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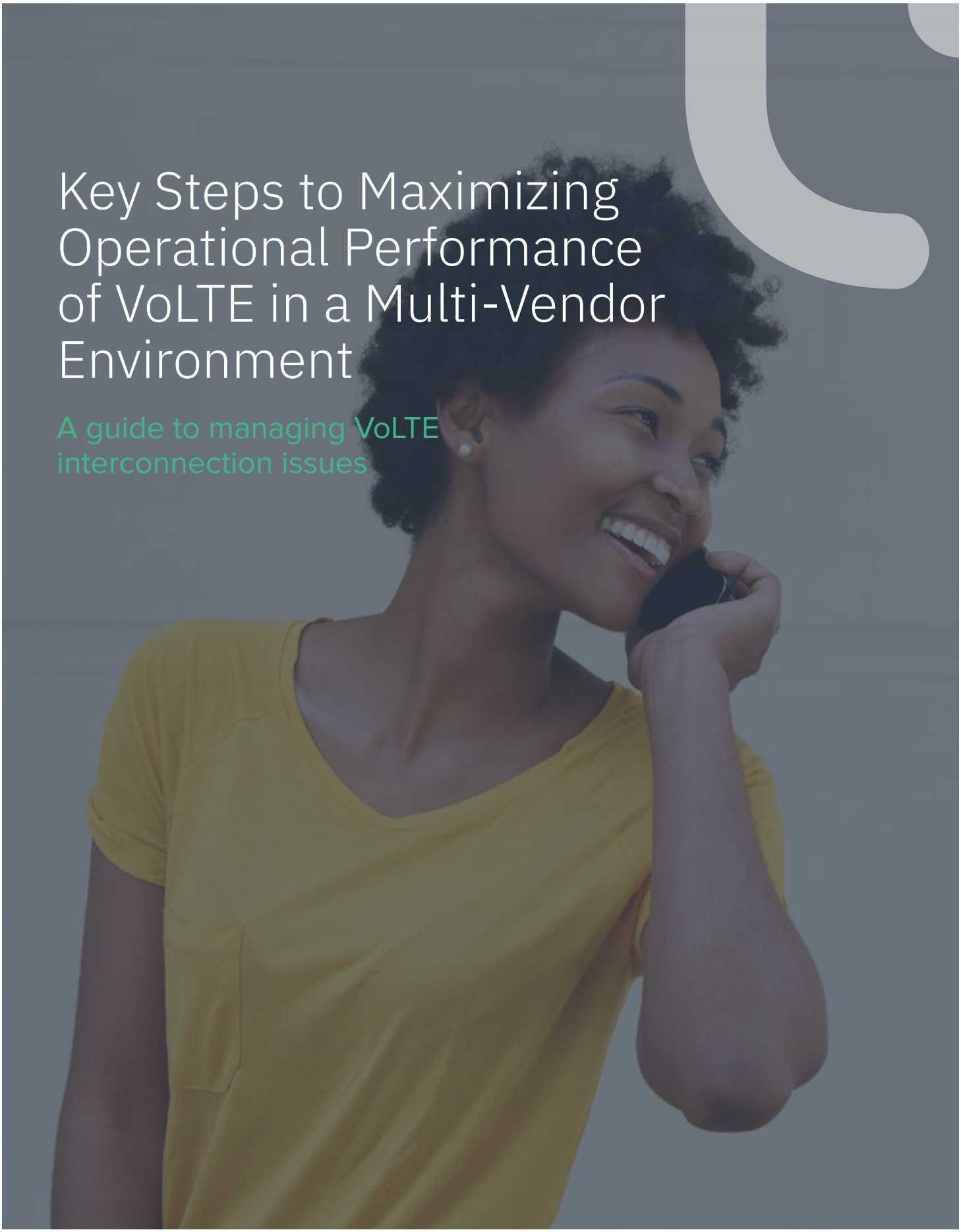
Key Steps to Maximizing Operational Performance of VoLTE in a Multi-Vendor Environment

A guide to managing VoLTE interconnection issues



Content

Introduction

Maximising operational performance of VoLTE in a multi-vendor environment

VoLTE deployment is accelerating. Everyday, we meet or have discussions with people who are actively involved in bringing VoLTE services to market. While launching VoLTE is an important and time-consuming task, we have to ask, what happens then? Too often, the challenges of maintaining and supporting live VoLTE services becomes a secondary consideration. Happily, it's a major concern for us. Our customers that have launched VoLTE services switch modes, to provide active support, assurance, ensure that customers get the right experience, and more. In other words, they need to turn their attention to operational assurance issues.

This is an entirely new area. We've learned a great deal from our experience to date and we have collected a series of articles that discuss lessons we have gained from active, live VoLTE deployments. It covers a variety of topics and provides insight into key issues that we expect you will encounter and the steps needed to address them.

For example, it's well known that network outages have increased in recent years. The main contributory factors have been unprecedented user demands, faster network speeds and capacity constraints. Addressing this must require consideration of that fact that VoLTE is completely different from LTE. It introduces new elements, entities and interfaces. Further, it has higher performance requirements, meaning that it must deliver a different level of QoS than previous generations of mobile technology.

This is unprecedented. It's not just an evolution to LTE, it's something of a revolution.

What this means is that MNOs need to pay particular attention to factors such as 'mean time to repair' (MTTR). To reduce this to the minimum, MNOs must be able to perform tasks such as:

- Awareness – Identify the fact that a problem exists in your network.
- Root cause analysis – how do you determine the underlying cause of an issue?
- Problem resolution – what processes are necessary to rectify a problem?
- Active monitoring – how can you test to see if a problem has really been resolved and ensure that ongoing monitoring is performed in order to ensure that it remains fixed?

At the same time, it also means that MNOs must continually optimize their networks to ensure that they deliver performance when and where it is needed, so that they maximize revenues, enhance customer experiences (and hence loyalty) while simultaneously reducing costs.

Our experience is based on real deployments. We've seen these problems and we've helped MNOs to address them so that they can deliver optimized operational performance and a better customer experience.

Our expertise is built from doing the hard work both pre-launch and post-launch in operational mode. We want to share these lessons with you, so that you can benefit and identify key areas that you are likely to encounter and be prepared with ideas of how to address them.

Forewarned is forearmed! Read on to learn more.

How critical is VoLTE service monitoring for my company?

VoLTE is becoming a critical service for most operators in the US market from a business and customer experience point of view. Let me share with you a few examples.

The industry is still in the early days of VoLTE, and we can see how operators, network vendors and device manufacturers are still to this day facing the implementation of a new voice service that is not quite mature enough.

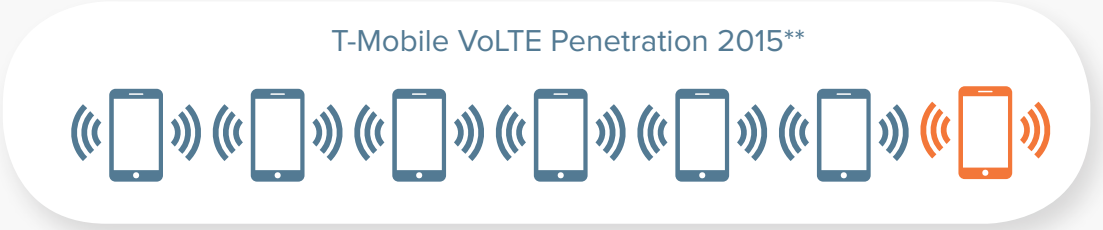
It requires an extraordinary level of reaction from testing and monitoring vendors, a very close collaboration with the players, and a natural evolution of existing tools to a new business in order to cope with these changes.

This is all in a market where Communication Service Providers need to manage relevant information related to customer experience in a few hours' time independently with the network architecture and vendors.

Hundreds, and even thousands, of network elements are involved in different domains, such as :

- Packet Switched Access Point (LTE, WiFi and Broadband)
- Circuit Switched for handover
- EPC
- IMS Core Elements
- Application Servers, for different services (voice, video, messaging, service continuity and supplementary services)
- Interworking with any voice service providers (PSTN, CS, VoIP, VoWiFi)

So, the monitoring system must be able to identify and isolate problems at every domain in order to assist the organization in solving an issue as soon as possible because the customer is being affected. Every component of domains are still evolving today, and they will continue to change even more dynamically in the upcoming months and years due to new technology strategies based on NFV



Nearly **40%** of voice calls in T-Mobile's network are transmitted via VoLTE

* - Source: http://www.dslreports.com/shownews/ATT-VoLTE-Available-to-295-million-Users-135975
** - Source:http://www.fiercewireless.com/story/t-mobile-nearly-40-percent-voice-calls-are-volte/2015-12-23

and SDN. Here I am not talking about counters, which of course provide very valuable information for a variety of purposes, but I am talking about information that can help me understand that the network is not working properly and that the end user is being affected. Some examples include:

- LTE Attach – can a dedicated bearer be established?
- Single Radio Voice Call Continuity (SRVCC) – is this available at 2G in a specific area? Is this affecting audio quality?
- Emergency Services – are these services, such as IMS Emergency Registration and VoLTE Emergency Voice Call, available?
- Are calls being forwarded to Voice Mail in case the terminating party is disconnected?
- If a terminated party is registered in a different network, can my customer make a call? Is my network negotiating properly with RTP configurations and codecs?

Device Independence

We also have the device angle. GSA confirms that there are 3,253 LTE devices, including LTE-Advanced, so we know that there are more than 200 VoLTE capable devices available. We also, however, are aware of the number of issues related commercial devices (GSMA's Network 2020 Issues Registry). One of the most common issues has been compromised audio as a result of the capacity required for the UE to manage the required number of speech frames in the incoming RTP Packet. This means that a device independent solution is needed in order to differentiate issues related to Network/Service and UE. There are important differences in terms of IMS clients in relation to customer experiences between devices/releases, so I can't see how a Service Monitoring system based on a limited number of smartphones can be relevant for measuring the availability and performance of a network.

We will examine issues of Isolation of Problems and Device Independence later in the document as both are crucial for managing the reliability of a network.

Next generation VoLTE service monitoring solutions

A VoLTE Service Monitoring Solution to Meet the Needs of Mobile Operators and Communications Service Providers

Looking back shows just how quickly technology moves. For example, it's surprising to consider that it's just 11 years since YouTube was founded – it's hard to imagine a time when the video-sharing app did not exist!

Gmail had just gone mobile, Vodafone and Microsoft linked up to offer a PC-to-Cell Phone IM Service, and 3 Hong Kong launched the world's first 3G video conferencing service with a TV commercial.

Likewise, mobile operators were still providing WAP services with data transmission speeds of up to 384 kbps (in the best case), and now we have widely available speeds of 300 mbps.

Technology moves fast. Unfortunately, many of the Testing and Monitoring products available for measuring end-to-end customer experience have not kept pace. Most were developed at the same time, driven by new content strategies such as WAP, Ringtones, MP3, Games, Streaming and SMS alerts.

That's why we've been collating feedback and suggestions from mobile operators over many years regarding their requirements for such a solution.

Here, at TEMS, we have used that data to evolve our TEMS Monitor Master, a VoLTE Service Monitoring solution, to cope with a whole spectrum of new requirements. Our evolved testing and monitoring product is now enabling Communications Service Providers to take advantage of its new capabilities.

We built certain components from scratch, while others were completely remodeled to provide a customer-centric approach based on Active Monitoring (discovering issues before customers do) and Passive Monitoring (reducing MTTR with Root Cause of Failure analysis).

I outline a summary of the components of our evolved solution, which have been specifically designed to meet the needs of communications service providers, based on what they have told us about their requirements:

- **TEMS Monitor Master**. Already an industry-leading testing and monitoring framework, specifically, for end-to-end service measurement, it can now be used for VoLTE Active Monitoring thanks to our new IMS Agent component that provides a robust, stable and agile way to perform test cases. It runs on a wireless or WiFi device, and on top of Hardware, Virtual Machine and Cloud infrastructures.

- **VoLTE Service Monitoring Test Case**s. Prior to this, there was no standard way of measuring and monitoring VoLTE-based services, so we defined a formal definition and implementation strategy to help the Operations team to solve a number of challenges, for example, whether issues are related to EPC, IMS or Application Server.

- **Device simulation.** The information provided by the Active Monitoring system must be relevant to the portfolio of devices available in the network (See: Previous page - How critical is VoLTE service for my company?). So it must be able to simulate different profiles in terms of network layers, such as Service, Network, Protocol, Access and Security. One of the biggest challenges is ensuring interoperability between different UEs to ensure that a call can be established between different device models and manufacturers.

- **Multi-bearer.** Of course, VoLTE occurs over LTE most of the time, but handover to CS and WiFi is also important for ensuring customer experience when subscribers are in transit. It requires the Active Monitoring system to support all bearers to ensure interoperability between CS and LTE domains, and when the subscriber is using a WiFi hotspot that is not under the control of the operator.

- **Multi-domain.** Access, EPC, IMS, Application Servers, and so on, require not only different technical approaches, but also different organizational methods. This means that each can act independently of each other and with different 'owners' in the Engineering and Operation groups. The Active Monitoring system must be able to monitor each area and all the Network Elements to be able to identify in real time those components that are causing availability issues or performance degradation.

- **Analysis of Root Cause of Failure.** The target here is to reduce MTTR (Mean Time To Repair) so the Operation Team needs a clear picture of how customers are being affected by the problem, and which element is causing it. This requires a combination of Active and Passive monitoring to provide in-depth analysis of how customer experience is being affected at any time of the day or day of the week. The component works by analyzing signalling that has been collected by a Passive Probing system or existing CDRs/Logs.
- **Reporting.** This is one of the most important aspects, as the system must be able to supply relevant, easy to understand, information to the right person. The dashboard accommodates multi-layered detail that allows administrators to drill down to increasing levels of detail. Here, contextual search is a powerful feature. Reports provide automated analysis, such as multi-domain metric comparison, to enhance understanding of service performance and true customer experience.

We have incorporated all of these components into our evolved solution in response to what Communication Service Providers have told us they require now and in the future.

Our aim is to help them to improve Customer Loyalty by controlling and ensuring Service Availability and Performance. The solution is proven and is already helping Mobile Operators to better understand problems and make the right technical decision.

In the coming pages, we will provide more detailed information on each of the features outlined here.

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If I already monitor LTE, am I good for VoLTE?

Not at all. We have heard several stories of mobile operators that put in place a monitoring mechanism for LTE very successfully in the past. But when they applied the same approach to VoLTE monitoring, unfortunately it didn't work, for different reasons that I am going to try to explain in this section.

The chart below shows the traditional two dimensions that Operators often use to measure how well their Network will deliver complex services.

There are a number of differences between the two. The following factors should help to identify these, and highlight ways that mobile operators can tackle the problem.

- **Service vs. Communication Channel.** VoLTE is a service that provides a set of functionalities, such as voice, video and messaging, on a packet-switched network. Conversely, LTE represents the channel between the network and the user equipment (UE). But communications service providers also use LTE to provide other services, such as video. At the same time, OTT players – such as Facebook, Google and Netflix, to name a few – use LTE in the same way. Both have the same priority (in terms of traffic) and in the latter case, the service provider is the OTT, so the operator doesn't have any responsibility for the application apart from securing the communication channel with "best effort" QoS.

- **Commitment vs. Best Effort**. Carriers have committed, with local and international regulators, to provide a voice call service inside and outside the country, now with the responsibility to deliver a clear audio experience to help people with hearing problems. On the other hand, there are no regulations or responsibilities applied to OTT applications from a service point of view. The only responsibility that operators have is to ensure a stable LTE channel between the UE and public internet.

- **VoLTE is about communication between people in real time.** Mobile subscribers can use VoLTE services to communicate with others who are on the same or different networks. OTT Application response can be delayed sometimes for a few seconds, but in my opinion this is a minor issue because it doesn't have

any impact in the customer experience. However, the same delay during a call has a big impact, even more so if it happens several times during the same session.

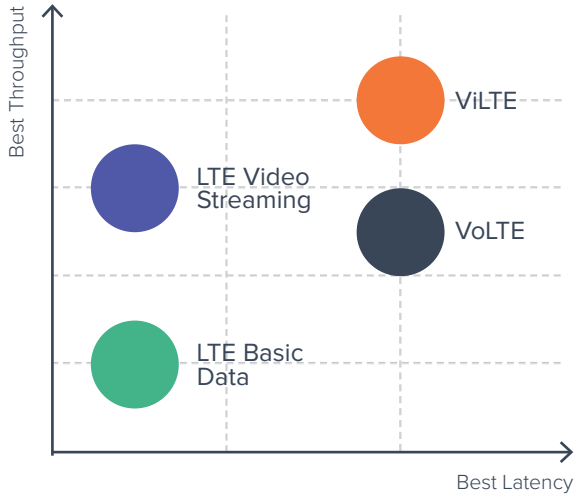
- **Network Elements and Interfaces**. A number of elements and interfaces are involved in establishing and maintaining an LTE tunnel between a device and the operator's network. All of these elements are also required for VoLTE but, in addition, it includes a very complex process to help the network cope with synchronization issues between subscribers involved in the service. The VoLTE service therefore requires the participation of several elements in the IMS and interconnection domains, together with a new set of interfaces. This can equate to more than seven different elements and 15 interfaces – just for a very simple use case.

As a result of these factors, combined with aggressive time to market and limited budget, mobile operators are facing unprecedented 'dark areas' in the network, where they have no information that allows them to fully manage the customer experience.

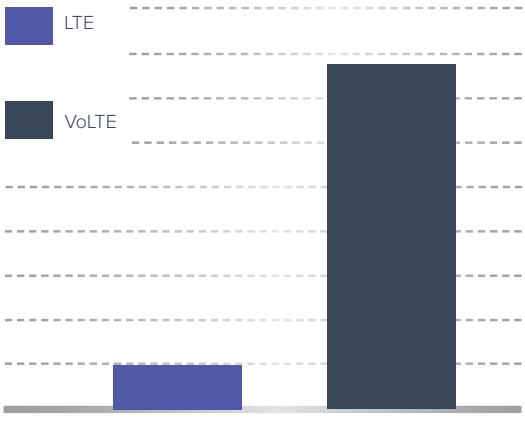
However, there are different mechanisms available for providing visibility even when there is no information collected from a Passive Probe, which produces logs/CDRs, or an Active Probe, which can measure end to end customer experience and the performance of each individual network domain and element.

Collecting information is a challenge that can be solved, but the analysis of high volume data is a real problem right now, so in the absence of probes one of my recommendations is to define a representative set of subscribers for observing their real experience and to adopt an Active Service Monitoring approach that can help to drive actions related to the service that's being provided.

The chart below shows the traditional two dimensions that Operators often use to measure how well their Network will deliver complex services.



GAP analysis between LTE and VoLTE.



Based on number of network elements and interfaces, amount of subscribers involved, synchronization and latency (both mandatory) in the case of VoLTE.

* - Source: https://www.linkedin.com/in/andrew-chisholm-72836b

Monitoring VoLTE customer experience

Here we pose a few questions relating to your current service monitoring capabilities. For example, was your current service monitoring system able to identify the last network outage you had?

If so, did it provide you with a generic message or was it specific enough to enable the Operations team to quickly identify and pinpoint the problem precisely? When we ask these questions, we always receive a lot of different responses – unfortunately, none of them were what the Business Unit was hoping to hear from the team in charge of the network or service.

Heavy Reading* research confirms that most CSPs feel that their networks are satisfactorily instrumented, with 67 per cent of CSPs surveyed believing they have adequate or good visibility into key network service quality factors. However, the percentage who considered they had excellent visibility – 16 percent – is still relatively small.

Network outages have been increasing significantly for the last few years, mainly due to the high demand of new services, faster speeds and greater capacity demanded by users.

This new orientation and a concern with ever-faster time to market causes numerous stability issues to many carriers, regardless of size and maturity level. As a result, the number of outages has increased by 200 per year since 2014, with the signs suggesting that it's going to be even higher this year, according to confirmed network outages so far.

I shared my opinion about monitoring differences between LTE and VoLTE in a previous section, and I would like to address in this post, the requirements of an Active Monitoring system that is able to identity Service Outages and reduce MTTR (Mean Time To Repair) on a pro-active basis.

The following list outlines some of the main recommendations for such a system:

Find issues before customers do. Performing test cases 24x7 from an end user point of view provides the opportunity to discover any problem or delay before customers do.

Customer experience requires controllable use cases. Use cases related to OTT services are much simpler in comparison with VoLTE, as I explained in my previous post, because the carrier is only responsible for securing the right LTE channel between the UE and OTT service provider. VoLTE to VoLTE, or SMSoIP to SMSoIP use cases, are also very generic approaches that can't be used to analyze the experience of customers using VoLTE-related services. Every use case must have a specific definition (signalling call flow) and implementation so that it can be measured and improved.

There are dependencies or scenarios that must be controlled independently of the VoLTE call itself, such as LTE Attach, IMS Entry Point Discovery, IMS Registration and IMS Subscription to Events. For instance, the Network provides the P-CSCF to be used to the UE during LTE Attach, which can create problems during calls if it is not the correct one, and the tool may end up reporting issues in the call that are false for this reason.

Dropped Calls is one of the most important metrics in the legacy domain, but today's technology offers the opportunity to redefine it in order to gain a better understanding of the problems that customers are facing. So in the case of a VoLTE to VoLTE call, for example, we can measure success rates for Call Setup Preconditions, Call Setup Resources Confirmation, Call Setup Alerting, Call Setup Answer, Audio Exchange and Call Release.

SRVCC is a very important aspect because customers are moving between LTE, CS and WiFi coverage areas, a common scenario that the network will need to manage perfectly. The system must be able to measure Handover and Audio Quality precisely and independently of the bearer in order to help the operator better manage customer loyalty and subscriber experiences.

Device Independent. It's simply not possible both in terms of logistics and budget to monitor the service with every different UE model and version, subscriber profile and at every different location. As a result, I strongly recommend using a very limited number of smartphones in order to have insight into customers, as well as a device independent probe that can perform end-to-end test cases and simulate any kind of device. By using this approach, CSPs can have a monitoring system that is truly representative in regards to the available portfolio of devices in their markets and have use cases available for customers. It's important to note that the number of capable

VoLTE devices is increasing every day (GSA confirms that there are 3,253 LTE devices currently).

Roaming. There is a very clear business case for a virtual device-based solution, because it's not possible at this point in time to use any real device for testing different networks so the industry requires a device that can be used for testing different configurations worldwide.

Audio Quality Measurements. First, the system must be able to measure digital audio (most of the systems available today use analogue audio, instead using external connections with the device) and, second, it needs to independently manage two audio channels per UE (RTP traffic from the UE to the network, and vice versa) in order to properly score POLQA. Today, every VoLTE solution measures POLQA MOS and metrics-related audio stream, but the most important thing is to confirm that this mechanism is based on digital audio and able to differentiate in/out streams.

Some Active Testing or Monitoring solutions can be too ambiguous. This means that the system detects a problem, such as 'VoLTE to VoLTE issue', and then the user needs to analyze manually where the issue is (isolation of issues), which can take, in the best case, a few hours during business hours. From an organizational aspect, network operations are divided into different groups, each with different responsibilities, such as eNodeB, EPC, IMS, Services, so the most important thing is that the system should be able to raise an alarm to the right team. For example, LTE Attach to eNodeB team, IMS Registration to IMS team and VoLTE call setup preconditions to the EPC team.

Networks are going to continue evolving rapidly in the coming years, which will increasingly lead to even more network outages. In my opinion, Network Operations or Service Assurance teams need to have real information about customer experience in relation to service availability and performance in real time, as well as detailed information that can be used to reduce, as much as possible, MTTR such as Isolated Test Cases, Service Steps, Metrics and information collected inside the network from the most relevant interfaces. The most important thing is that the team in charge of the operation of the live network realizes that these capabilities provide significant benefits to their daily job.

How to uncover hidden areas of your VoLTE network to deliver the customer experience you really want?

Engineering and operations teams, often hold two contrasting views of the network. First, there is the idealized view (**figure 1**) – something that represents the most reliable architecture, something that has been designed optimally for customers and which delivers the best service quality – but for which, crucially, budget is not an issue! It's a network you can love from the start, as it represents perfection and is fully under your control.

The second view (**figure 2**) is the reality. It reveals what you can really control and the information that is available to you for measurements that provide insight into performance and troubleshooting. There is a huge gap between the two. The clear goal is to try to align the two and use the right approach to ensure we get closer to the idealized view.

Here, our challenge is how can we Identify a problem inside the network that is affecting a customer?

We need to determine if problems that are detected in the network are really correlated with issues that are observed from the customer perspective. There are a number of hugely important factors that must be considered in order to provide an appropriate response to this challenge to your organization. These include:

Multi-site environment. Services involve elements that are hosted in different locations, so it's essential to protect the functionality and performance of the transport layer between centers.

Network Interfaces. There are 28 different network interfaces that are implicated in a multi-bearer VoLTE call. These span different domains, such as CS and PS, User, and Network to Network interfaces for interoperability with other operators. To make matters worse, there are different functional and technology areas such as RAN, EPC, IMS, and Application Servers.

Network Elements. At least 10 different components are required to participate in a very simple VoLTE voice call. Of course, there is also high availability and redundancy designs that help to assure the use of services but, at the same time, these precautions make troubleshooting activities more complicated.

Subscriber databases. Three mandatory databases (HLR, HSS and PCRF) must be synchronized in order to avoid service issues, and these also have to provide with information related the subscriber to any Network Element. The information must be properly provisioned in order to avoid failures that affect individual customers: these kind of results should be properly considered in order to differentiate service from provisioning issues.

This is the non-ideal, real world view and is the result of budget constraints that impact us all. Money, time and resources – delivering everything our engineering friends would like is simply impractical. The result is a huge gap in our coverage, a dark area, that impacts the user interface and more - the EPC and EPDG related Voice services; Application Servers, such as TAS and SCC AS; interoperability with legacy domains and other carriers; and a host of questions that relate to issues that affect individual services as opposed to overall service quality issues.

Worse, all of this must now be considered alongside the deployment of complex CEM systems, hungry for data, which demanding the collection of signaling from yet more interfaces in order to deliver on their promise – but which also dramatically increase the cost of implementation.

It's clear that the management of Customer Experience, using information collected from the Network, requires an enormous amount of money, time and resources. As a result, it will take a long time before you can see the

28
Different network interfaces in a VoLTE call

10
Network components in VoLTE call set up

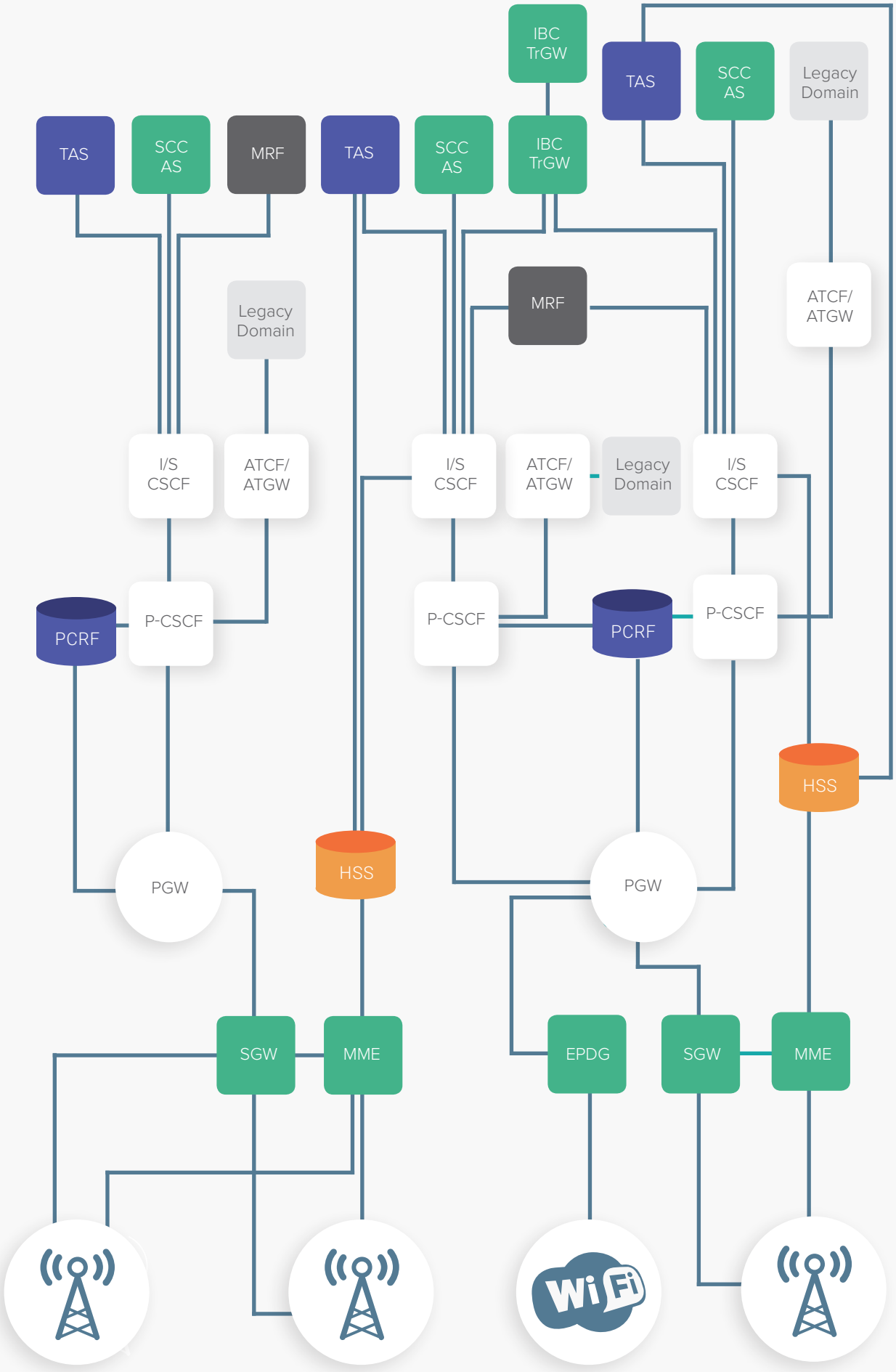


Figure 1: Idealized view of a very simple network

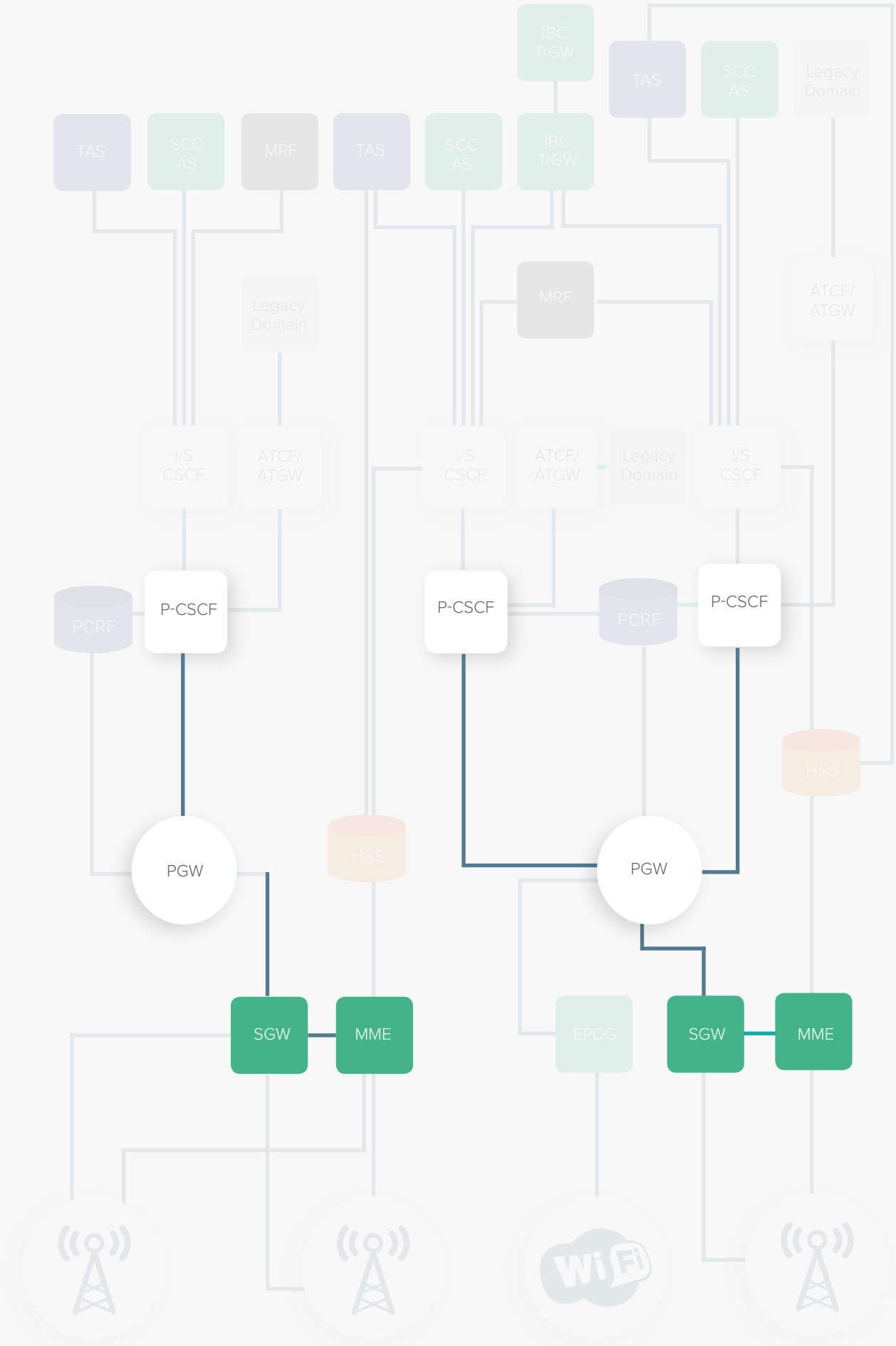


Figure 2: Realistic network view

benefits of these investments when problems occur with new services such as VoLTE, VoWiFi or RCS. The gap between fantasy and reality seems to be growing!

But what if we switch focus? What if we can change our perspective to think about challenges from the perspective of the customer right from the start? In other words, how can identify a problem from the perspective of the customer and its cause?

Well, we can. Such a focus is based on the combination of active monitoring and passive results. We can do this today. To do so, we need to consider the following:

- That the definition of test cases must be solid. A full implementation of signaling call flows is required in order to know exactly interfaces and systems are involved.
- That there is a correlation between Location - Test Case – Step that is extremely useful for automated analysis inside the Network.
- Analysis from within the Network can be achieved using information from passive probes, CDRs, logs, or Active Agents in different Network Domains.
- Provision of real facts in real time about how many customers can be affected.

VoLTE customer experience and service monitoring - the perfect combination for an active monitoring strategy

When we consider strategies for monitoring, there are two key questions that spring to mind. First, how does the network behave in terms of reliability and performance? Second, how does a customer experience this behavior? In other words, we must consider both service monitoring and customer experience monitoring.

Service Monitoring needs to be independent of user devices, because its primary focus is to identify errors and delays that may impact a specific service. As a result, it means that the monitoring system in question should be able to interact with the network and analyze every response independently of every other. In the event of an error, it must deliver accurate information to the operations center and network alarm system, and then rerun the same test cases to detect further errors.

Of course, the alarm system must be able to manage active alarms and frequent updates, so that accurate information is delivered to the operations team. Similarly, alerts need to be sent such that triggered alarms are deactivated as soon as the test case is performed correctly.

For example, in the event of a severe incident, such as an outage of a P-CSCF node, the monitoring system should automatically attempt to repeat the relevant test cases. Even if the P-CSCF returns to service, tests should be repeated in order to measure its reliability and performance. This helps the troubleshooting team to focus on elements that fail most frequently.

On the other hand, Customer Experience Monitoring requires a device centric approach, including the ability to simulate devices. This is because customers experience services through devices and, therefore, to measure their real experiences, we must be able to factor in devices, irrespective of any network issue.

Again, it means that the monitoring system should be able to interact with the network and analyze every response independently. However, in the event of an error, the system should behave differently. To use the same example of the P-CSCF as before, the system should be able to send alerts and requests to a different P-CSCF or provide other feedback, according to the high availability or reliability strategy implemented within the network. Early detection and Device simulation modes are different techniques for each of the approaches. Early detection relates to Service Monitoring, while Device simulation to Customer Experience or End to End (from one device to another) monitoring.

Both modes are key elements of an Active Monitoring strategy and are required for an accurate, optimized monitoring program that, in combination with automated analysis of information within the network, can provide an invaluable system for the operations group, enabling them to focus on the most relevant problems before and during an outage.

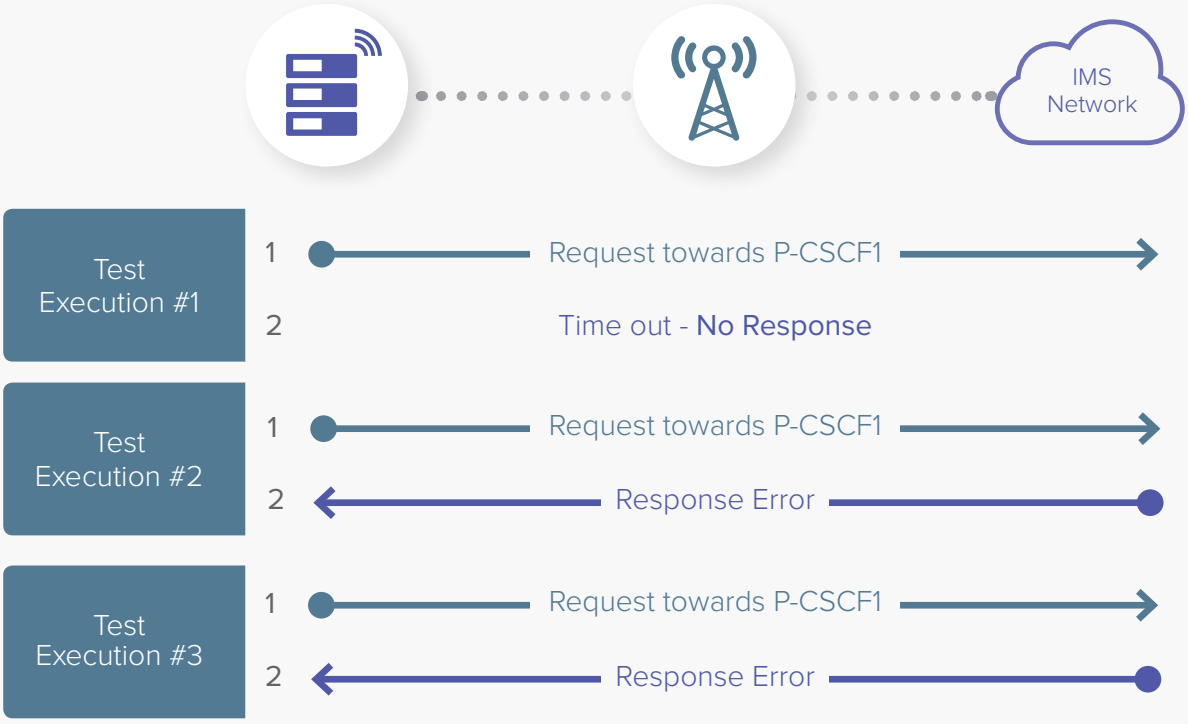


Figure 3: Early detection mode for service monitoring

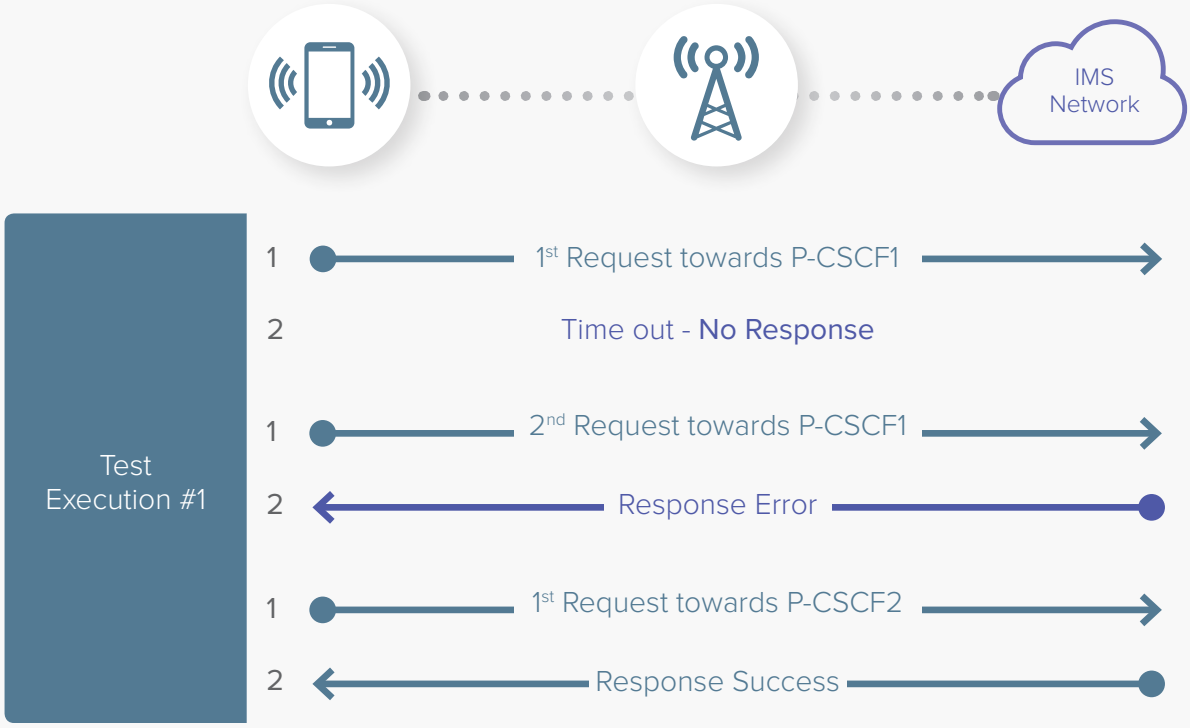


Figure 4: Real device or Device simulation mode

VoLTE multi-layer monitoring

While Functional monitoring is important in complex networks, it's even more so when there is a multi-layer and multi-vendor environment. A functional monitoring system should be able to help engineering teams assure that each element in the network is performing correctly.

In other words, doing the job for which is designed, as we noted on page 4 ("How critical is VoLTE service for my company").

A complex, service, such as VoLTE is composed of many critical, functional elements, each of which has its task to perform. There are so many aspects to validate and verify!

- **LTE Attach:** Can a dedicated bearer be established?
- **SRVCC (Single Radio Voice Call Continuity):** Is it available over 2G/GSM in a specific area? How does it affect audio quality?
- **VoLTE to CS handover:** Are the preconditions for voice calls available in a the context of VoLTE to CS handover? How does this affect audio quality?
- **Emergency services:** Are IMS Emergency Registration and VoLTE Emergency Voice Calls available?
- **Voicemail:** Are calls forwarded to voicemail in cases in which the called party is disconnected?
- **Inter-network connectivity**: If the called party is registered in a different Network, can my customer make a call? is my network correctly negotiating RTP configuration and codecs?

Counting requests with Deep Packet Inspection (DPI) solutions provides useful information for analysing demand on each of the elements. Signaling analysis also provides important information for troubleshooting individual subscriber complaints.

However, a service-oriented, functional approach, in addition to such counters and call traces, is required for providing an overall supervisory service truly aligned with business needs. Such an approach is mandatory for today's Communication Service Providers, due the fact that network quality has the highest impact on Customer Loyalty. Active agents that can perform service and functional testing are required.

This example shows an active Agent placing VoLTE calls towards a specific System Under Test (P-CSCF, PCRF and MRF). The idea is that engineering teams can setup Virtual Subscribers at different locations within the network and can measure the availability and performance of each element for a particular service scenario, such as IMS Registration, VoLTE Voice Call, SMS, and so on.

Remember, hundreds and even thousands of network elements are involved in different domains such as:

- Packet Switched Access Point. LTE, WiFi and Broadband
- Circuit Switched for hand-over
- EPC
- IMS Core Elements
- Application Servers for different services. Voice, Video, Messaging, Service Continuity and Supplementary Services
- Interworking with any Voice Service Provider. PSTN, CS, VoIP, VoWiFi

Multi-layer monitoring can also help accelerate time to market, ensuring that the Agent in charge of service and functional supervision can be up and running in a very short period of time, with the result that valuable information can be more quickly collected.

Virtual infrastructure is the basic requirement for this approach. With a virtual infrastructure, Agents can be dynamically deployed across the network for controlling different network domains and elements. Such Agents, a key new software component, will play a critical role in the evolution of networks to SDN and NFV. It allows scale up and down, based on actual needs.

We offer a complete portfolio of solutions that covers end-to-end Quality and Service Assurance throughout the entire lifecycle of networks. Solutions to help you reduce time-to-market, lower OPEX and CAPEX, optimize performance, and ultimately, win and retain more customers.

We're here to help. If you want to know more, please get in touch and we'll work with you to find a solution. Together, we'll make VoLTE a success for you, from deployment to in-service assurance and operation.

	Trial	Soft Launch	Commercial Launch	Life Cycle	Local Inter-connect Launch	Roaming Launch
	Purpose: Is the service ready to offer to customers?	Purpose: Is the organization ready to offer to this service?	Purpose: Revenue and customer loyalty monitoring	Purpose: New Services and service/ capacity optimization	Purpose: In-country ubiquitous service	Purpose: Worldwide universal service
	Target: Friendly customers	Target: Customers in a specific region	Target: Different customer segments	Target: Different customer segments	Target: Different customer segments	Target: Different customer segments
Customer Experience - 1st Stream	**Active Agents**	**Active Agents**	**Active Agents**	**Active Agents**	**Active Agents**	**Active Agents**
Network Domain:	RAN	RAN	RAN	RAN	RAN	RAN
Locations:	1	2-3 in important cities	At a relevant city with high revenue or VIP customers	2-3 in most important cities	1-2 depending on frequency results	At any relevant country with large revenue or high-value VIP customers
Mode:	Device simulation, 1 or 2 different devices	Device simulation, 1 or 2 different devices	Device simulation, 1 or 2 different devices	Device simulation, 1 or 2 different devices	Device simulation, 1 or 2 different devices	Device simulation, 1 or 2 different devices
Test Cases:	Basic use cases	Critical use cases	Critical use cases	Critical use cases	Critical use cases	Critical use cases
Purpose:	Identify the fact that a problem (availability or performance) exists in the network in relation to each of the use cases/ devices available	Identify the fact that a problem (availability or performance) exists in the network in relation to the most critical use cases/ devices/ locations	Identify the fact that a problem (availability or performance) exists in the network in relation to the most critical use cases/ devices/ locations	Identify the fact that a problem (availability or performance) exists in the network in relation to the most critical use cases/ devices/ locations	Identify the fact that a problem (availability or performance) exists in the network in relation to a specific interconnection service	Identify the fact that a problem (availability or performance) exists in the network in relation to the most critical use cases, devices and visited networks
Alarms:	None required	As soon as the Agent identifies a problem. Critical use case - device - location	As soon as the Agent identifies a problem. Critical use case - device - location	As soon as the Agent identifies a problem. New Use case - device - location	As soon as the Agent identifies a problem. Critical use case - device - location	
Customer Experience - 2nd Stream	**Active Agents**					
Network Domain:	RAN					
Locations:	1					
Mode:	Device simulation, 1 or 2 different devices					
Test Cases:	Non-critical use cases					
Purpose:	Identify the fact that a problem (availability or performance) exists in the network in relation to the most critical devices					
Alarms:	As soon as the Agent identifies a problem. Non-critical use case - device - location					

		Trial	Soft Launch	Commercial Launch	Life Cycle	Local Inter-connect Launch	Roaming Launch
Service Monitoring - 1st Stream			**Active Agents**	**Active Agents**		**Active Agents**	**Active Agents**
	Network Domain:		P-CSCF	RAN		RAN	RAN
	Locations:		For each EPC	At a relevant city with high revenue		1-2 depending on frequency results	1-2 depending on frequency results
	Mode:		Early detection	Early detection		Early detection	Early detection
	Test Cases		Critical use cases	Critical use cases		Critical use cases	Critical use cases
	Purpose:		Identify the fact that a problem (availability or performance) exists in a specific P-CSCF in relation to the most critical use cases/devices	Identify the fact that a problem (availability or performance) exists in the network in relation to the most critical use cases/ devices/ locations		Identify the fact that a problem (availability or performance) exists in the network in relation to a specific interconnection service	Identify the fact that a problem (availability or performance) exists in the network in relation to a visited network
	Alarms:		As soon as the Agent identifies a problem. Critical use case: P-CSCF	As soon as the Agent identifies a problem. Critical use case - device - location		As soon as the Agent identifies a problem. Critical use case - interconnection service	
Service Monitoring - 2nd Stream			**Root Cause Analysis**		**Root Cause Analysis**	**Root Cause Analysis**	**Root Cause Analysis**
	Network Interface:		Gm (SIP), Gm (RTP), S11, Gx and Rx		Gm (SIP), Gm (RTP), S11, Gx and Rx	AGm (SIP), Gm (RTP), S11, Gx and Rx	Gm (SIP), Gm (RTP), S11, Gx and Rx
	Subscribers:		Active Agents in RAN domain		Active Agents in RAN domain	Active Agents in RAN domain	Active Agents in RAN domain
	Purpose:		Determine the underlying cause of the issue		Determine the underlying cause of service degradation	Determine the underlying cause of interconnection issue	Determine the underlying cause of roaming domain issues
Device Stream			**Active Agents**			**Active Agents**	
	Network Domain:		RAN				
	Locations:		1-2 for each network vendor			1-2 depends on frequency results	
	Mode:		Device simulation, all different devices and combinations			Device simulation, all different devices and combinations	
	Test Cases:		Cases relevant to device interconnection			Cases relevant to device and operator interconnection	
	Purpose:		Identify the fact that a problem (availability or performance) exists in the network in relation to a specific device			Identify the fact that a problem (availability or performance) exists in the network in relation a specific device and interconnection service	

KNOW YOUR NETWORK™

About Infovista

Infovista, the leader in modern network performance, provides complete visibility and unprecedented control to deliver brilliant experiences and maximum value with your network and applications. At the core of our approach are data and analytics, to give you real-time insights and make critical business decisions. Infovista offers a comprehensive line of solutions from radio network to enterprise to device throughout the lifecycle of your network. No other provider has this completeness of vision. Network operators worldwide depend on Infovista to deliver on the potential of their networks and applications to exceed user expectations every day. Know your network with Infovista.