



# Public Safety over LTE | Ensuring Quality of Experience

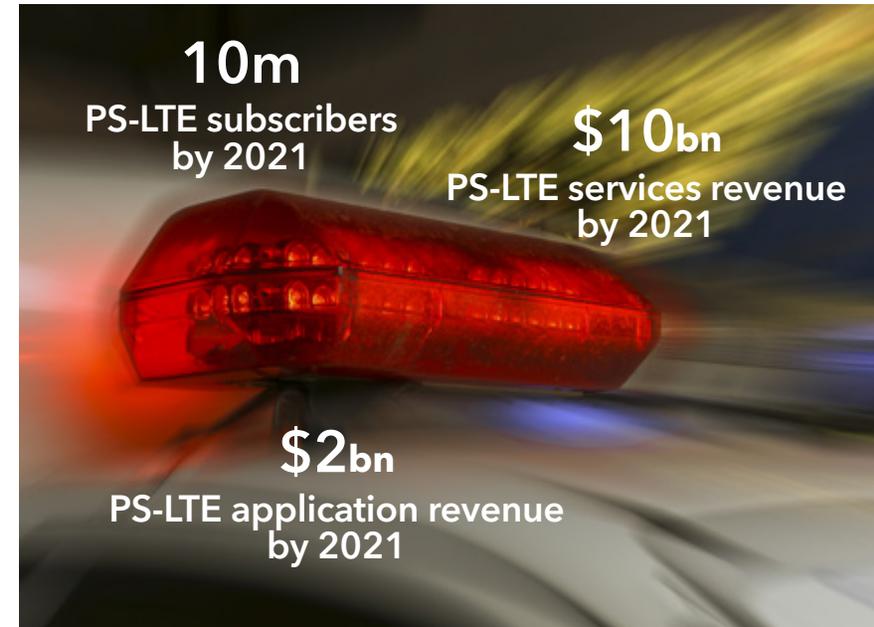
Measuring What Matters Most for Mission Critical Communications

## Table of Contents

Introduction	3
What's Special about PS-LTE (vs. Consumer LTE)	4
The Preferred Method to Evaluate and Why	7
The 5 Pillars of Experience	8
Real World Challenges	9
Questions Worth Answering	11
Getting Started with a Test Plan	12

Mission critical communications have long relied on legacy TETRA and P25 technologies. While cellular services have evolved over the past decade to provide wideband audio, multimedia calling, and high bandwidth data connections, the first responders who use LMR (Land Mobile Radio) systems haven't moved ahead at the same pace. But neither has cellular been ready to provide the essential critical communications capabilities to allow LTE to be a viable alternative.

**That's all changing now.** LTE is adding support for critical communications technologies such as push-to-talk, peer-to-peer operation, and prioritization. Public Safety over LTE (PS-LTE) networks are underway or in operation in several countries including the United States, United Kingdom, South Korea, Australia, Qatar and others. Leading analyst firms such as Gartner, IHS and SNS predict that over the next few years (~2017 to ~2021) several billion dollars will be spent annually on PS-LTE infrastructure, the number of PS-LTE subscribers will jump from about 2 million to over 10 million, and PS-LTE service revenue will grow to over \$10 billion per year<sup>1</sup>.



**Consumer cellular is getting an upgrade to serve as the critical communications backbone for first responders.**

**Prioritization, push-to-talk and peer-to-peer are among many new LTE capabilities.**

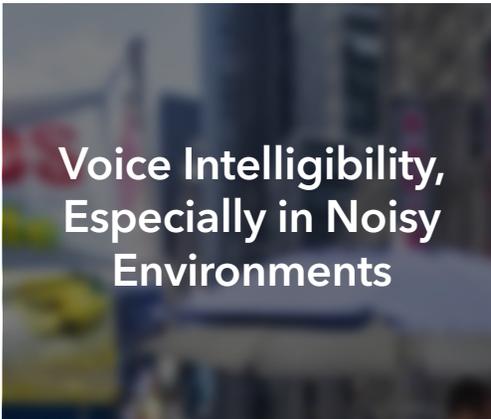
Accordingly, new multimedia devices are being built for PS-LTE including smartphones and other handsets, tablets and notebook PCs, wearables, and portable or vehicle mounted modems and routers. In addition, multitudes of new services and applications are being developed to run on those devices.

Yet how do you truly assure the quality of experience for first responders? Is a device ready? Is a service ready? How does it compare? How can it improve? Traditional conformance testing is now simply insufficient to test what matters most – the live user experience.

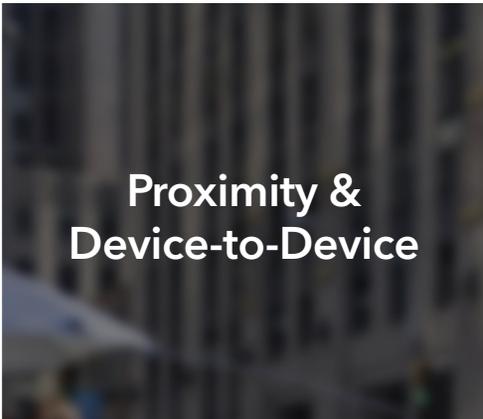
This eBook explores what's special about PS-LTE vs. consumer LTE and why quality of experience matters. It covers the 5 pillars of a quality mobile experience including real world challenges and important questions worth answering.

<sup>1</sup> LTE in Public Safety, IHS Technology, May 2016; and The Public Safety LTE and Mobile Broadband Market: 2016 - 2030, SNS Research, June 2016

# What's Special about PS-LTE (vs. Consumer LTE)



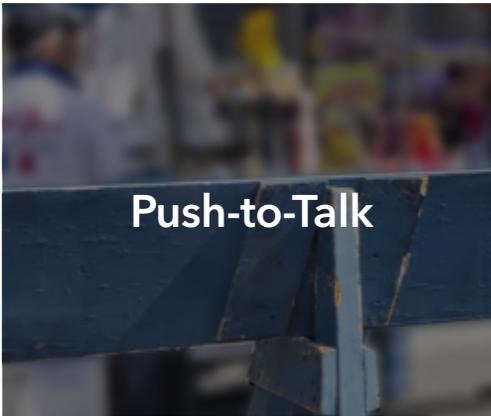
Voice Intelligibility,  
Especially in Noisy  
Environments



Proximity &  
Device-to-Device



Mission Critical  
Video Calling



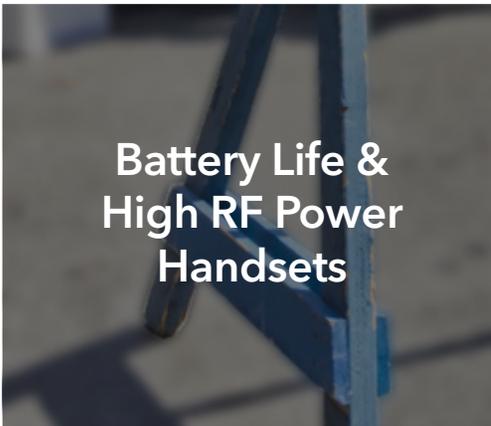
Push-to-Talk



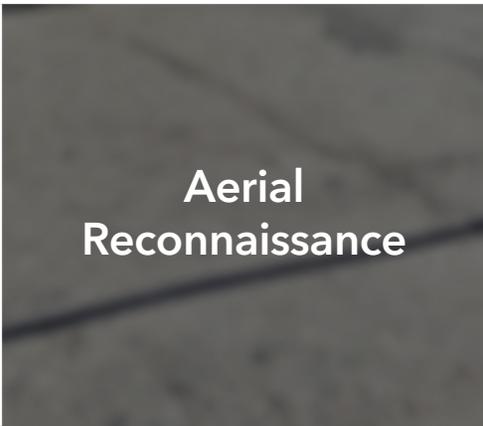
Group Calling &  
Messaging



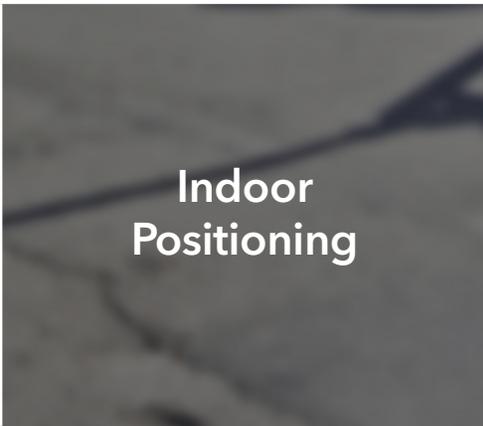
Priority &  
Preemption



Battery Life &  
High RF Power  
Handsets



Aerial  
Reconnaissance



Indoor  
Positioning

While consumers enjoy LTE's bandwidth, high-def voice over LTE (VoLTE), streaming video, and an endless variety of apps, the consumer LTE network needs several upgrades to be ready to handle the specific needs of first responders and associated government agencies.

Some of these changes are part of the network design itself, some are handled in the terminals (called user equipment or UE), and yet others require cooperation between both. 3GPP<sup>2</sup>, the standardization body that governs world-wide cellular networks, has begun rolling out new specifications to support mission critical communications in the R12 (2015), R13 (2016) and R14 (2017) releases of the LTE spec.

**Beyond a heightened need for even more stringent security requirements, there are many new use cases in cellular to accommodate Public Safety.**

## Voice Intelligibility

Voice intelligibility is paramount in emergency response. Like consumer-grade smartphones, critical communication devices must be able to deliver clear audio (i.e., high audio Mean Opinion Score, or MOS). However, some will also require noise cancellation and other techniques to ensure intelligibility in loud or windy environments and while the user is wearing facial protection or other special gear.

## Proximity & Device-to-Device Communication

Proximity Services (ProSe) and Device-to-Device (D2D) operations allow devices to discover each other, to communicate directly, and to form meshes. These capabilities allow for communication without any base station or network for unserved areas or where networks have been disrupted.

## Mission Critical Video Calling

Video calling allows two-way real-time person-to-person calling while 3GPP's R14 Mission Critical Video (MCVideo) over LTE also provides for multi-party calls.

## Push-to-Talk

Push-to-Talk (PTT) is the “walkie-talkie” calling model between two or more parties where one speaker at a time has the ability to transmit voice. MC-PTT brings this “floor control” model of arbitration to LTE (as in, you have the floor, go ahead and speak).

## Group Calling & Messaging

Group calling and messaging features provide one-to-many, many-to-many and dispatcher modes allowing communications among various personnel, teams, patrol or departments.

## Prioritization & Preemption

Prioritization of first responder traffic, and the corresponding preemption of other traffic, are a cornerstone of LTE's ability to provide the robustness and reliability required for mission critical communications. In crowded networks, consumers can be dropped while first responders are recognized and given the highest priority access to resources at the RF layer, eNodeB, and core network.



## Battery Life

Mission critical devices require a long battery life, and they operate in power-hungry situations such as lengthy service hours and with extensive usage. In addition, some networks will support high RF power devices (HPUE, or high power user equipment) that extend coverage for better range and in-building performance. These HPUE consume even more battery power, as expected.

## Aerial Reconnaissance

As drones have become sophisticated over the past few years, their use in public safety applications has been rapidly increasing. Aerial reconnaissance provides “first eyes” on a highway incident, for example, and ongoing information about crowd conditions. LTE networks can be adapted to better cover low altitude airspace to provide drone flight control, and “first person view” video to fly without having the craft in line of sight.

## Indoor Positioning

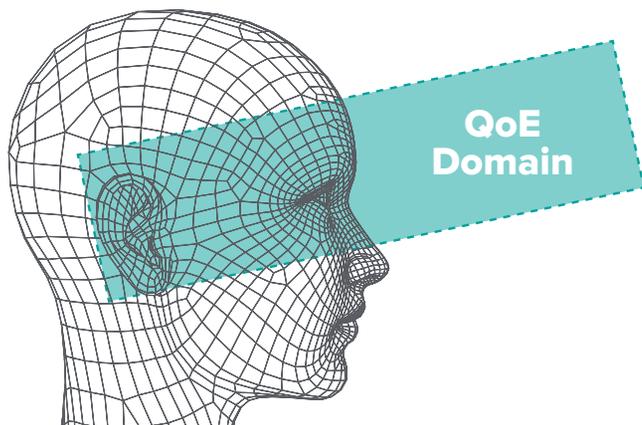
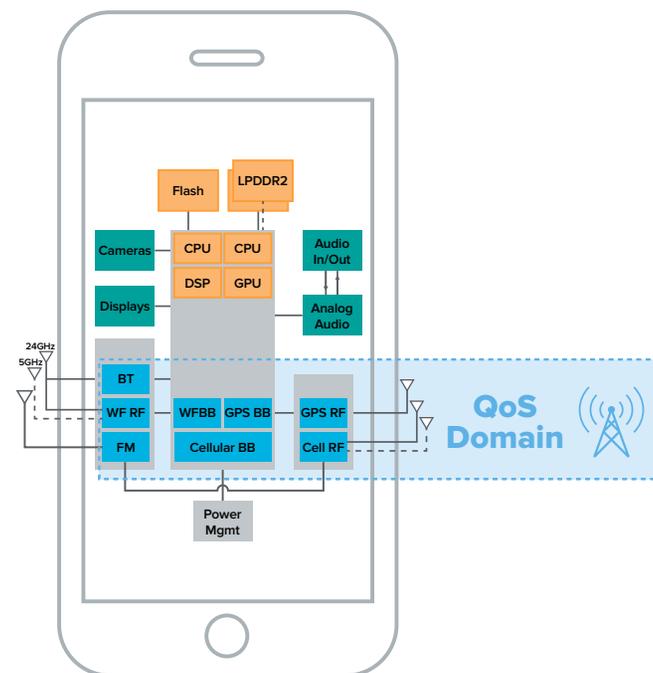
The transition to LTE brings promise of improved location accuracy due to new LTE positioning technologies and their integration using hybrid techniques. Accurate positioning in consumer devices leverages GNSS global satellites with assistance from the cell network, called A-GNSS. Yet obtaining a position fix indoors is difficult due to multi-path reflections and multiple sources of interference. In dense urban areas with closely-situated multi-story buildings, just a few feet can make a huge difference in helping to locate first responders as well as directing them to persons in need. With GNSS impractical indoors, alternate hybrid positioning technologies are used to either augment or replace satellite positioning. In LTE, current standards support Enhanced Cell ID (ECID) and Observed Time Difference of Arrival (OTDOA) to augment A-GNSS for device-based positioning techniques. Additionally, new indoor positioning methods such as Wi-Fi beacons are now being deployed.

# The Preferred Method to Evaluate and Why

While understanding the user experience of consumer mobile devices and services is extremely valuable from a business perspective, it becomes critical in the realm of public safety. The traditional tools of measuring **quality of service (QoS)** KPIs such as RF signal, resource blocks, packet loss, jitter, and bits per second maintain a role, but are no longer sufficient to ensure what matters most - the live user experience.

When we think about what users actually experience when good networks and devices go bad, it is not interpreted as codec mismatch, failed carrier aggregation, excessive chip mW consumption. They experience garbled calls, stuttering and blocky video, slow app performance and a dead battery.

Realistically, every service launch is susceptible to issues in deployment configuration, device and network interoperability and performance. The best carriers and OEMs in the world directly measure what users perceive and test for these experiences, in the lab and in the field. And they compare themselves to their own progress and to other providers. They have moved beyond a focus on conformance to a focus on **quality of experience (QoE)** as the preferred method to test and evaluate.

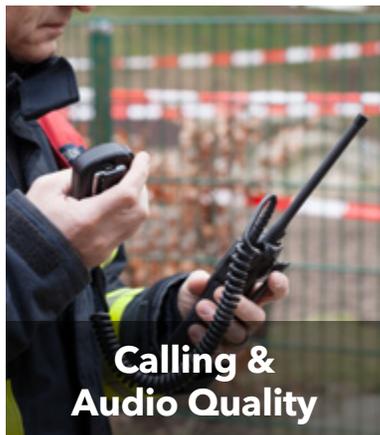


## 8 Key Elements of a QoE Mobile Services Test Methodology

- Pre-launch evaluation in the lab and on live networks
- Fit for launch certification process
- Active test in live networks ongoing, day-to-day
- Benchmark in comparison over time, and to others
- Quantitative, repeatable results for fast triage and issue resolution
- Centralized project workflow automation to keep process simple
- Automated reports for quick visuals of key KPIs
- Utilization of a cloud infrastructure, deployed globally

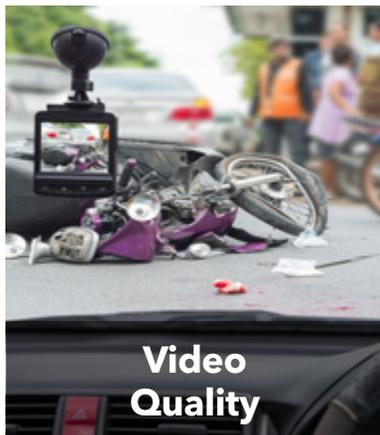
# The 5 Pillars of Experience

To understand if mobile devices and services are ready to launch, how they compare to others, and how to improve, it's important to understand and assess the 5 pillars of experience. This approach is a progressive evolution from more traditional testing, which focused primarily on protocols and lower-level KPIs.



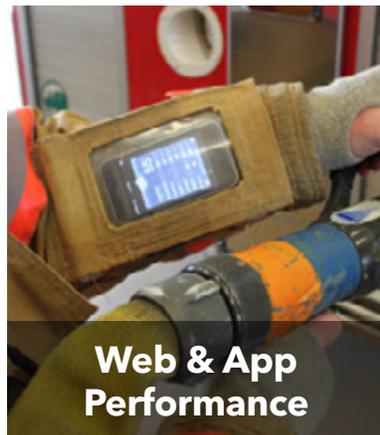
## Calling & Audio Quality

Whether for VoLTE, VoWi-Fi, PTT, HD voice or over-the-top voice apps, assessing call and audio quality involves evaluation of POLQA MOS. This is an industry standard model using POLQA algorithms for voice quality to calculate MOS, the Mean Opinion Score. In addition, factors such as mouth-to-ear delay, call completion success rate, connect time and call drop rates are key test factors in ensuring QoE.



## Video Quality

Assuring video quality has never been more challenging given the increasing types of video and the multiple factors that can affect its delivery and experience. Smoothness, frame rates, slips, drops, A/V sync all come into play. Multiple test methods can be utilized including Gross Error Detection (a simple frame-based analysis), PEVQ VMOS (a detailed reference based analysis) and non-reference VMOS.



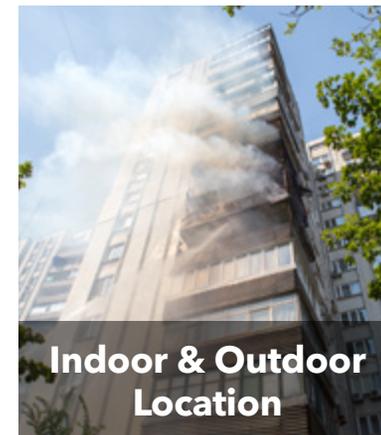
## Web & App Performance

It's important to objectively evaluate the user experience of data services in a controlled, repeatable measurement to servers deployed world-wide. This involves mimicking realistic user activity (including web browsing, file upload and download), HTTP and UDP throughput and latency to determine KPIs such as speed and RF bearer plus signal level.



## Real World Battery Life

While battery specifications have an important function, real-life user scenarios matching real-world user experiences may yield very different results. A QoE methodology leverages a more realistic usage profile including streaming, calling, browsing and messaging to be recorded under test, while assessing battery depletion (hours) and inline power consumption.



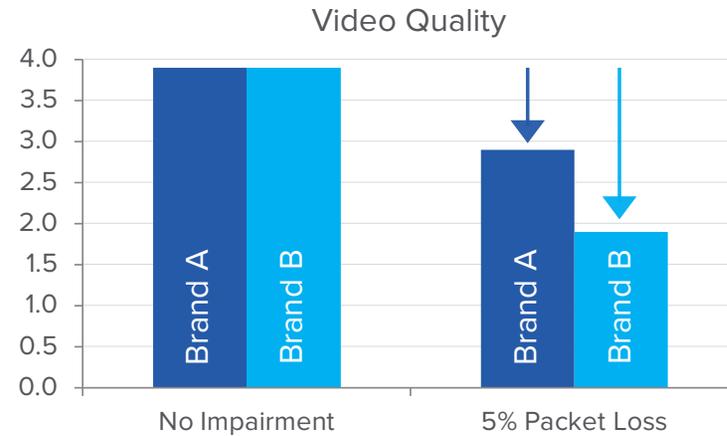
## Indoor & Outdoor Location

Although most consumer LTE vendors are already familiar with A-GNSS conformance and positioning performance testing, it will be a new aspect of evaluation for PS-LTE solutions. In addition, there are added security concerns such as GPS jamming and spoofing sensitivity to address. These methodologies are further supplemented by testing of emerging indoor location based technologies such as Wi-Fi beaconing.

## 1 What happens when the network isn't ideal?

In the first example of a real world challenge, we have two high-end, name brand smartphones "seeing" the same network conditions. The application is IR.94<sup>3</sup> video chat. When the network is smoothly delivering all packets from point A to point B, both devices see no impairment to video quality. But what happens when the network isn't ideal, meaning that all bits don't get from point A to B? In the real-world, networks are not perfect, even when prioritization is in place. Networks can still experience varying degrees of congestion, packet loss and RF interference.

2-way  
**Video**



**Brand A falls off about 20%**  
**Brand B falls off about 45%**

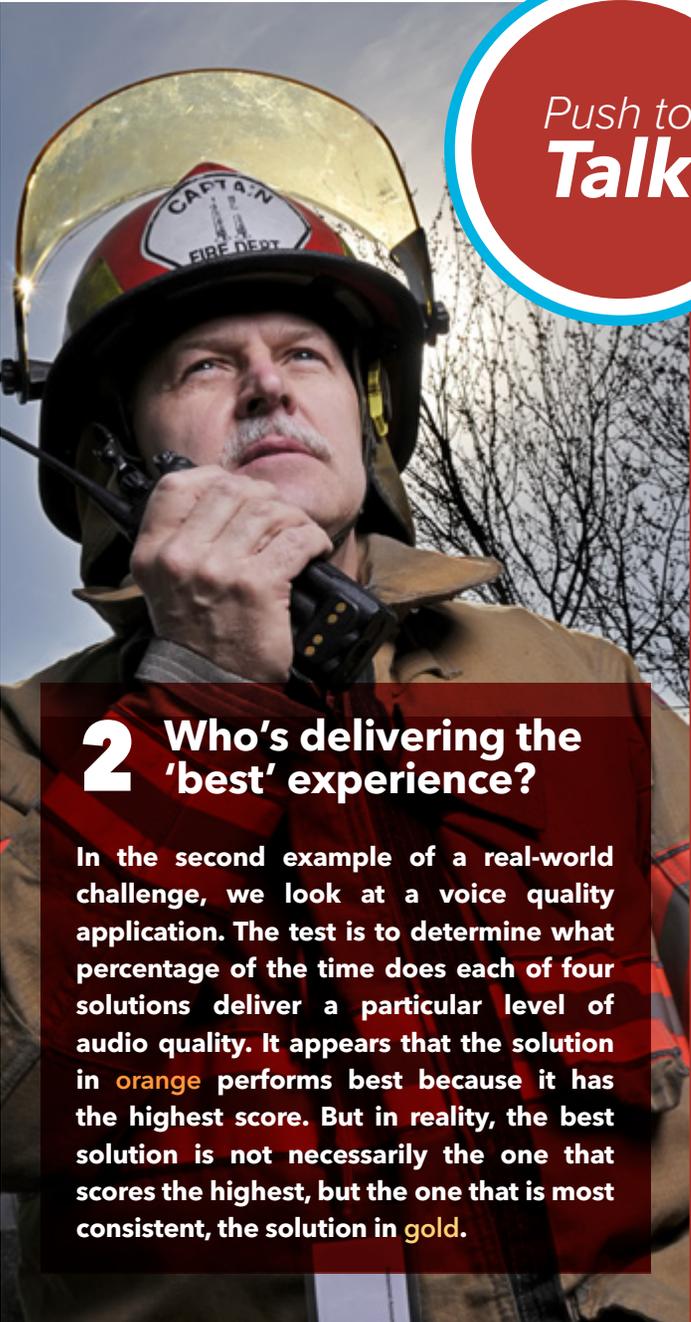
## Two brands of high-end smartphones

### Video chat under identical conditions

How well does the device handle it?

In the case of the two smartphones, when the network is no longer ideal - one does well under adverse conditions (Brand A), the other falls flat (Brand B). This illustrates the significant difference in a video quality experience when the devices do not get all packets delivered. Interestingly, this occurred at a 5% packet loss impairment, which can be typical for cellular networks. These results help demonstrate just one example of how user experience can vary significantly, and the importance of comparative testing in realistic conditions.

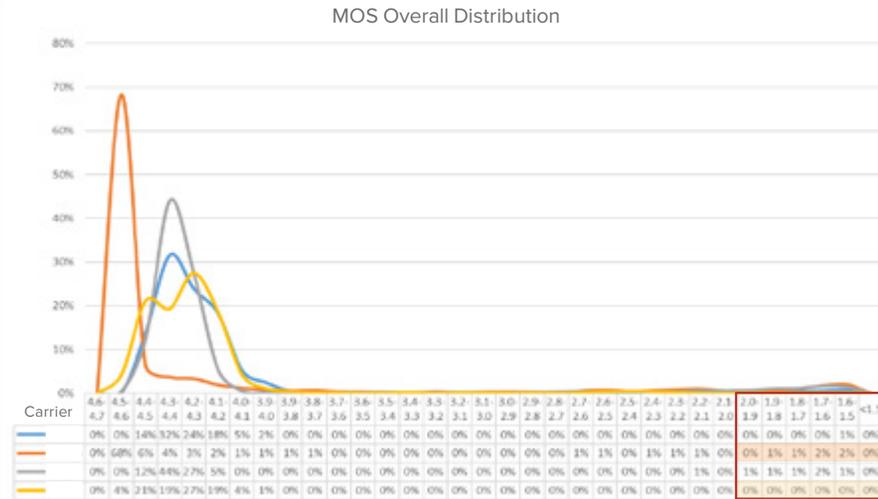
<sup>3</sup> IR.94 IMS Profile for Conversational Video Service, as defined by the GSM Association, [www.gsma.com](http://www.gsma.com)



Push to  
**Talk**

## 2 Who's delivering the 'best' experience?

In the second example of a real-world challenge, we look at a voice quality application. The test is to determine what percentage of the time does each of four solutions deliver a particular level of audio quality. It appears that the solution in **orange** performs best because it has the highest score. But in reality, the best solution is not necessarily the one that scores the highest, but the one that is most consistent, the solution in **gold**.



### 4.5 MOS is "excellent"

### But it hides the true user experience

In reality, 135 of 1000 calls are poor

In taking a closer look, although the **orange** solution achieved the highest MOS score most often, 135 of 1000 calls are poor (<2.0 MOS). The **gold** solution is much more consistent with only 48 of 1000 calls being poor, yet that's still a 5% 'failure' rate. While voice services over consumer LTE have at times settled into a 'good enough' optimization, the bar will need to be raised for PS-LTE. The results in this example help illuminate two key points. First, the importance of not just taking a measurement, but interpreting and assessing the results from a user experience perspective. Second, the realization (and caution) that what is acceptable consumer voice quality, is not necessarily sufficient when applied in a public safety application.

# Questions Worth Answering

Legacy LMR systems primarily operate point-to-point with gateways. This is in high contrast to cellular with network elements, complex signaling and protocols at every layer of the stack. At the application layer, the complexities continue to multiply. Global standardization of PS-LTE will address and improve interoperability, but it is not designed to ensure quality of experience.

When any new technology standards emerge, many companies that develop mobile technologies and products typically begin with more questions than answers. It's a good place to start.

Who are you? What is your role? Are you an agency, a network provider, device manufacturer or content provider? Is your role development, operations or marketing? What is your goal? Are you trying to achieve a simple pass/fail, an ensured experience, a comparison to someone else? Do you have a requirement to monitor over time? What questions are you trying to answer?

There are many paths to follow and at times, it's easy to get lost in the maze. Understanding the questions worth answering helps frame a successful test strategy.



- Am I delivering the best voice quality possible?
- Is my noise cancellation effective?
- Is my PTT signaling compatible with all networks and infrastructure?
- How well does my device cope with loaded network conditions?
- How quickly does my device obtain first position fix?
- How long does my battery last in cell edge conditions?

- Is the service ready to launch everywhere?
- Is it consistently providing reliable service?
- Is voice quality maintained across LTE-to-P.25?
- How well do we stack up?



## Focus areas for testing:

- User Equipment (UE)
- Radio Access Network (RAN)
- Evolved Packet System (EPS) and IP Multimedia Subsystem (IMS)
- Network services/service delivery platform
- Applications
- End-to-end regression testing
- Active test and performance monitoring

PS-LTE represents an exciting step forward for an entirely new class of public safety applications and services. It will open up a vast array of new opportunity powered by high bandwidth, the Internet of Things (IoT) and forthcoming 5G capabilities. It will bring with it new advantages to improve situational awareness and incident management for those who serve and protect.

In this eBook, we've touched on only some of the key aspects that make PS-LTE unique beyond the capabilities of consumer LTE, and stressed the importance of understanding and measuring quality of experience. Testing is a fundamental part of any design lifecycle, but becomes mission critical when users may be at serious risk.

In getting started, ask for help with what techniques work best for which use cases. A mobile experience has multitudes of diverse use cases with quality impacted by complex and numerous factors.

Next, establish your role and goals first. Doing so will guide you through the many test methodology choices.

And lastly, look for a consultative testing partner - and flexible solutions. Unlike legacy public safety networks, mobile LTE technology changes at an extremely rapid pace. Empowering your teams with a set of test scenarios and tools that will facilitate cost-effective testing simplifies the testing process, can help reduce overall development costs, and shorten time-to-market - all while delivering superior quality of service and experience.

If you're interested to learn more about Spirent's solutions or would like to consult with our mobile QoE experts, please contact us by visiting

[www.spirent.com/contactSpirent](http://www.spirent.com/contactSpirent)

## 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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