GlobalData.

Voice in 5G: The Long Transition

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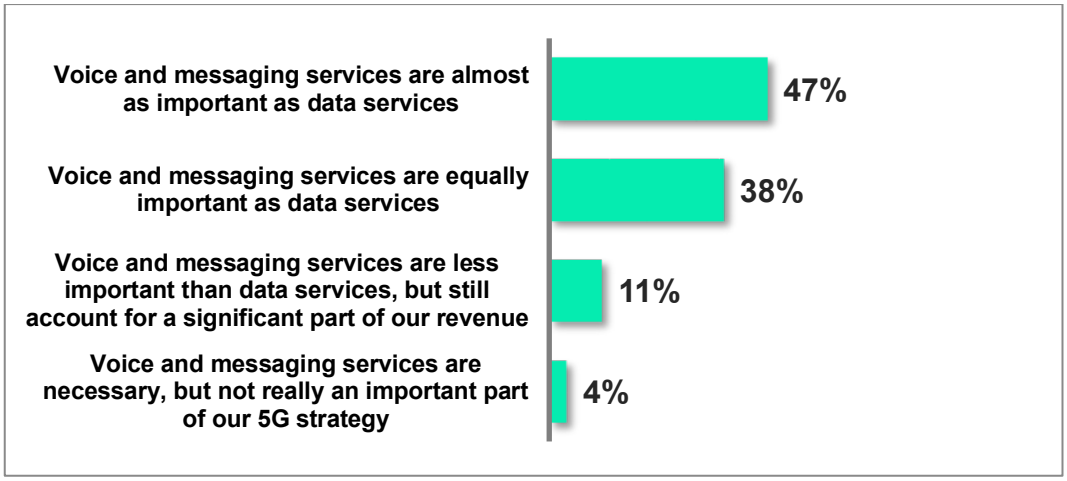
1. Introduction

Mobile voice is a boring topic – or at least it should be. Voice calls have been possible for a century and a half, and mobile voice has been generally available since the 1980s. Almost every mobile customer assumes that mobile voice will always be there when he or she needs it, and is almost always right. Carrier voice remains the most reliable voice channel despite increasing competition from web-based voice services. Thanks to this reliability, carrier voice will remain a mandatory capability in 5G networks even as service providers introduce new and innovative services. Mobile voice is still a priority for carriers, as a survey we 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?



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At the same time, carriers face challenges in their voice infrastructure: many are still supporting large portions of their voice traffic on 2G and 3G networks. Unfortunately for them, much of this legacy equipment is going end-of-life, so they must plan their new voice environment and migrate to it while retaining the quality and reliability of their voice offerings. Most operators are not yet ready to deploy 5G voice, which leaves Voice over LTE (VoLTE) as the most likely standard. But even VoLTE – as mature as it is – faces practical difficulties in things like roaming. Unifying support for different voice generations in a single system is likely the best solution for operators that are still carrying voice traffic on circuit-switched networks while planning their voice services in 5G.

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 August 2020 survey of 53 global operators, all but three of which were multiplay fixed-mobile carriers.

2. Voice Technology: Multiple Standards Underpinning a Single Service

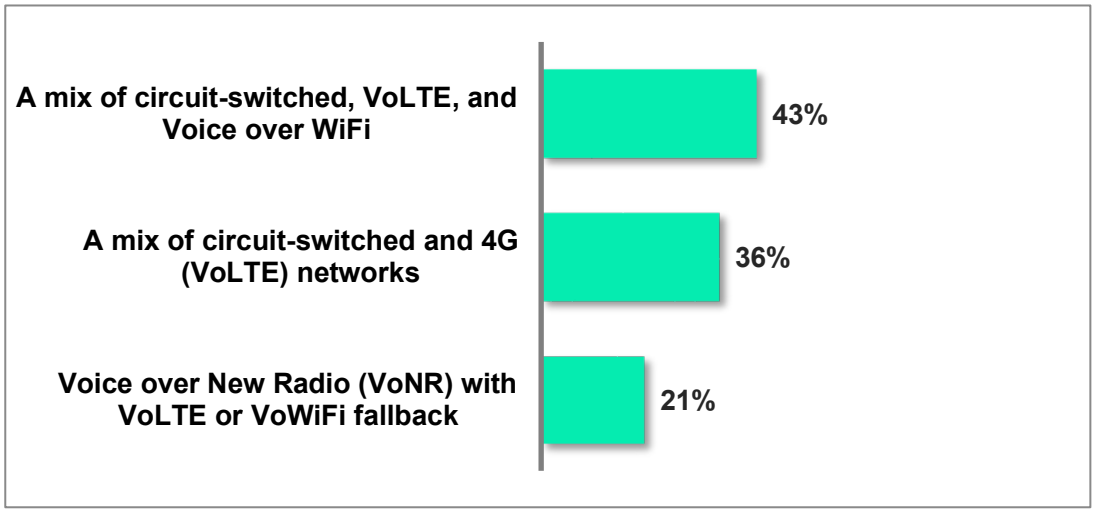
Our interviews indicate that telcos generally believe that carrier-grade voice is worth preserving and developing for two main reasons:

a) customers expect it of them, and

b) providing voice communications that can satisfy strict service level agreements (SLAs) can become a foundation for new 5G enterprise service offerings.

Mobile voice is 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?



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An overwhelming 79% of carriers are still using circuit-switched (2G and 3G) networks, as well as IMS-based voice (VoLTE and VoWiFi). Each generation presents its own challenges.

2.1. The Persistence of Circuit Switching

In some regions, 1980s-technology 2G networks remain even when 3G networks have been switched off. In large part, this is because 2G was designed for voice, while 3G's data capabilities are outclassed by the far more efficient LTE. 2G messaging – simple SMS – also supports telemetry in IoT deployments where the connected devices can have a service life of anywhere from 10 to 30 years.

Handset support is also a critical factor: despite ever-cheaper smartphones, 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. Part of the cost calculation for switching off older networks, therefore, will often be subsidies for 4G/5G handsets for the circuit-switched holdouts. More often than not, regulators will delay circuit-switched decommissioning for similar reasons: even 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.

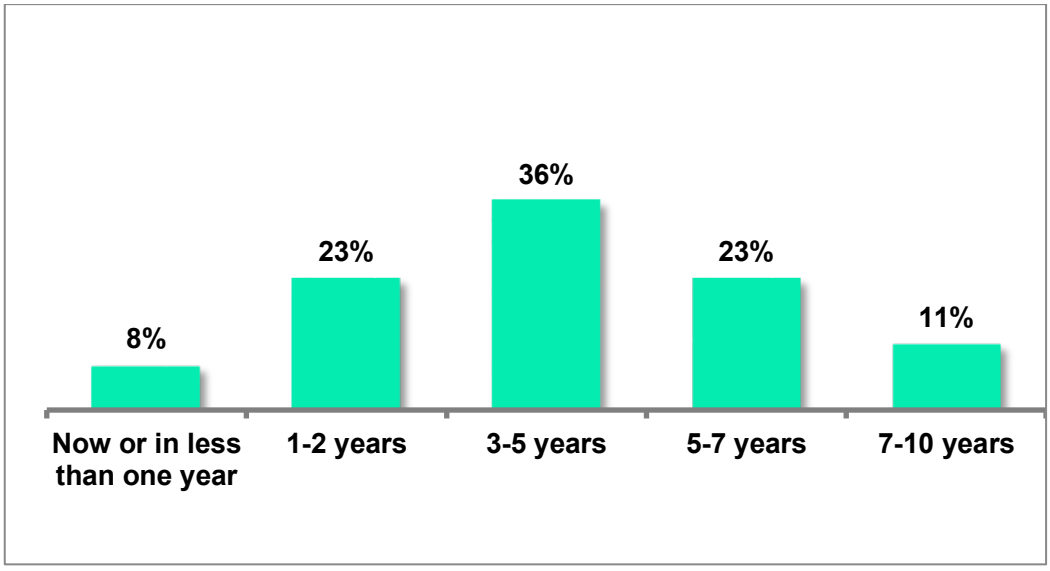
Meanwhile, while LTE is nearing 100% adoption among carriers, Voice over LTE is nowhere near that widespread. This discrepancy owes in large part to telcos' focus on mobile broadband as the monetization engine of 4G: voice has often stayed on legacy networks because LTE was optimized for mobile data. Now that the forces for upgrading

voice networks are growing stronger and stronger, VoLTE is becoming the primary standard for both 4G and 5G voice.

2.2. VoLTE: The Most Important Voice Technology Upgrade

VoLTE is a mature technology, while Voice over New Radio is still in the teething phase. But this does not mean that VoLTE is widespread at most operators:

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



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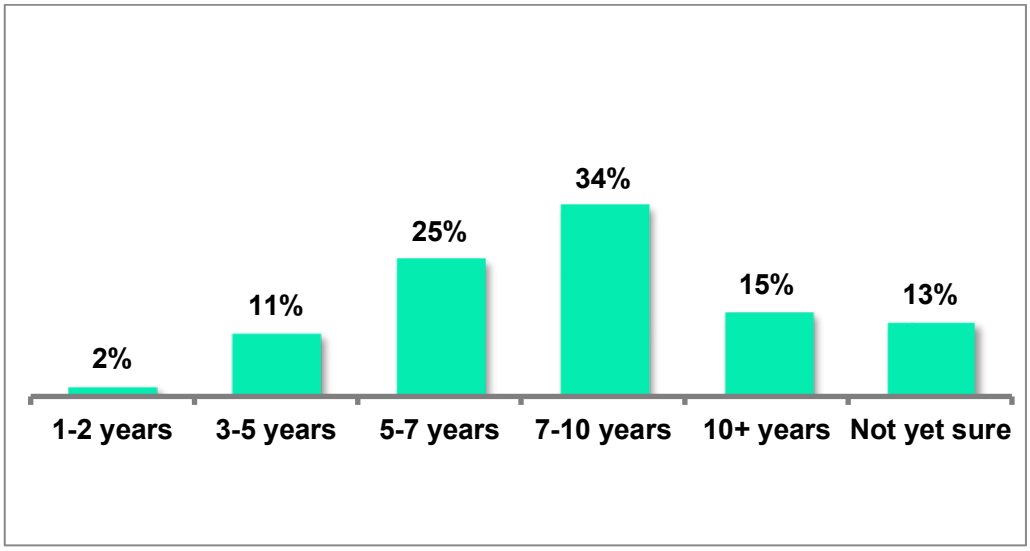
As the chart above shows, 70% of respondents will take three years at a minimum to move to 100% VoLTE; over a third will take anywhere from five to ten years to move completely to the standard.

But is there a chance that telcos will bypass VoLTE and adopt Voice over New Radio immediately? As the following chart shows, this kind of leapfrogging is very unlikely:

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



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For almost two thirds of surveyed telcos, 100% VoNR will arrive seven years or longer from now. Given that the horizon of most telcos' CapEx plans is seven years at most, this response suggests that plans for transition to VoNR – and with it 5G SA – are still soft.

The relaxed timeline likely owes to the fact that VoLTE provides high-quality voice, and can be used in the dual-connectivity mode of the 5G NSA architecture that the majority of operators are implementing first. There are also technological barriers: when asked what was holding telcos back from moving to VoLTE, 66% said that nothing was holding them back, but only 19% said the same about VoNR.

Most operators must move their voice traffic from legacy networks to VoLTE, not only because it provides faster call setup times and clearer voice quality than circuit switched voice, but for the following technical and business factors:

- ☒ 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.

- ☒ As the previous graph indicates, 100% VoNR remains in the distant future for most operators; even if an operator is operating 5G SA, it may still not have VoNR in a given location. 3GPP standards do not provide for voice fallback from 5G SA to 2G/3G networks. They do, however, enable fallback to VoLTE. In turn, VoLTE enables fallback to 2G and 3G via Circuit-Switched Fallback (CSFB). 5G SA therefore requires VoLTE availability to avoid dropped calls in a multigenerational network.

- The related issue of voice call handover also requires VoLTE to be available where VoNR has not yet reached 100% coverage. The SRVCC mechanism enables call handover from VoLTE to circuit-switched networks when users move from LTE coverage to 2G/3G coverage, while PSHO performs the same function from VoNR to VoLTE. The 3GPP has defined SRVCC handover from 5G to 3G in R16, but as of early 2021, no UE on the market supports this feature. For CSPs that have shut down 3G networks, therefore, if VoLTE is not available when a caller leaves VoNR coverage, the call will drop.

- Due to a quirk of the standards, poor Voice over LTE coverage can lead to poor mobile data connections until the distant future of 100% VoNR coverage. When both VoNR and VoLTE are unavailable, subscribers will be unable to establish 5G data connections. This behavior is set by section 5.16.3.5 of 3GPP Release 15, which specifies that a 5G terminal set to "voice centric" will generally not be able to access 5G data services if it is unable to access VoLTE or Vo5G voice service.

The evolution of voice networks, therefore, 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 for voice. Mobile operators should therefore prioritize moving toward IMS-based voice so they can provide a solid voice experience before the eventual move to large-scale 5G.

2.3. Roaming Keeps 2G and 3G Alive

Even though VoLTE is a mature and well accepted voice standard in most respects, complicated standards keep circuit-switched networks alive for roaming purposes. The 3GPP offers two protocols for VoLTE roaming: RAVEL and S8HR. 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.

The other VoLTE roaming standard, S8HR, does not require quite as complex a network reconstruction. However, S8HR only supports charging by data packets and not by minutes – the way that roaming has been charged since the first mobile networks were launched in the 1980s. This dramatic change to the billing model could potentially drastically reduce carriers' roaming revenue stream. The other major challenge with S8HR has to do with potential legal issues in complying with lawful interception requirements, since S8HR interfaces are incompatible with legacy interfaces.

This lack of easy roaming mechanisms often means that carriers fail to execute VoLTE roaming agreements with carriers in other countries. This leads to poorer user experience: If a VoLTE subscriber roams to a visitor network that does not have a VoLTE roaming agreement with the subscriber's operator, the 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.

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.

3. The Voice Core Will Need to Support 2G through 5G

For many service providers, a primary requirement for a new voice core network is that it must support old network standards. We have already seen that some operators will be running circuit-switched networks for several more years, if for no other reason than to support inbound roaming until more 5G roaming agreements are signed. They will therefore need to operate circuit-switched core networks as well as 2G/3G RAN.

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.

Another complicating factor is that many 2G and 3G cores 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.

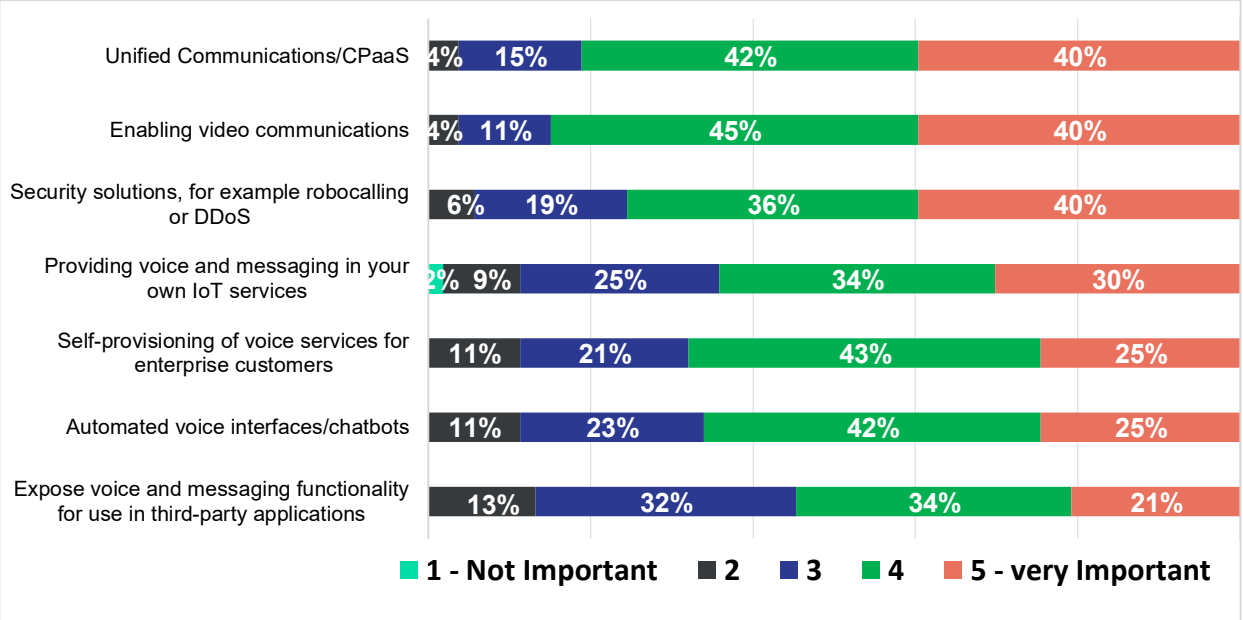
In our survey, only 17% of our respondents reported that they did not expect to deal with the problem of end-of-life circuit-switched core networks; most of the remainder are planning on either some form of extended support for their legacy core, or are moving to a converged core that supports both circuit-switched and packet-switched voice. 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]

[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].

4. Other Requirements for Voice Core Networks

Voice is, of course, the primary service that telcos need to enable with their IMS core networks. But as the following results show, video, collaboration, and security services are also vitally important.

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).



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Video calls and unified communications overwhelmingly rank as Important or Very Important in the survey, indicating that telcos believe that carrier-grade reliability and quality can still differentiate their conferencing services from the plentiful, popular, and inexpensive over-the-top services. Core networks must therefore support this functionality

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.

widely across the various technology generations deployed at the operator. Security solutions are nearly as important, so voice solutions must be robust, protecting against both attacks that threaten the infrastructure and those that affect the privacy and experience of the individual user.

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 similarly 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.

This Whitepaper is sponsored by Huawei Technologies.