor working in the Middle East in particular. Many of them would have had only the voice channel on their phones to stay in touch with their families and communities back home, especially those from South Asia and the Philippines.

What effect did the COVID-19 pandemic have on the volume of voice traffic carried on your current networks?



The good news is that the vast majority of CSPs were able to cope with surges in voice traffic through COVID-19. However, in another question, roughly half the CSPs reported that while they were able to cope, they were concerned that they were fast running out of spectrum resources to cope with the “new normal” of voice traffic. CSPs in Western Europe in particular felt that their spectrum resources were getting stretched, while those in North America complained of having struggled with service outages and reduced quality of service.

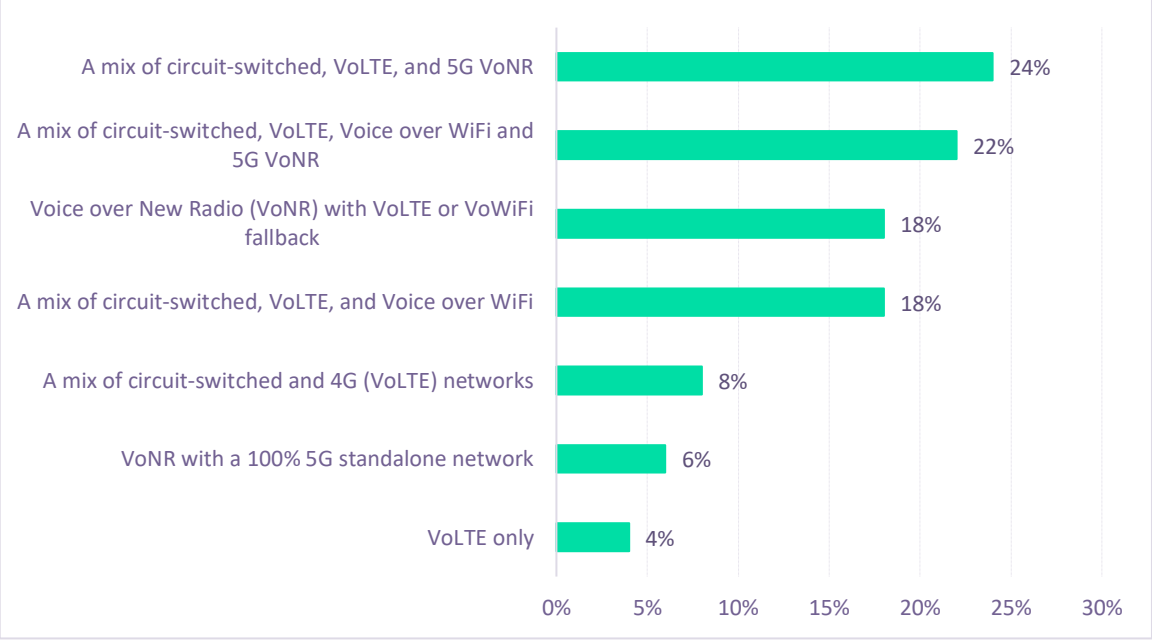
This whitepaper discusses the current state of voice networks, the different priorities of telcos as they upgrade their technology, the different architectural approaches to migration, and the additional features and services that may be enabled by the new technology. Sources include GlobalData's ongoing research, conversations with telcos, and an October 2022 survey of 50 global operators. The sample of operators included mobile pureplay operators, but the majority were multiplay fixed-mobile carriers and large groups that span multiple countries.

2. Voice Technology is Increasingly Fragmented

One of the major differences since our previous voice networks survey in 2020 is that a massive number of CSPs have now launched 5G commercially. Many of these CSPs initially launched with the non-standalone (NSA) architecture - with 5G RAN deployed connecting to a 4G core network – to enable them to continue to use 4G networks for voice. However, several have now launched standalone 5G networks, which means that they have the potential to operate Voice over New Radio (VoNR).

As a result of the shifting mix of cellular networks around the world, the mix of voice services has also shifted and become significantly more diverse. Mobile voice remains an essential service everywhere, but circumstances vary depending on the operator and the country. Our surveys indicate that mobile voice can be supported by 30-year-old technology, brand new network standards, or the most common option: a mix of circuit-switched and IP voice spanning two or three network generations.

Which option best describes the network technology you currently use to provide voice services?



Survey data shows a mixed picture in terms of the number of technologies that are currently being used for voice communications; there are some stark differences between the 2022 and 2020 surveys.

- The biggest difference over the last two years shows up in the number of CSPs who have launched 5G, with a number of CSPs who have launched standalone with 100% VoNR, and the majority rolling out either VoNR with a fallback to VoLTE/VoWiFI, or a mix of circuit-switched, VoLTE, VoWiFi and VoNR.
- The Asia-Pacific and Western European regions showed a higher degree of fragmentation in the voice technology mix. With multiple countries in each region, the network evolution across these markets is quite varied.
- A big factor in this shifting technology mix is that a number of CSPs around the world are looking at the sunset of their 2G and 3G networks to free up spectrum resources and reduce OPEX. However, this is not a universal trend with several regions/markets persisting with 2G.

Almost every carrier is operating multiple network standards and will continue to do so for some time. This will create challenges across the board in operations, cost management, and user migration.

2.1. As 2G networks persist, so does Circuit Switching

With all the hype surrounding the launch of 5G commercial networks, the continuing persistence of older networks gets little attention. The reality is that depending on the individual market, 2G networks are still active and being used by tens, if not hundreds of millions of subscribers.

In some regions, 1980s-era 2G networks based on GSM cellular technology remain. This is particularly true for emerging markets like India, Indonesia and in Lactam and Africa. 2G is persisting even in markets where CSPs have taken the decision to “sunset” their 3G networks. There are several important reasons for this phenomenon:

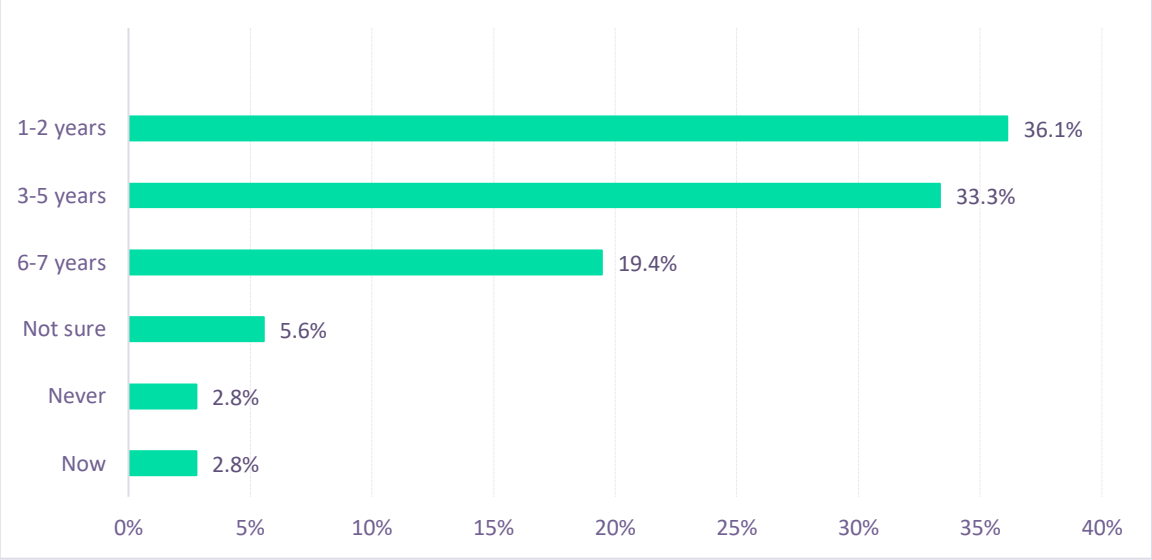
- 2G-era GSM networks were primarily designed for voice communications, while 3G networks introduced packet data to allow connectivity to the Internet. The reality is that 3G had a patchy record and has been successfully replaced by 4G LTE which was far more efficient for data. With the entire industry, across both networks and devices, converging around LTE, 3G simply became expendable and it was far more valuable to refarm 3G spectrum.
- This means that in many countries, 2G networks continue to be used for voice communications, and their voice cores require continued maintenance.
- Messaging networks also have played a great role in the persistence of 2G networks. In several countries, P2P messaging has been supplanted by messaging applications like WhatsApp and Telegram. However, the traditional SMS channels is still used widely for marketing purposes and also for two-factor

authentication regimes. For example, in India, nearly all types of financial transactions, especially those done online, require a one-time password (OTP) for completion and these are delivered by SMS. SMS is also used to support telemetry in IoT deployments where the connected devices can have a service life of anywhere from 10 to 30 years.

- Affordability of mobile devices like smartphones continue to play a part in the persistence of 2G. A substantial portion of the user base in low-ARPU markets still prefers 2G- and 3G-based feature phones for their lower cost, higher durability, and longer battery life. As a result, CSPs would have to incur a significant subsidy bill to induce these subscribers to upgrade their devices to 4G LTE ensuring that these 2G network linger on.
- While many markets have achieved near nationwide coverage for LTE, there are several that still struggle with adequate coverage. In these markets, migrating to VoLTE becomes challenging without adequate coverage. Beyond coverage, there is also the issue of capacity for voice in some markets where spectrum holdings for LTE are constrained.

Many Asian countries have already decommissioned 2G or scheduled it for 2022 or 2023; the same is true of the United States and Canada. European markets are generally targeting the mid- or late 2020s. In some markets, 3G is still prevalent for similar reasons. Regulatory support on refarming is not universal across the world and this can be a constraint on the decommissioning of 3G networks. In other places, like in the USA, carriers are still required to maintain 3G networks in rural areas, and many emergency networks have yet to make the transition to 4G.

Do you have a timeline to "sunsetting" your 2G/3G voice network?



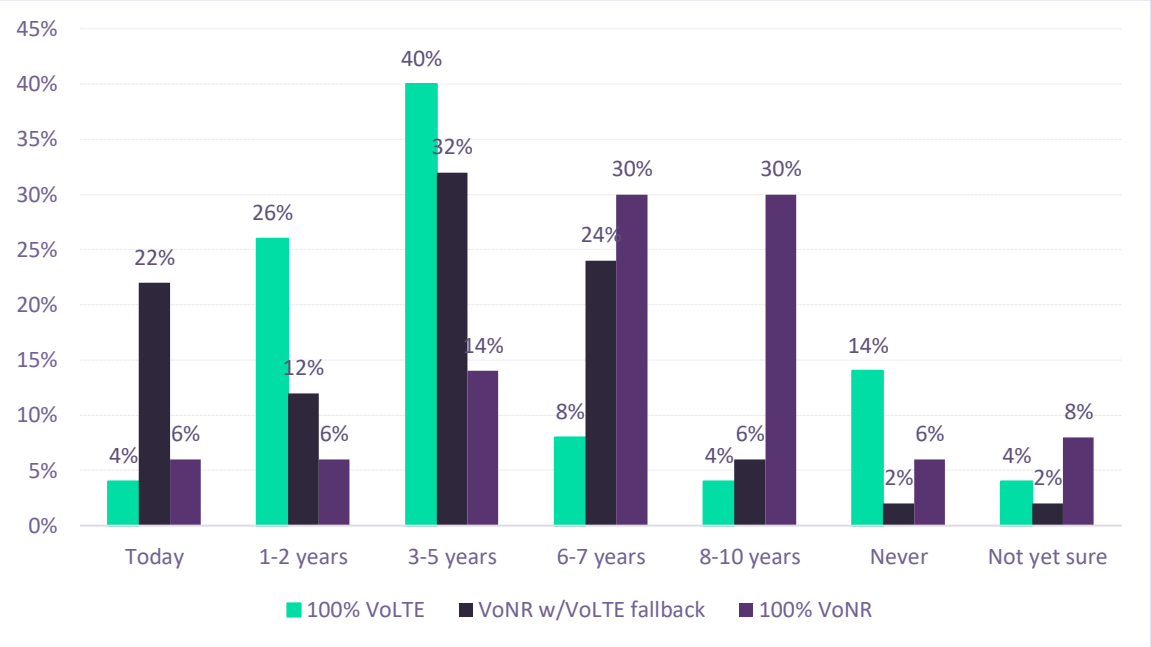
(n = 36)

Over 50% of operators surveyed indicated that it would take a minimum of three years for them to sunset their 2G/3G networks, with a small percentage indicating that they would "never" shut these networks down. Nearly two thirds of CSPs in Eastern Europe would keep circuit-switched networks active anywhere from 3-7 years from today. Western European CSPs planned to keep these networks active almost as long.

2.2. VoLTE is the new baseline for Voice

As 4G LTE has enjoyed success around the world, coverage has increased and there is sufficient capacity available in terms of spectrum resources in many markets. Of course, this is not true everywhere but there is no question now that in terms of adoption, 4G LTE is likely to be the most successful cellular technology in history and is now truly a global standard. However, the success of 4G LTE has not translated to widespread deployment of VoLTE, despite VoLTE being a mature technology.

Under your company's current plan, how many years will it be until you are providing voice communications with 100% VoLTE/100% VoNR?



n = 50

One major shift from the previous study in 2020 is that about 40% of respondents will take three years at a minimum to move to 100% VoLTE, dropping sharply from the 70% number in 2020. This would indicate that a number of CSPs have deployed VoLTE or are already in the process of migration with several others planning to migrate in the next couple of years. However, over a third will take anywhere from five to ten years to move completely to the standard.

At the beginning of the 5G era, some CSPs considered bypassing VoLTE altogether and going straight to a VoNR core when they launched 5G commercially. However, at the time, there was little clarity on when the standalone (SA) version of 5G would be technologically viable, not to mention the poor availability of VoNR support in handsets. As a result, most CSPs rolled out 5G commercially with the NSA version.

This move made a lot of commercial and technical sense at the time in the markets where 5G spectrum was made available early. It also meant that CSPs could continue to use their VoLTE networks as the baseline for voice communications and optimize their 5G NSA networks for data. Our survey data supports this as well, with 22% of those surveyed indicating that they have already launched 5G VoNR with fallback to VoLTE, and another 12% planning deployment in the next 1-2 years. In other words, a third of CSPs will invest in VoNR with fallback to VoLTE in the short term.

Today, however, a number of CSPs around the world have launched 5G SA, or “true” 5G. As a result, we are already seeing CSPs who have launched these networks with 100% VoNR. True, these numbers are still small, with barely 6% of those surveyed indicating that they had deployed 100% VoNR already. The vast majority, however, will take a minimum of three years – and up to 10 years – to deploy 100% VoNR.

That said, the majority of CSPs are more likely to focus on VoLTE in the short term, owing to the fact that VoLTE provides high-quality voice, faster call setup times, and clearer voice quality than circuit-switched voice. It can also be used in the dual-connectivity mode of the 5G NSA architecture that the majority of operators are implementing first. In the 2020 survey, about 34% of the respondents indicated that they would take anywhere from 5-10 years before reaching 100% VoLTE traffic on their networks. In the current survey, this number has dropped significantly to 12%. However, there were some respondents (14%) who indicated that they would “never” reach 100% VoLTE.

While this statistic may be surprising, the reality is that it is not that simple for CSPs to migrate to VoLTE and VoNR for a number of reasons. Beyond the technical aspects, there are a number of commercial/business reasons as well that are hindering wider adoption.

- Spectrum – the timing and amount of spectrum availability for LTE is a huge determinant of VoLTE adoption. LTE networks typically operate in 2.1 GHz spectrum bands and lower, where spectrum channel sizes are not typically large. LTE also operates in unpaired spectrum bands, which means that available spectrum can be used either for voice or for data. This inherent dilemma, coupled with the fact that CSPs chose data as the monetization vehicle, mean that CSPs do not have sufficient spectrum available for voice, prompting them to persist with 2G/3G networks despite the poorer economics for voice. The only way to get additional spectrum for LTE is to refarm 2G/3G spectrum, but until voice traffic moves to

VoLTE, carriers will not be able to re-farm their circuit-switched spectrum, potentially leading to spectrum bottlenecks in their LTE and 5G networks, which will continue to hamper VoLTE and even VoNR adoption.

- Voice fallback – given the importance and criticality of voice communications, CSPs have always looked at network architectures that allow them to have a fallback option. This strategy helps to mitigate problems like cell-to-cell handovers, roaming beyond coverage areas, and insufficient capacity in certain locations. The problems are further exacerbated due to the reality that CSPs never deploy new technologies with blanket, nationwide coverage from day one. As a result, VoLTE will need voice fallback to 2G/3G circuit switched networks, enabled through a mechanism called single radio voice call connectivity (SRVCC) handover. VoNR will need fallback to VoLTE as well via evolved packet switched handover (EPS HO). 3GPP standards do not provide for voice fallback from 5G SA to 2G/3G networks. With networks increasingly spanning multiple generations, voice fallback is crucial to avoid dropped calls and poor quality.

- Device support – VoNR can fall back to VoLTE and with Release 16 of the 3GPP standard now finalized, we should also see a fallback option to 2G/3G voice as SRVCC is extended. Only a limited number of devices today support this feature, however. In this scenario, if VoLTE is not available, then there is no fallback option and the call will drop.

2.3. The Requirement for Roaming Further Complicates Voice

CSPs around the world are faced with an increasingly fragmented landscape in terms of the number of customers they have to service over multiple generations of cellular technology, from 2G all the way to 5G networks. For their part, customers expect quality voice communications on demand. Moreover, they increasingly expect to have the same level of quality voice communications anywhere they go in the world. This is where roaming comes into the picture.

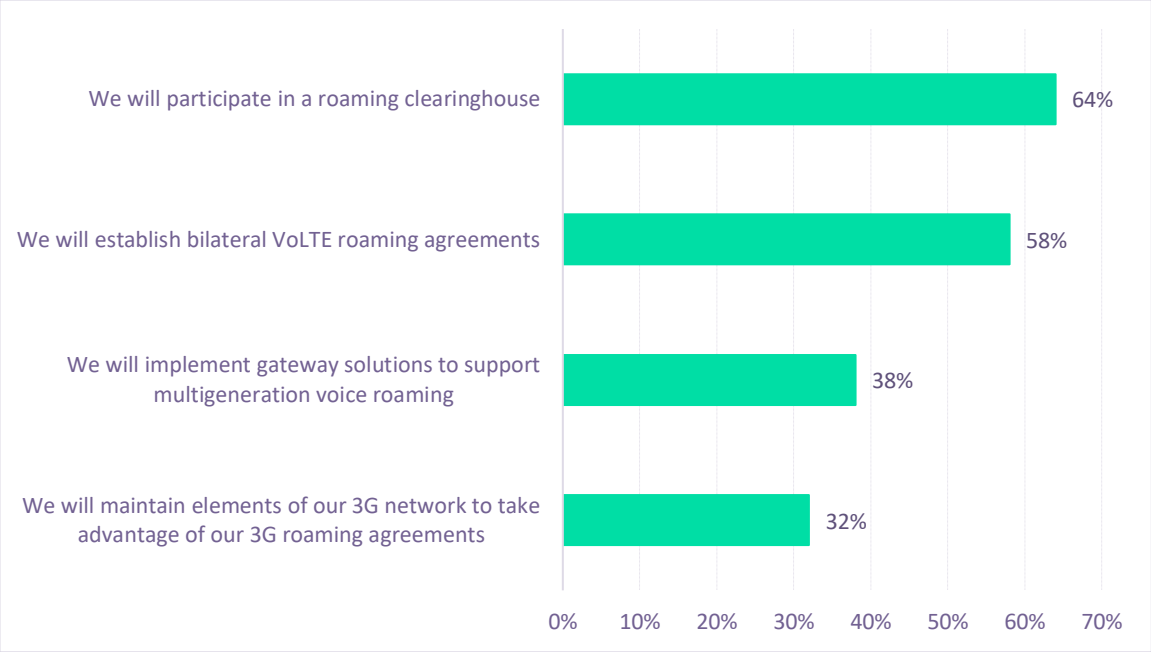
In the recent past, roaming has been a major constraint for the adoption of VoLTE. The two protocols for VoLTE roaming are RAVEL and S8HR, and both have had their challenges.

- RAVEL has never gained traction because it requires retrofitting of existing networks, which is complex and requires heavy mediation between two operators before an agreement can be reached.
- S8HR is not as complex an implementation. However, it poses significant business model challenges for the CSP as the protocol only supports charging by data packets and not by minutes. The implication of this is that the switch to a packet-based charging model would greatly reduce CSP revenues. S8HR also has issues with enabling lawful intercept, which is increasingly a regulatory and policy compliance issue in most markets.

The upshot of these challenges has been a relative lack of VoLTE roaming agreements with carriers in other countries, which harms user experience. In situations where VoLTE roaming agreements aren't in place, the roaming connection must generally revert to circuit-switched voice. This means that every operator without extensive VoLTE roaming agreements must retain spectrum resources on 2G/3G networks for inbound roamers and therefore cannot completely shut down its circuit-switched networks – or implement gateways, continue to broadcast 3G availability, or implement other technical patches.

The result is a Catch-22 in which operators are scared off from reaching VoLTE roaming agreements because of the complexities of technology and lawful interception requirements in IP networks; this concern results in maintaining 2G/3G networks that use spectrum that could otherwise be used for LTE or 5G services. What this means in reality is that CSPs have adopted a number of approaches to handling LTE roaming for voice:

How do you plan to enable VoLTE roaming?



The majority have opted to participate in roaming clearinghouses, where third parties take on the task and complexity of administering and managing roaming connectivity. Several are also investing more effort into clinching bilateral VoLTE roaming agreements, with over 50% of CSPs in all regions reporting this approach. A few, especially in MENA and APAC, indicated that they would adopt gateway solutions to support their multi-generation networks. The numbers also show that most carriers are pursuing multiple solutions.

The evolution of voice networks is essentially a story of progressive migration from circuit-switched voice to VoLTE, with an eye toward possible eventual migration toward VoNR as spectrum, technology, and time permit. While the technological and financial calculations behind any given telco's migration plan are diverse and complex, VoLTE is a fundamental technology and can become the baseline platform for voice, or it can act as the crucial

bridging technology to aid the migration. Mobile operators should therefore prioritize moving toward IMS-based voice so they can provide a solid voice experience as they progress to full 5G. In any case, the upcoming complete 2G/3G shutdown in the USA and other major roaming destinations will boost VoLTE adoption across the world to preserve international voice functionality.

3. CSPs Must Rationalize Voice Generations

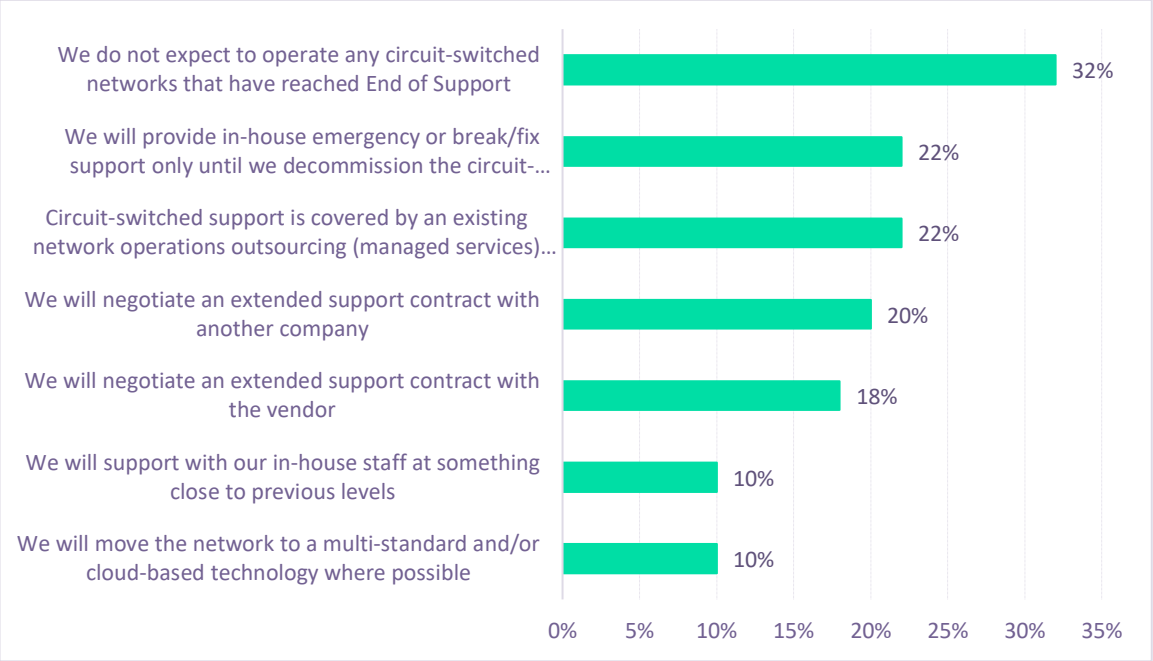
As CSPs grapple with the strategic imperative to launch 5G networks and the related costs of deployment, they are equally struggling with the challenge of keeping foundational services like voice communications active at acceptable quality levels. With increasing fragmentation in cellular networks, CSPs now have to grapple with the provision of voice over multiple networks, from 2G to 5G. This reality often prompts CSPs to migrate to a single voice core, as opposed to maintaining multiple voice cores and technologies.

The coexistence of 2G, 3G, 4G, and 5G networks will create OpEx and evolution problems. Carriers must run multiple voice networks, making operations and maintenance complex and expensive. The two-step evolution to VoLTE and then to VoNR brings additional complexity in the core network as well. Carriers will continue to look for solutions to simplify O&M, reduce OPEX, and speed the path to 4G/5G networks.

To be clear, the decision for CSPs is not straightforward or binary. Depending on the market they operate in and the regulatory landscape in that specific market, CSPs have many challenges and tradeoffs to navigate. For example:

- In many cases, the 2G and 3G cores that CSPs are forced to maintain are going end of life with their vendors, or are about to. Telcos therefore face the dilemma of whether they should continue to invest in their old circuit-switched environments, or to find a new way to keep supporting their circuit-switched networks cost-effectively while they migrate to 4G or 5G.
- Single voice core offerings are available from major telecoms vendors. 22% of carriers already report that they will migrate to a single voice core that supports 2G/3G voice, VoLTE, and VoNR on a single platform.
- Over a third of the survey respondents indicated that they would be willing to migrate a part of their voice networks to the public cloud to save costs, for resiliency, or for joint service development and provisioning. However, only 20% of respondents were willing to move their entire voice core to the public cloud.

If you plan to continue maintaining your circuit-switched networks for which the vendor has declared End of Support, or, if this has already happened, how are you maintaining such networks today?



The outlook from CSPs for extending support for circuit switched networks is mixed, as are the considerations that are currently informing their choice of vendors.

- In our previous survey in 2020, only 17% of respondents reported that they did not expect to deal with the problem of end-of-life circuit-switched core networks. In 2022, this number jumped to 32%, indicating a shift in perception around end-of-life equipment. This result suggests that CSPs are looking at other options to continue support for circuit-switched voice.
- Most of the remainder are planning on either some form of extended support for their legacy core (through existing vendors or third parties) or planning to move to a converged core that supports both circuit and packet switched voice.
- While a third of CSPs surveyed indicated that they would like to see a single vendor with end-to-end solutions, the majority (60%) indicated that they choose a vendor for each part of the network separately based on individual evaluations and would integrate the components internally.
- The transition to 5G is also providing CSPs with an opportunity to reevaluate their pool of vendors for voice. While a small number (16%) indicated that they would likely stay with their existing vendors, around a third indicated that they would use the transition to 5G to either introduce competition amongst vendors or replace underperforming vendors. A majority (52%) indicated that they plan to use the transition to 5G to add new vendors offering best-of-breed solutions.

Converged voice cores can help simplify voice network architecture, optimize resource sharing, and reduce equipment and interface load on live networks, thereby solving some of the O&M, investment, and evolution problems caused by the coexistence of 2G/3G and 4G/5G voice networks. Additionally, the converged voice core can greatly simplify VoLTE roaming issues, facilitating VoLTE development, and paving the way for the large-scale commercial use of 5G.[1]

4. Voice Core Networks Must Support Other Features as Well

CSPs who have invested in IMS core networks have done so primarily to meet their objectives of servicing voice traffic over their networks. However, there are a number of other services that need to be serviced over the IMS core, including video, collaboration, and security services and others. There has been significant effort put into a newer technology called “IMS data channel”, which is a part of the 3GPP Release 16 specifications. This has alternatively been “interactive voice” or “5G New Calling” by various vendors but the idea is the same. That is, to use the IMS network for introducing data streams in sync with voice communication channels so that the end user can access both voice and data services simultaneously in the same session and over the same spectral resources.

With a host of potential use cases for this enhanced interactivity, CSPs can avail of these additional features to drive new pricing bundles or tiers for a premium experience, especially for business users.

These services become even more important as CSPs launch 5G commercial networks. With the focus on monetization of services to help mitigate the expected high CAPEX on 5G networks, the decision on IMS core networks must be taken in a holistic manner so as to cater to voice but also other services that can be monetized.

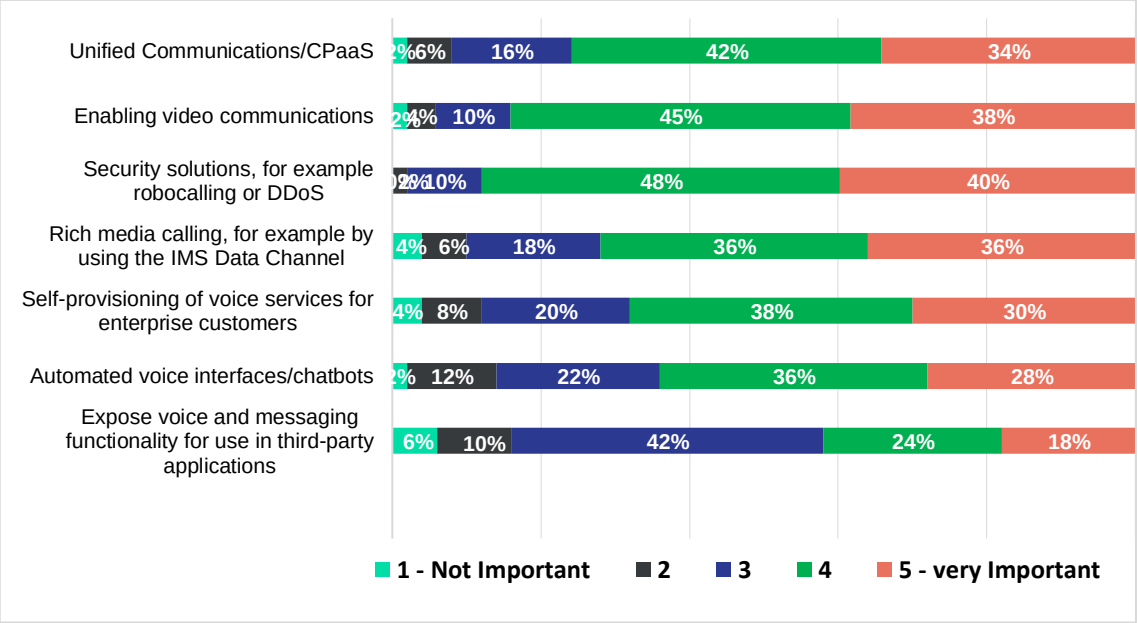
- Unified communications and CPaaS are identified as crucial with 76% of respondents identifying these services are Important/Very Important. Both these service categories assume importance especially for the enterprise segment, which is a crucial driver of future revenues for the CSP.

[1] GSMA document NG. 122, *Service Domain Centralization (SeDoC) Use Case Analysis*, promotes the idea of a converged voice core. The key to this convergence lies in supporting of the CS access with the IMS service domain centralisation (SeDoC) architecture, studied by 3GPP in 3GPP TR 23.719 [6] and specified in Annex G/H of 3GPP TS 23.292[9].

The document provides a solution to the VoLTE roaming problem: Existing RAVEL and S8HR VoLTE roaming agreements are not popular with global CSPs because of complex deployment, diminishing roaming revenue, and regulatory concerns. When deployed in the visited PLMN, the converged voice core combines 2G/3G/4G/5G voice networks and makes the visited PLMN appear as a CS network to the home PLMN. Roaming signalling can be carried out using CS roaming agreements, which are mature and available globally, while the voice traffic is transported over 4G/5G radio networks. With the converged voice core, RAVEL and S8HR, VoLTE roaming agreements are not necessary for visited PLMN. Since VoNR is an evolution of VoLTE, they share the same roaming mechanism. Solving roaming for VoLTE therefore automatically enables roaming for VoNR.

- Video communications is another service that has been identified as crucial for future revenues, with 84% indicating them as Important/Very Important. Again, video communications will not only be heavily consumed by the consumer segment but increasingly within enterprises as they move to Work from Home and Hybrid work regimes and collaborative platforms become the norm.
- Security solutions are the highest rated category with nearly 90% indicating that these are Important/Very Important. Security is becoming increasingly critical as the number of connected endpoints increase with IoT devices exploding in adoption. As a result, the attack perimeter becomes much wider and needs protection.

What offerings do you plan to support with your VoLTE/5G voice infrastructure? Please rate each choice on a scale from 1 (not important) to 5 (very important).



n = 53

5. Conclusion

Voice will remain an important service for mobile carriers. Most carriers in our survey ranked voice as either equally important or almost as important as data services, and our interviewees also indicated that it was essential. While modern, IMS-based voice – VoLTE and VoNR – is the goal, the fact that voice is still handled by circuit-switched networks at many operators means that those operators will need to support mobile voice generations.

Since different network generations will coexist for a significant period of time, and since circuit cores are going end of life, many operators will want to consider a converged core that smooths the transition from legacy voice technology to VoLTE and eventually to VoNR. Since voice can be a foundation for new service offerings, that core should also support value-added audio and even video services on VoLTE and VoNR networks.

This Whitepaper is sponsored by Huawei Technologies.