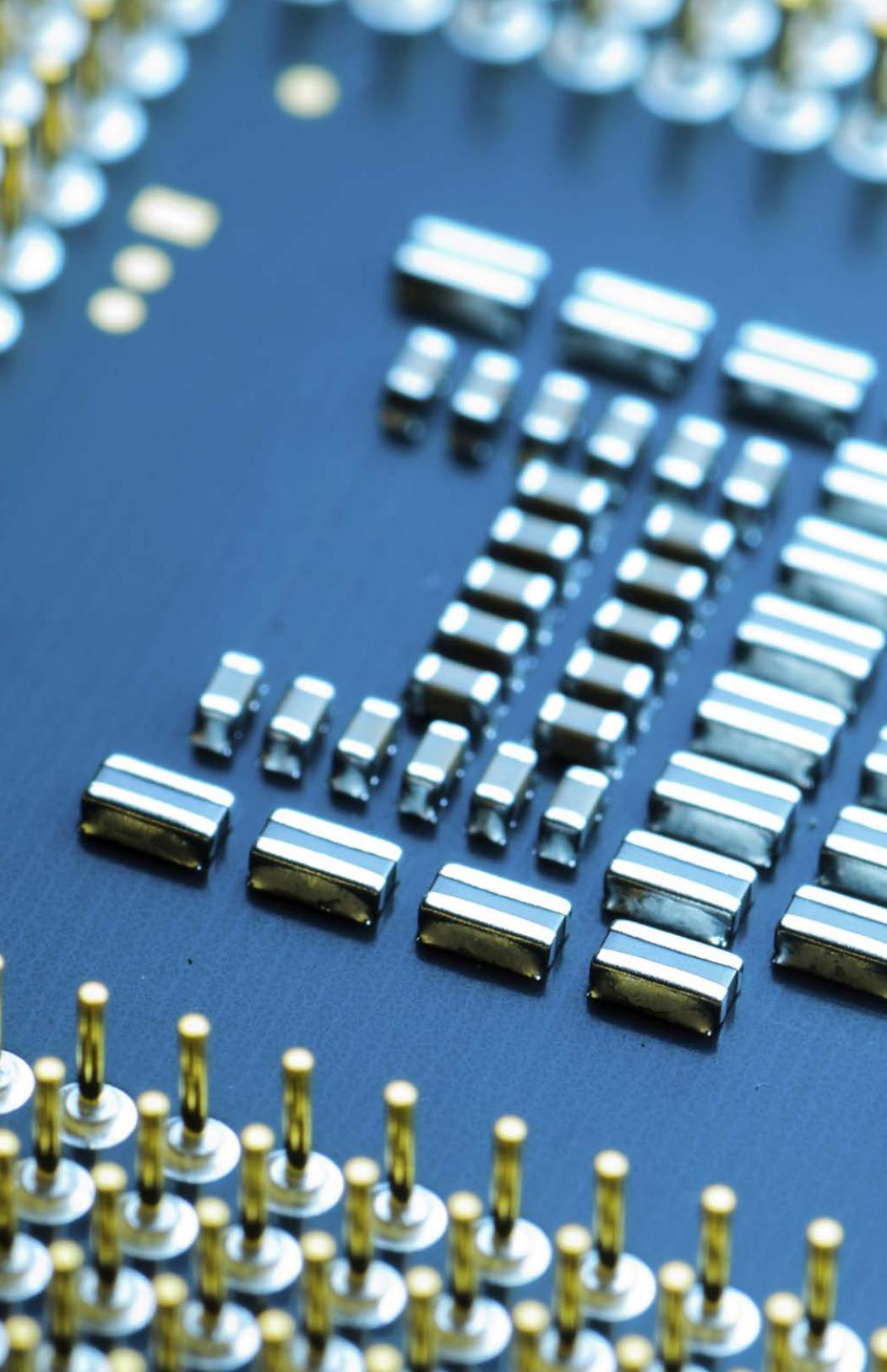


Every Twist and Turn, Tried and Tested

VoLTE Testing Explained

Find out how testing addresses the challenges of bringing your VoLTE networks, VoLTE-enabled mobile devices and new services to market quickly and efficiently. Without any worries about performance or quality.



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The Big Move to VoLTE

For decades, wireless operators relied on the circuit-switched voice domain to deliver voice services, and that worked fine. But when operators decided to migrate to the data-centric Long Term Evolution (LTE) technology, which can deliver greater capacity and lower latency at a time when mobile data consumption is at an all-time high, they needed a new way to deliver voice services.

Before wireless operators started their transition to LTE, consumers were increasingly turning to over-the-top (OTT) solutions, such as Apple's Facetime and Microsoft's Skype, for voice and video services. While those services initially didn't always deliver the best calling experiences, the creators of the OTT solutions made great strides in the intervening years to improve the quality of service. Now, as wireless operators move to deploy their own version of IP-based voice services, the sound and delivery quality must be top of mind to compete with OTT and legacy voice systems.

But these new voice technologies are coming at a time when consumers are using their mobile services in ways they didn't in previous generations. Gone are the days when you picked up a phone to make a phone call and set it down until the next call. Nowadays, consumers are constantly checking their smartphones for email, Facebook

updates and Twitter feeds. The Internet of Things (IoT), which involves everything from LTE modules in cars to heart and glucose monitors, brings with it a whole new set of services that are constantly tapping the mobile networks. Because voice and data services travel over the same LTE pipes—pipes that were separate entities in earlier technologies like circuit switched—decisions must constantly be made by the network so that an emergency 911 call, for example, is given priority over a run-of-the-mill email.

Today, operators all over the world have begun to deploy VoLTE. Rigorous testing has been required to make sure services work as advertised, but operators have used VoLTE as a jumping off point for new services aimed at delivering high-quality voice and video conferencing services, among others, that rival anything that has come before (3G) or after (OTT).

Spirent Puts VoLTE to the Test

Bringing VoLTE-enabled mobile devices and VoLTE services to market is difficult, and the expectations on quality and end-user experience continue to grow. Improvements in time-to-market and quality are possible with test strategies that measure the right metrics, in the right environments, at the right time. To accomplish this, ideal test solutions for LTE voice services will have the following characteristics:



Metrics that focus on the end-user experience (including speech quality, the ability to make and maintain calls, and mouth-to-ear latency) over headset and Bluetooth interfaces.



Field test solutions that can test any device, on any network, anywhere in the world and still provide one central location for results collection and analysis.



Ability to use the same voice service measurement systems in the field and in the lab, providing comparable KPIs.



Lab test solutions that provide simple interfaces for LTE and VoLTE configuration while also enabling fast creation of automated VoLTE tests.



Coverage of industry-compliance tests originating from operators and standards organizations.

CHAPTER 1

Infrastructure Testing

U.S. Operators Prep for VoLTE Deployments

By Monica Allevan

Many operators have taken a wait-and-see approach to VoLTE because they can—3G is a perfectly fine network technology to handle voice calls, and circuit-switched fallback (CSFB) fills in where VoLTE doesn't. But the world is moving to an all-IP architecture, and processing calls on VoLTE just makes for better economics.

First, of course, operators need to ensure that VoLTE calls sound as good as the quality their customers are accustomed to hearing with earlier technologies. In the early days of mobile phones, customers put up with static and fast-busy signals because they valued the mobility aspect of the technology. Consumers didn't expect their mobile phone calls to sound as crystal-clear as their old wired phones.

But as technology has advanced, mobile phone networks and the devices that run on them are producing better sound quality. Naturally, operators want their VoLTE call services to sound at least as good

as 3G, and once that goal is met, they can set their sights on making calls perform even better than 3G.

It's worth noting some significant milestones thus far. Verizon Wireless gets credit for completing the first VoLTE call in February 2011, according to Analysys Mason. But it was SK Telecom in South Korea that deployed the first HD VoLTE service and LG Uplus that launched VoLTE service in August 2012. In October 2012, KT followed its South Korean brethren by launching VoLTE. Also in the late summer of 2012, MetroPCS launched a limited VoLTE service in the United States.

New Ways of Connecting

In the past, with 2G network and 3G networks and circuit-switched call setups, the brains or the smarts of a call set-up was all done by the network. Therefore, the network had complete control and prior knowledge of what the two end points were and could select. For example, the right codec or the best codec that would be agreeable to both end points of the call. With VoLTE, the call set up has more to do with the end-user equipment than the mobile network infrastructure.

"This is kind of the first application where we have low priority data like Internet surfing and email running over the same high-priority traffic like a voice call or a 911 call, so we have to make sure the prioritization is working properly," said Ross Cassan, director of Product Marketing, Networks & Applications Group at Spirent Communications.

That's accomplished in part by sending a lot of data, and different types of data, through the network with a lot of "contention" scenarios where the network has to make decisions about what to do. One such scenario might involve sending the maximum number of calls through the network that it

can support and then start to add more calls to see how it behaves. If it's working properly, the people who are already connected will keep their connections and the people trying to get a connection will get a busy signal.

"We have to make sure the prioritization is working properly."

*Ross Cassan
Director of Product Marketing,
Networks & Applications Group*

Another scenario is if the data pipe is filled with Internet traffic and a new user needs to make a 911 call but the space is full. The network needs to be intelligent enough to say, "OK, I'm going to stop some of this or delay some of this web traffic or email to make sure that call can go through," he said. "Those are the types of scenarios we do"—introducing that contention and evaluating the network's response.

Interoperability Leads the Way

Considering the types of changes introduced via VoLTE, it isn't surprising that the largest U.S. carriers are taking their time. Operators that launched their businesses based on their ability to offer mobile voice services can't afford to offer anything less than stellar service, especially in a world where over-the-top (OTT) services are perceived as eating their lunch.

In a world with an ever increasing demand for access to anything, anywhere at any time, carriers' reputations are evaluated not only by the perceived voice and video quality, but also by the availability and resiliency of the service. Issues such as anywhere connectivity, access management, seamless mobility and interoperability should be addressed in a proper VoLTE implementation.

From a North American perspective, VoLTE is indeed more than Quality of Service (QoS) and Quality of Experience (QoE). Carriers needed to build and verify the infrastructure to provide VoIP services. Questions asked included: Is it possible to differentiate the different

types of traffic by priority? Is the infrastructure able to provide the resources for VoLTE? Is it possible to provide seamless services during mobility phases? QoS/QoE is the last step in a long chain of technical hurdles that had to be overcome by service providers.

"There are lots of challenges to VoLTE," said Michael Thelander, CEO and founder of Signals Research Group. One of the biggest problems in addressing the complications that come with deploying VoLTE is finding where they're at in the first place. "If different operators or vendors have done things slightly differently in how they're deploying VoLTE, then you have an interoperability issue," he said. Put another way, if you're Operator A and VoLTE is working on your network, that's one thing. But doing it across other networks, which is required, is another challenge entirely. Thelander equates it to having a high-quality CD with a scratch in it; you might have the Cadillac of networks, but if there's a glitch, it's not going to be worth much.

Other analysts echo that sentiment, and many point to the lack of eye-popping revenue expectations as one big reason VoLTE took its sweet time to market. “Overall, there are many challenges to VoLTE, mainly that the business case is not assured at all, so while operators will have to deploy it eventually—unless they hang onto 2G indefinitely, or go for generic VoIP—most will need to find an improved ROI,” said Caroline Gabriel, research director at Rethink Technology Research.

“I think the delays have been for several reasons—while they still had multimode networks and handsets, there was no rush to move to VoLTE; they had other priorities, especially given the significance of doing a big IMS-based deployment for voice,” she said. “To justify that beyond

merely clinging to dwindling the legacy cash cow of voice, they need to develop new revenue streams and added value applications, and those have not yet been forthcoming.”

Of course, the challenges are not insurmountable. At some point, carriers will introduce VoLTE in more markets around the world. “Everything is fixable,” Thelander said, adding that the hype around VoLTE has come and gone. “Now it’s just about implementing.”

The future shows that carriers, device manufacturers and end users will inevitably move to a pure LTE world. In this scenario, VoLTE is so far the only way for carriers to regain control over what used to be their major source of revenue, while adding new offerings.



CHAPTER 2

Device Testing and Interoperability

Infrastructure & Handsets: They Just Need to Get Along

By Monica Allevan

The benefits of VoLTE for network operators are well documented. For one, running voice over their LTE networks will lead to greater efficiencies, and operators are under great pressure to lower their CapEx and OpEx budgets while finding new sources of revenue.

As with any wireless technology migration, the handsets and networks both need to work smoothly in order for VoLTE to successfully make its mark. With IMS-based technologies such as VoLTE, much of the call setup logic is pushed from the central network to the User Agent endpoints now embedded in the handsets. The success of

VoLTE deployments now rely on User Agents from multiple providers being interoperable.

For much of 2012 and 2013, the circumstances under which the two have met in the United States were less than ideal. But operators and their equipment partners are hopeful the biggest challenges are behind them.

“The new handsets are using IMS or SIP-based specifications, so there’s a lot of flexibility in the interpretation of the specs.”

Mike Keeley
Director, Core Technologies Group at Spirent Communications

Working Well Together

One of the most urgent concerns for network operators preparing to launch VoLTE services is getting the handsets from different manufacturers to initiate and complete calls within the same network. The handsets must be able to negotiate with one another, and because different manufacturers are basing their handsets on their own interpretations of the specification, the devices aren't always communicating with one another as they should.

The new handsets are using IMS or Session Initiation Protocol (SIP)-based specifications, so there's a lot of flexibility in the interpretation of the specs, said Mike Keeley, Director, Core Technologies Group at Spirent Communications, which tests pre-commercial devices for operators.

Once handsets from different manufacturers are able to originate and terminate calls with one another on the same network, there's the next challenge. Operators need to ensure their networks and devices are able to place and accept calls from devices

on other operators' networks. After all, the expectation is for a consumer to make a call and have that call go through whether the person they're calling is on Operator A, B or C.

The third main problem area is the scenario involving what happens when a VoLTE device from one geographical market lands in another market, Keeley said. The end-user of that device also expects to make a phone call when his or her plane lands, and each operator needs to accept registrations from these roaming devices and get calls through, even if the SIP implementation of these roaming devices differs from the SIP implementation of native devices.

While SIP by its definition leaves itself open to adding a lot of extensions—which gives operators a lot of flexibility and the ability to offer different services—"that same flexibility can also be your undoing when it comes to interoperability," he said.



Operators Big and Small

AT&T and Verizon Wireless are two of the biggest and most highly visible carriers that initially delayed their VoLTE rollout plans; many other carriers are at various stages in the process.

“Competitive carriers wish to deploy robust wireless services and provide their customers with high-speed mobility on 4G LTE networks. Many CCA members have deployed, or are in the process of deploying, 4G LTE networks with the goal of incorporating VoLTE technology soon after, building on a long list of competitive carrier innovations and industry ‘firsts,’” said Steven K. Berry, president and CEO of the Competitive Carriers Association (CCA).

“Competitive carriers are very interested in VoLTE, which promises better voice quality, lower power consumption, and greater efficiencies, and have also invested in other IP calling technologies,” Berry said. “But it is important to

keep in mind that deploying these latest services does not come without challenges, and the transition will not happen overnight. Until VoLTE technology is deployed and VoLTE handsets are available, carriers, whether large or small, still need a legacy network until they can fully transition to a completely functional 4G VoLTE solution.”

CCA’s Data Access Hub, with its “one connection to many,” has the potential to change the landscape in a big way, according to Berry. Through the Hub, carriers have the ability to connect and access other participating carriers’ networks. Spirent is committed to the data access hub concept and that’s significant as its participation “essentially creates a nationwide footprint that all competitive carriers, and ultimately their consumers, can enjoy,” he said. “As more and more carriers deploy 4G services, the larger the 4G network for participating carriers and greater the potential for deploying VoLTE services.”

New Beginnings

Industry analyst Jeff Kagan said he believes the migration to VoLTE is going at the right pace. “The carriers are simply making sure the technology is road ready when they launch,” he said. “Even then, the technology will continue to improve going forward. Just the way it did with VoIP.”

The problems associated with delays in VoLTE rollouts in the U.S. didn’t signal an end to the technology itself, but rather a beginning. “This is a new technology so any delay is actually to make sure the service quality is better,” Kagan said, adding that it takes time to prepare the network. “Anytime a new technology is rolled out, there are always slight bumps in the road that have to be managed and corrected. Then it becomes a great addition to the industry.”

“The technology will continue to improve going forward.”

Jeff Kagan
Industry Analyst

CHAPTER 3

Applications

VoLTE Aims to Outperform Alternatives

By Brad Smith

VoLTE enters a voice communication world inhabited for years by so-called “over-the-top” (OTT) services like Skype, Apple Facetime, and Google Talk, that offer free or inexpensive calls. But analysts and those in the industry say VoLTE has a distinct advantage when properly tested and implemented.

VoLTE and OTT services both treat voice like data, but with a difference. OTT services, says long-time telecom analyst Roger Entner of Recon Analytics LLC, “run over the data network and are as good as you can get. There are no guarantees and no expectations [of quality]. Sometimes they work and sometimes they don’t. With VoLTE, ‘doesn’t work’ is not acceptable.”

Analyst Monica Paolini of Senza Fili Consulting says LTE operators are incentivized to work together to enable VoLTE calls across networks, something OTT providers don’t do because most of them use proprietary technology. VoLTE users should see higher quality voice calls than OTT as well as better service, Paolini says.

Features Ahead

The technical specifications for VoLTE provide for the delivery of voice using IP Multimedia Sub-systems (IMS) over the LTE network. Wi-Fi data networks also use IMS, which means wireless carriers also could use Wi-Fi to offload traffic.

In fact, mobile operators using VoLTE and IMS, which is the ultimate migration, can expand their services beyond high-speed data and improved voice to improvements in unified communications packages, including presence, for enterprises and consumers.

Verizon Wireless Chief Network Office Nicola Palmer says the carrier, which started migrating to LTE in 2010

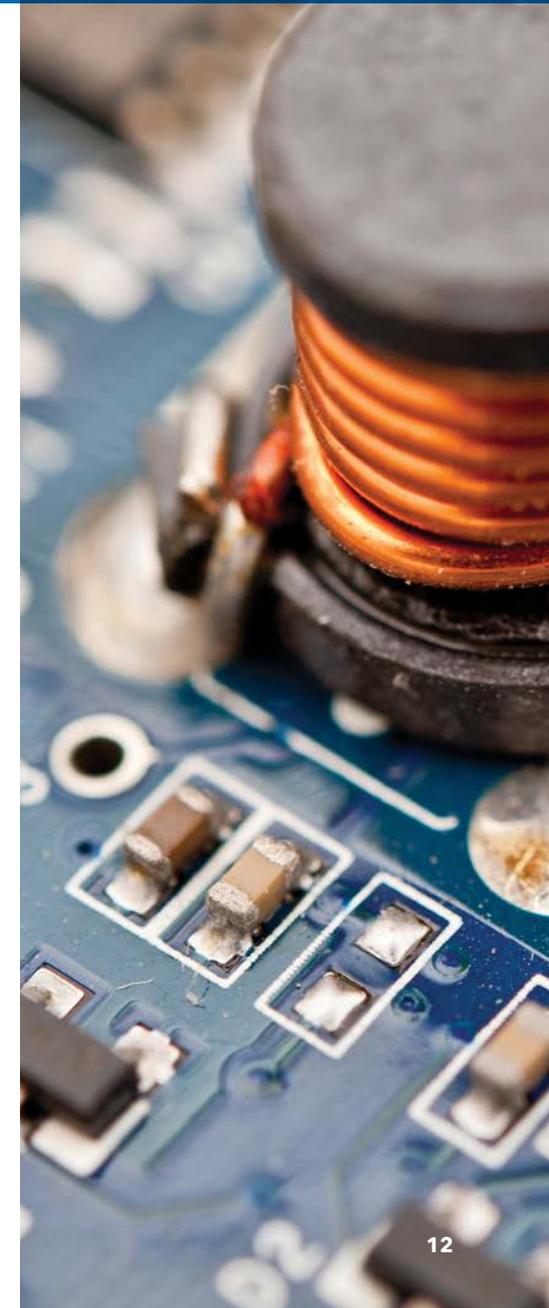
and launched VoLTE in 2014, says VoLTE means not only a better voice experience but also enables additional benefits like video chat and video-casting.

Nokia Solutions and Networks has done tests comparing the performance of handsets using VoLTE and those using OTT solutions.

"The tests reveal a clear winner," according to a blog post by Gerald Reddig, product marketing manager for NSN. "VoLTE clients are more network friendly than OTT VoIP and provide a superior customer experience with respect to power efficiency.

"Furthermore, VoLTE features that ensure Quality of Service bring even greater benefits for users, especially in highly loaded networks, where voice quality is likely to break down for VoIP services. With VoLTE, mobile operators have a powerful tool to compete with the OTT players."

Initial VoLTE implementations will use circuit-switched fallback (CSFB) to assure voice quality, as well as the circuit-switched network for simultaneous voice and data (SVLTE). But these solutions eat up handset battery life and network resources so ultimately the operators will migrate to a full IMS solution, Reddig says.



OTT and Operators

It's conceivable that carriers could establish a business relationship with an OTT provider that would provide higher QoS for voice calls, although telecom operators seem reluctant to share what is still their main service. Reddig also says studies have shown OTT VoIP consumes significantly more handset battery power and uses more bandwidth than operator VoLTE.

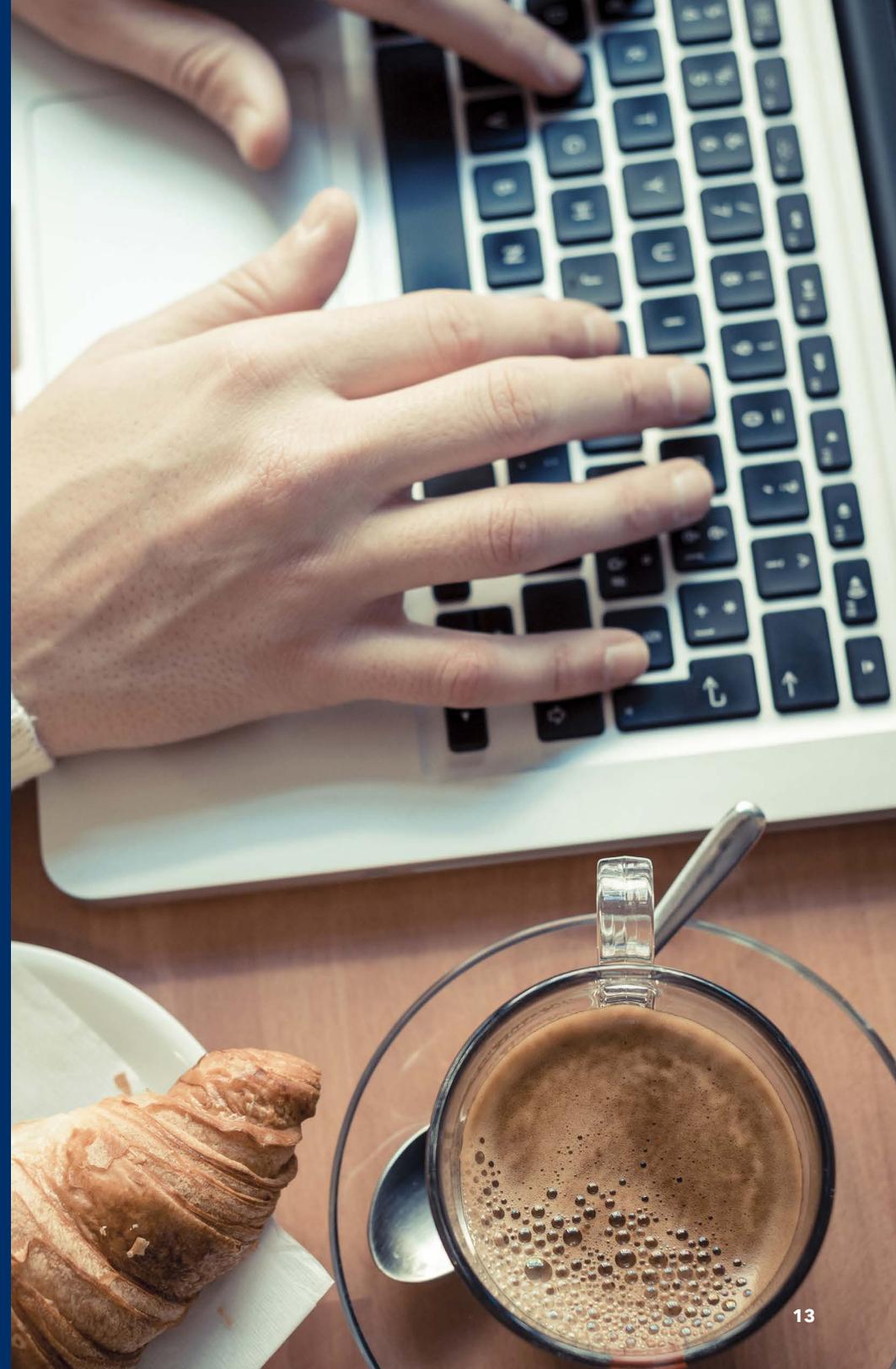
“VoLTE would give higher quality.”

Monica Paolini
Analyst at Fii Consulting

Paolini says she has seen some operators exploring business relationships with OTT providers, using a financial revenue-sharing model. “VoLTE would give (OTT providers) higher quality,” she says.

With network QoS such an essential part of VoLTE, the technology has become a focus for Spirent Communications, the leader in testing wireless networks, services and devices. Jeff Atkins, Spirent's marketing director, says the company is measuring VoLTE deployments through the networks and the handsets, ensuring end-to-end service quality.

“It's a key area of focus for us,” Atkins says, adding that mobile subscribers will have multiple ways of making voice calls using traditional circuit-switched networks, VoLTE or OTT apps. Spirent has developed quantitative testing services for comparing the user experience of VoLTE, OTT and circuit-switched voice services and ensuring VoLTE offers the best experience.



CHAPTER 4

User Experiences

**It's New and It's VoLTE, But
Will Consumers Notice?**

By Brad Smith

When any new technology comes out of the lab and enters the real world, there is always the question of how it will meet consumer expectations. Mobile industry insiders have extolled the benefits of VoLTE, but will users embrace it?

There have been concerns as LTE networks and handsets have spread that there may be some drawbacks. One of them has centered around the battery life of smartphones running VoLTE and associated applications. Another has questioned whether users will really experience improved voice call quality, including the value-add for HD Voice.

Putting It Under the Microscope

Spirent Communications has been looking at these questions while also developing solutions to issues. Jeff Atkins says the company saw some “very poor performance” in early-stage network deployments of LTE.

“But once the network has been optimized and the bugs ironed out, we’ve seen VoLTE exceeding other (VoIP) applications,” Atkins says. Spirent has seen much the same thing with smartphones, with those purpose-built for VoLTE clocking much better battery life.

“Battery life is always a concern [with handsets],” says analyst Chris Nicoll of Analysys Mason. “But I think less so in devices purpose-built for VoLTE, meaning that a vocoder for voice to packet is included in the DSP (digital signal processor) and not running on the device’s main processor. This should mean that battery life should not be impacted and may actually improve if a dual-radio setup for CSFB (circuit-switched fallback) is not required.”

Spirent’s handset tests look at a variety of factors affecting performance, including everything from the number of cores to the screen size. Power consumption has skyrocketed with the advent of smartphones, Atkins says.

“The consensus is that batteries won’t get much larger,” he says. “And there aren’t many signs that power needs will go down with browsing, talking and video using a lot more power than traditional apps. We see the industry looking more and more at improving power efficiency, including the mobile OS, antennas, RF and baseband components, and more.”

Tests of commercial LTE smartphones done by Spirent, Signals Research Group, and ETS-Lindgren showed that poorly-performing smartphones could significantly degrade the mobile user experience as well as make inefficient use of network resources.

Atkins says Spirent is testing every VoLTE device that some carriers launch and its tests show that the best-



performing devices use as much as 60 percent less power, which can vary by how the handset is used. Spirent has designed tests which can replicate real-world user activity, he says.

VoLTE and HD Voice Quality

Will consumers see a difference in voice call quality with VoLTE?

There might not be a big difference between a 3G HD voice call and VoLTE, says analyst Nicoll, but there will be a noticeable improvement, especially compared to non-HD calls. “Which also means audio streaming will sound richer, fuller and more satisfying,” he adds. “But the big immediate benefit for LTE users is moving to HD Voice.”

HD voice over either 3G or VoLTE provide a richer voice experience because HD suppresses the background noise and makes the call clearer, according to Roger Entner, founder of Recon Analytics. Entner cautions that handsets will need to be both VoLTE and HD voice ready for the best experience.

Again, the best experience is also enabled by fine-tuning the handsets with the networks. That’s what Spirent is doing with its Fit4Launch service by going into a carrier market and measuring the live network with real consumer handsets.

At one time, mobile operators literally drove the streets making phone calls to test call quality. With LTE, they’ve turned to Spirent’s solutions to give them scientific measurements to assess quality. That includes comparing voice calls over a circuit-switched network with calls using VoLTE to make sure the latter is at least as good. Spirent measures how long it takes to set up a call, speech quality, ability to maintain a call, and what kind of delay there might be.

“What we’ve done is make it a science,” Atkins says, “with a set of metrics that matters to users. We’re measuring both the network and the handsets, transcending the technology to measure quality.”

At least one VoLTE user is convinced of the technology’s benefits. That’s Nicola Palmer, chief network officer for Verizon Wireless, who of course has been running her own personal tests, something she’s discussed in an online interview on Verizon’s website.

“I can tell you that I personally have made VoLTE calls on our commercial network and the quality really is quite remarkable,” she says.



VoLTE Testing Solutions—What to Test



User Experience, App Emulation and QoE

- End-user voice quality and call performance
- Streaming video and chat
- Applications & security
- Customer Experience Management



User and Network Modeling

- Realistic device behavior and device/service call modeling
- Real-world mobile apps traffic modeling
- Carrier busy hour call modeling
- Maintaining the expected Quality of Service

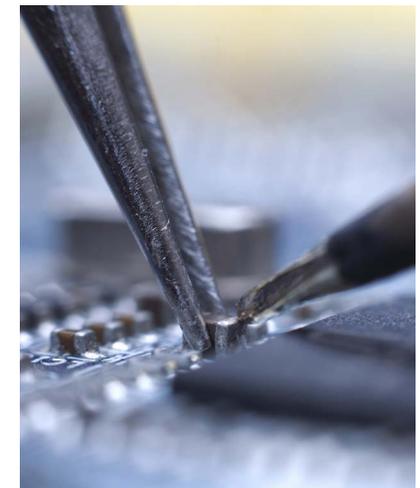
Device Testing and Emulation

- Device operation with the IMS subsystem
- Interaction with the Evolved Packet Core
- MIMO antenna performance
- Roaming between radio access networks (using multiple radio technologies) and Wi-Fi
- VoLTE E911



Mobile Core Node Emulation and Test

- VoLTE progressive end-to-end network topology
- Seamless 'any-G' mobility
- IMS integration and IOT
- Policing, charging and billing node
- Voice, video and VoLTE E911
- SrVCC & CSFB
- Network and service resiliency and redundancy
- Offloading alternatives



Spirent provides a range of solutions to validate and verify the quality and performance of VoLTE infrastructure, devices and services.



Landslide

is a comprehensive end-to-end performance test system that emulates millions of mobile data subscribers using various access technologies to simultaneously access the wireless network.

8100

system automates VoLTE testing for industry compliance, including coverage of leading network operator acceptance test plans.

Umetrix Voice

test platform enables reliable measurement of VoLTE and HD Voice quality and call performance for any device, on any network, anywhere in the world using live infrastructure or in a lab environment.

Fit4Launch

is the leading program for mobile service providers and OEMs to identify device performance and quality issues before they hit the market.

InTouch

is a Customer Experience Management (CEM) software solution that enables mobile operators to understand and quantify services such as VoLTE as experienced by their customers.

About Spirent Communications

Spirent Communications (LSE: SPT) is a global leader with deep expertise and decades of experience in testing, assurance, analytics and security, serving developers, service providers, and enterprise networks.

We help bring clarity to increasingly complex technological and business challenges.

Spirent's customers have made a promise to their customers to deliver superior performance. Spirent assures that those promises are fulfilled.

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