



Delivering Quality
VoLTE services



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Table of Contents

Introduction.....	4
VoLTE benefits for operators.....	5
VoLTE challenges	5
Delivering end-to-end voice quality.....	5
Detecting one-way calls or mute calls.....	5
Measuring the Call Drop Rate.....	6
Correlating the network data in real-time.....	6
Monitoring Single Radio Voice Call Continuity (SRVCC).....	6
Ensuring Circuit-Switched Fallback (CSFB) functionality	6
RADCOM Network Intelligence for VoLTE	7
Online and Historical Call Tracing	9
Rule-Based Correlation (RBC).....	10
In-depth packet analysis for the cloud-native environment	11
Enabling full decode of captured packets	12
Supported Codecs and Protocols.....	13

Introduction

Voice over LTE (VoLTE) enables operators to offer customers higher quality voice services in an all-IP network, evolving their traditional voice services carried by 2G and 3G networks into the 4G and 5G era. Voice over Wi-Fi (VoWiFi) enhances this offering by enabling operators to offload traffic to lower-cost Wi-Fi networks and utilize the wired network to supplement network coverage within buildings to improve customer satisfaction.

By playing to their network strengths and delivering an end-to-end VoLTE and VoWiFi service, operators provide customers a clear and superior voice experience over other OTT offerings. VoLTE and VoWiFi create new revenue opportunities, enabling operators to compete in a fiercely intensive market environment.

Over 270 operators across 119 countries have already commercially launched VoLTE HD services worldwide, with over 2.1 billion VoLTE subscribers already enjoying the benefit of these services. These numbers are projected to reach over 5 billion by the end of 2023 and 6.4 billion by the end of 2025. Current VoLTE services are delivered by an IP Multimedia Subsystem (IMS) that provides the control (call setup, management, and voice applications) environment for VoLTE through an LTE access network. In June 2018, 3GPP standardized that IMS will be the foundation for enabling 5G voice calls, so VoLTE is the future delivery platform for voice services on 5G (Vo5G).

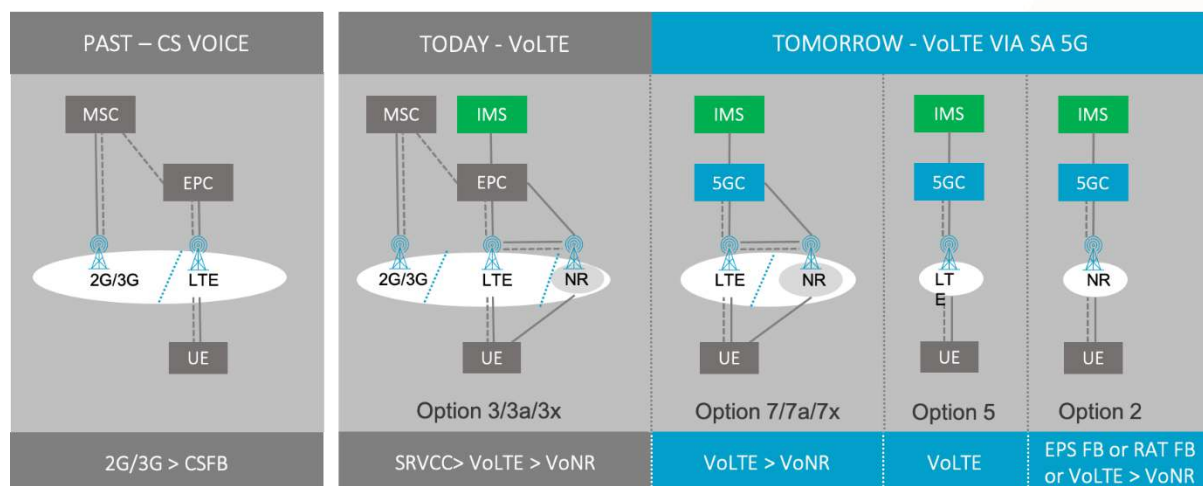


Figure 1 - Progression from VoLTE to Vo5G

VoLTE services include HD voice, Wi-Fi calling, HD voice+ (with improved voice quality, and music within calls utilizing the Enhanced Voice Services codec as well as messaging applications in which you can share content during a call and an extension of VoLTE. This enhances voice services with a high-quality video channel known as Video over LTE (ViLTE). Future services are expected to be such things as augmented reality (AR) and virtual reality (VR) for teleconferences.

VoLTE benefits for operators

- Provides customers with a rich, all-IP carrier-grade voice service that enhances the customer experience and increases brand loyalty
- Improves voice call quality, network access and reduces latency, leading to increased customer satisfaction and usage
- Sustain ARPU through the introduction of enhanced call quality, voice performance, and new services
- Offer customers Wi-Fi offloading to free up bandwidth and utilize the wired network to increase customer network coverage and customer satisfaction

VoLTE challenges

While the Quality of Service (QoS) ensures that VoLTE services are delivered with the telecom-grade quality, a typical VoLTE call straddles numerous network nodes, functions, and domains. From the complexity of a call set up to ensure the core network is providing the expected performance, VoLTE has multiple dependencies and failure points. So, operators need to deploy end-to-end service assurance that monitors and analyzes the entire call flow to prevent VoLTE service degradation.

Some common VoLTE challenges for operators include:

Delivering end-to-end voice quality

One of the main advantages of VoLTE is the higher audio quality, which is enabled by wideband AMR technology that doubles the voice bandwidth to almost 7000 Hz. Radio has a significant influence on the voice quality, and in the event of Radio loss, there will be a spike in the drop call rate. Operators require real-time assurance solutions that can measure the end-to-end voice quality from the handset to the network core to ensure continuous high-quality service delivery to customers.

Detecting one-way calls or mute calls

One-way calls or mute calls occur when there is packet loss or bearer disconnection, which influences the R-factor and leads to no packets flowing in one direction. This causes a loss of voice from one side of the call for a period of time. Detecting these types of malfunctions requires the operator to correlate the UL and DL RTP streams as well as packet loss and jitter, which are calculated together to analyze the duration of the minimum PMOS.



Figure 2 - One-way packet flow

Measuring the Call Drop Rate

Dropped calls, when one user appears to have disconnected, is one of the critical KPI's for operators measuring service quality. Typically, a dropped call occurs when there is an RTP/ RTCP timeout message, which is the result of one user not being able to detect the RTP for between 10-30 seconds. The Call Drop Rate may increase as a result of poor Radio conditions. Consistently measuring the Call Drop Rate will help catch any spikes that occur and pinpoint degradations in the Radio quality for real-time troubleshooting.

Correlating the network data in real-time

With the many protocols to consider, such as SIP, DIAMETER, DNS, RTP, RTCP, H.248, etc. real-time correlation is key to analyzing VoLTE services and monitoring the overall VoLTE customer experience.

Monitoring Single Radio Voice Call Continuity (SRVCC)

SRVCC seamlessly maintains voice calls when a subscriber is handed over from LTE to a 2G or 3G network; it is, therefore, crucial for preserving voice services as operators extend their VoLTE coverage. However, SRVCC is exceptionally complex and spans multiple network elements and is challenging to monitor.

Ensuring Circuit-Switched Fallback (CSFB) functionality

Circuit Switched FallBack (CSFB) enables the delivery of voice services to LTE devices using a CS network. LTE is a packet-based all-IP network that cannot support circuit-switched calls when an LTE device is used to make or receive a voice call the device "falls back" to the 3G or 2G network to complete the request. Monitoring CSFB is critical for operators to ensure their VoLTE services.

RADCOM Network Intelligence for VoLTE

RADCOM Network Intelligence is a fully cloud-native solution that has been selected by Tier one operators globally to ensure the quality of VoLTE deployments. RADCOM Network Intelligence delivers full network visibility to the VoLTE customer experience and an end-to-end view across multiple technologies. This perspective allows operators to pinpoint issues in real-time, rectify problems that affect service quality, and monitor the entire network from the RAN to the Core.



Figure 3 - RADCOM monitors end-to-end VoLTE services

RADCOM Network Intelligence correlates end-to-end VoLTE sessions (from LTE session establishment to SIP session termination) with SIP signaling analysis and multimedia quality measurements based on RTP/RTCP protocol analysis such as perceptual MOS (PMOS), jitter, packet loss, and R-factor. Delivering network insights that span engineering, quality assurance, and customer care, the operator can bring down silos and offer a unified approach to assuring VoLTE services.

From engineering tools (online and historical call tracing, in-depth protocol analysis), up to cell analysis, and VoLTE service dashboards for Network Operations Centers, RADCOM lets operators keep a finger on the VoLTE service pulse.

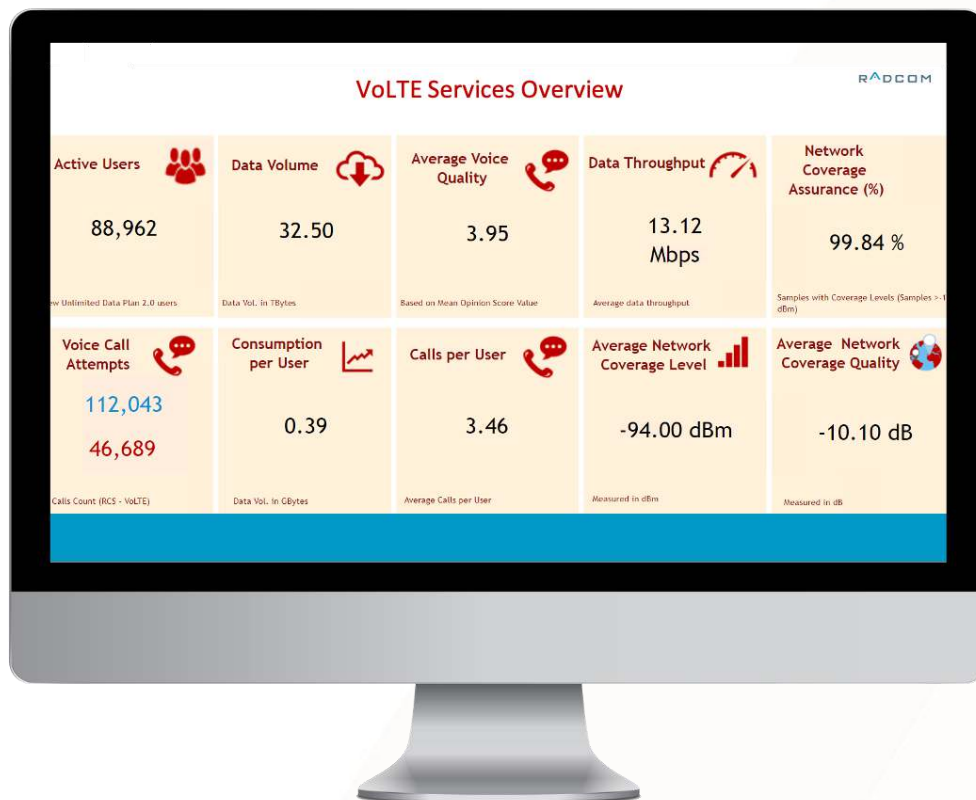


Figure 4 - Monitoring VoLTE service quality in the NOC

RADCOM Network Intelligence efficiently monitors VoLTE and VoWiFi service quality to provide operators with the following capabilities:

- Correlate the end-to-end VoLTE customer experience with network, device, cell and service performance in real-time
- Call establishment process analysis to inspect bearers and QCI
- Present network element issues on a map with quick drill-downs to KPI analysis over time, and easy analysis of other related KPIs
- Cross-protocol visibility into the call to ensure all call legs including signaling, subscriber registration, identification, authentication, policy and charging, networks interconnectivity and others, all function correctly
- Real-time traffic analysis to examine calls as they take place using versatile call trace filtering
- Historical calls records to inspect traffic disturbance events, screening by signaling information, QoS, Subscriber information, legs information and dozens of other filtering capabilities
- End-users' perceptual voice call quality – P-MOS, R-Factor, packet loss and jitter to ensure VoLTE service customer satisfaction
- Multiple KPIs for optimizing the network performance for VoLTE such as worst performing elements, low performing functions using continuous calls and signaling analysis overtime, network-wide performance insights
- Support for advanced HD codecs such as EVS (Enhanced Voice Services) to gain visibility into the complete VoLTE service offering

RADCOM Network Intelligence detects and classifies the different flow types within the operator's VoLTE and IMS service offerings by creating correlated sessions and using them for KPIs. With full visibility into the entire service and network performance, operators can better understand areas that need to be optimized. Flow-type classification can also be used to segment flows within the network and the IMS core to provide crucial key performance indicators (KPIs) for proactive troubleshooting and network planning.

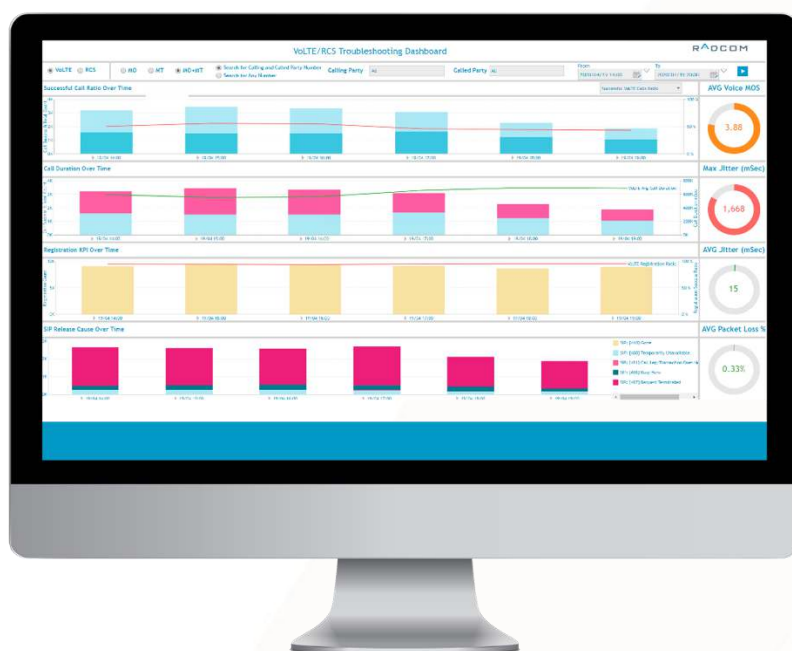


Figure 5 - Troubleshooting VoLTE services using RADCOM Network Insights

Online and Historical Call Tracing

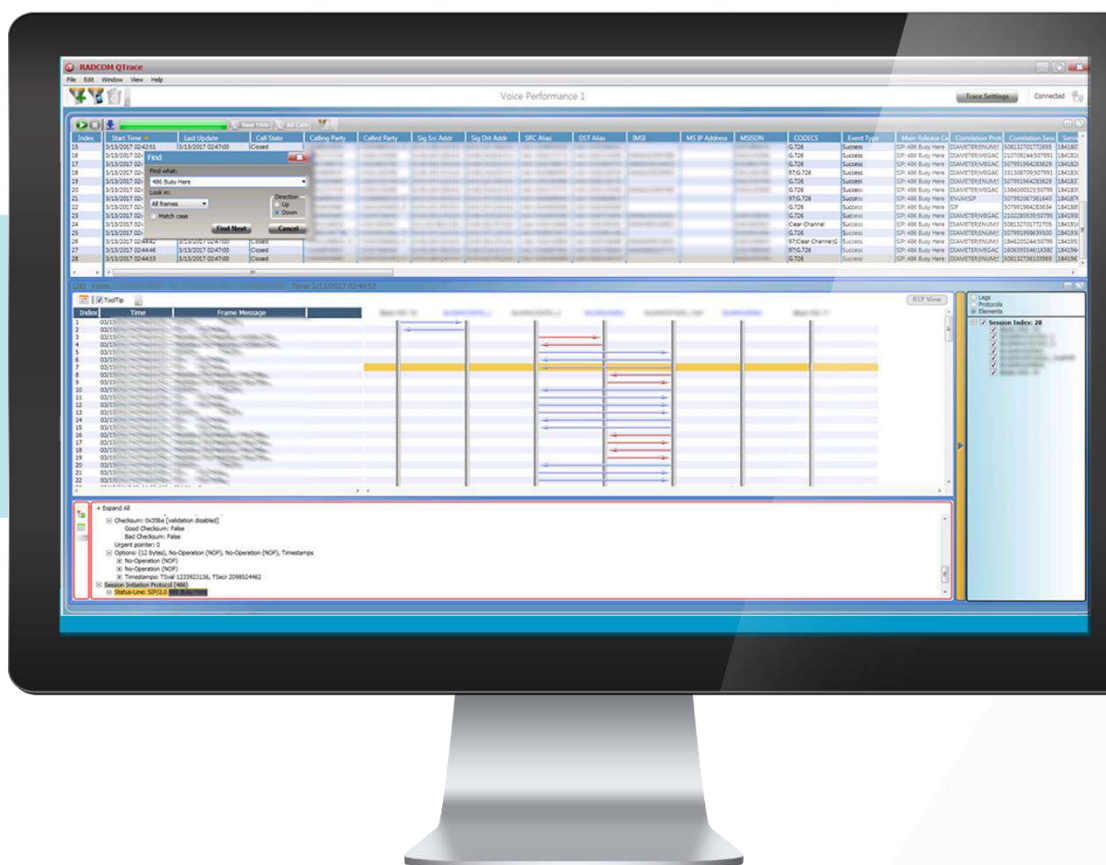


Figure 6 - Analyzing VoLTE using RADCOM's call tracing application

RADCOM's session-based, call tracing application, RADCOM Session Analyzer, is used for detailed network analysis with any combination of flexible filters, providing an end-to-end correlated view of the subscriber or network sessions for root cause analysis and quick resolution of issues.

RADCOM Session Analyzer provides a graphic diagram of a subscriber's call/data session or link in the network and lets a user perform a detailed analysis of signaling procedures, including full decoding of messages.

An end-to-end signaling ladder is provided for all IMS, VoIP, SMS over IP and video sessions. For VoLTE, end-to-end correlation is applied to combine all the various legs comprising the voice, SMS, or video session from the LTE radio interface to the IMS core. This correlation applies to net IMS sessions as well as interoperability with legacy networks and LTE 3G fallback (SRVCC/eSRVCC).

Analysis can be performed in real-time and on historical data covering each subscriber's interactions with the network.

RADCOM Session Analyzer enables an operator to:

- Trace end-user calls or data sessions to facilitate customer support
- Advanced filtering for subscriber calls/sessions combined with a user-friendly GUI to pinpoint the source of any network problem quickly
- Perform sophisticated search filtering, containing multiple criteria, narrows the range of query responses and reduces troubleshooting time
- Correlate full voice and data sessions in real-time for comprehensive troubleshooting
- Record voice calls for lawful interception or quality testing
- Run real-time call traces in parallel to probe monitoring
- Improve VoLTE/VoWiFi call quality with end-to-end troubleshooting
- Save data as PCAP/HTML/XSIF formatted files for detailed troubleshooting of control plane and user plane traffic
- Analyze at the packet level with the RADCOM's protocol analyzer

Rule-Based Correlation (RBC)

Using RADCOM Session Analyzer, Rule-Based Correlation can be run on demand and provides operators with a flexible approach for Intra and Inter-protocol correlation, such as conference calls, call hand-overs (SRVCC, eSRVCC), call forwarding and call waiting as well as additional customizations per operator.

The RBC process queries the CDRs in the database while implementing a pre-defined logic based on particular “rules” that enable the new correlation to form. Rules can be added, “on the fly” and be defined to run automatically (if required), when the user clicks on a CDR the full signaling is displayed.

RADCOM Network Intelligence provides an end-to-end view of VoLTE services enabling operators to focus on critical service-affecting issues and prioritize accordingly quickly. RADCOM's VoLTE service dashboard with the ability to drill down in seconds using an integrated call tracing application to an individual subscriber or session provides the operator with root cause analysis and quick time to resolution to maintain high VoLTE service quality whatever the demand.

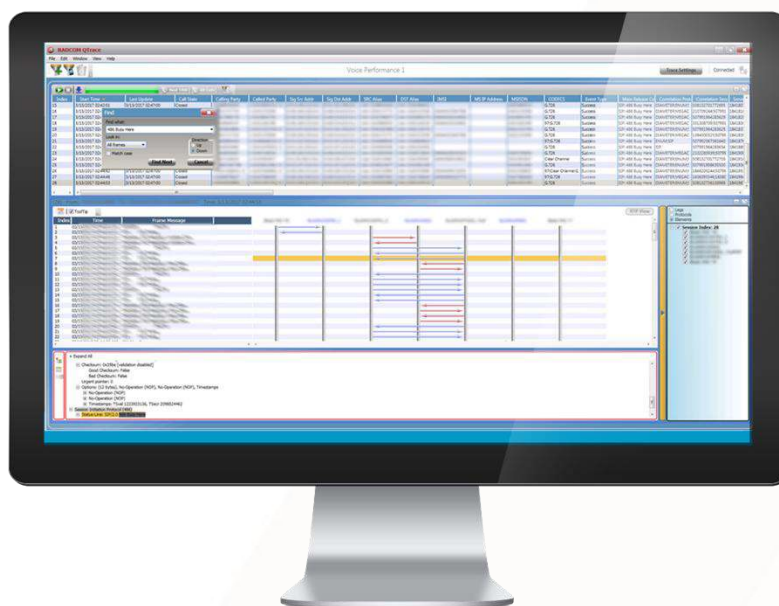


Figure 7 - Performing root cause analysis to optimize VoLTE services

In-depth packet analysis for the cloud-native environment

Due to the significant network changes taking place with operators transitioning to cloud-native architectures, low-level tools such as packet-based protocol analyzers are a must-have solution. They are becoming more and more critical for engineers who want to troubleshoot and optimize underlying network issues, debug new services, and view the health of network links between nodes.

Typically, packet-based protocol analyzers capture data at the engineer's current location. However, RADCOM's cloud-native solution, RADCOM Packet Analyzer, brings protocol analysis up to date by enabling an engineer to capture raw data from across the entire network (by region or a specific network probe) while supporting multiple users and providing both live capture and offline analysis of all network traffic.

By using RADCOM Packet Analyzer, engineers can view any packet flowing through the network for any selected subscriber or time span and can produce a full user- plane PCAP trace that is perfect for drive testing new technology roll-outs and in-depth troubleshooting.

With RADCOM Packet Analyzer's seamless integration into RADCOM Network Insights, an engineer can quickly drill down with a click of the mouse from RADCOM's Customer Care applications that monitor the overall VoLTE service quality to in-depth root cause analysis at the packet-level. RADCOM Packet Analyzer also integrates seamlessly with RADCOM's session-based, call tracing application, RADCOM Session Analyzer that enables an engineer to troubleshoot individual calls.

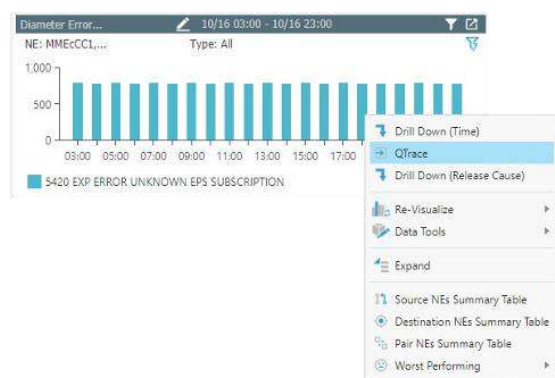


Figure 8 - Drilling down from RADCOM's NOC application to RADCOM's call tracing application

Enabling full decode of captured packets

RADCOM Packet Analyzer is used to monitor traffic at all levels, both call/session-related and non-call/session-related, as well as online or historical data, with all protocols displayed in a single view. Operators can filter protocol data separately or in combination with network element ID, transport layer parameters, protocol types, and additional filters such as IMSI and MSISDN. Users can then view a full decode of the captured frame, search and filter by any field and save the trace results for further analysis. In historical mode, RADCOM Packet Analyzer can be used to filter traces of any existing protocol that transverses an operator's network.

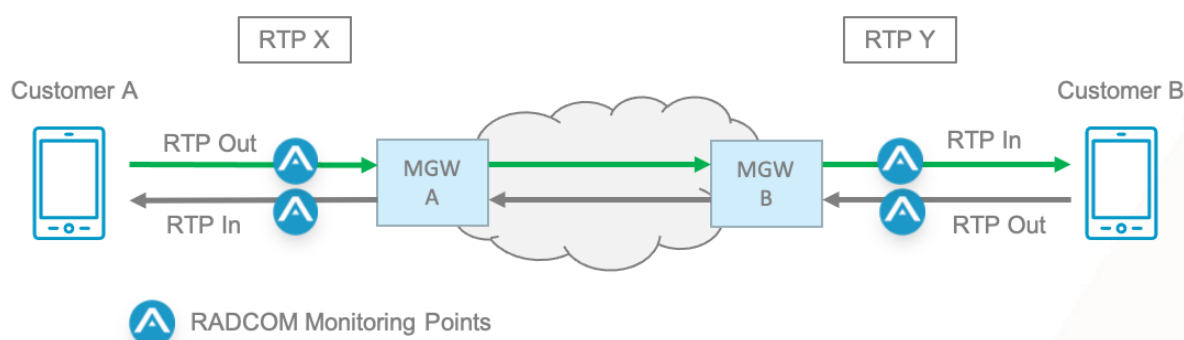


Figure 10 - RADCOM's Voice Quality Inspection Methodology

RADCOM Packet Analyzer enables operators to:

- Perform in-depth protocol analysis at the raw data level
- Proactively identify and resolve issues
- Drill down into any network element, protocol or message type
- Smartly capture filtered raw packets that are currently being transmitted through the network or in historical data

RADCOM Packet Analyzer extracts what is needed from the source, with the smart capture of filtered raw packets. It uses in-depth and flexible protocol analysis on the raw data level, covering any protocol type and traffic type, troubleshooting network elements at the function level, reference point, or interface level of the protocol.

Supported Codecs and Protocols

IMS:

DIAMETER, DNS/ENUM, H.248, HTTP, HTTP(s), LDAP, RTP, RTCP, SIP, SIP-I, SIP-T, SIPoIPSEC, sRTP, XCAP/ HTTP

VoLTE-EPC:

DIAMETER, GTP-C, GTP-U

Mission-Critical Communications (MCC):

Support MCPTT, MCVideo, and MCDData

Codecs:

AMR-NB, AMR-WB, EVS (NB/WB/SWB/FB), G.711 – (A/u-law), G.722, G.722.1, G.722.2, G.723.1, G.726, G.728, G.729 (A/B), G.729.1, GSM Full Rate (FR), GSM Enhanced Full Rate (EFR), GSM Half Rate (HR), iLBC, Opus, Siren, Speex

Voice quality engine

RADCOM's voice quality engine for VoLTE and VoWiFi uses an extended ITU G.107 E-model. The Perceived Mean Opinion Score (PMOS) engine adds the effects of loss bursts and burst recency in addition to the traditional E-model parameters.

By providing a voice quality measurement that is closest to a subscribers' perceived quality (R-Factor P-MOS CQ and P-MOS LQ), telecom operators are able to identify issues and optimize their VoLTE and VoWiFi services to ensure high customer satisfaction.