RADCOM

RADCOM Network Insights

Smart, automated, AI/ML-driven network intelligence for 5G

Publication Date: June 2020

Web Site:

http://www.radcom.com

Table of Contents

Introduction

RADCOM Network Insights delivers business-critical network intelligence to the operator by providing a complete view of the customer and service experience for 4G as well as SA and NSA 5G networks. RADCOM's solution is cloud-native and seamlessly integrates into the operators' network, is dynamic, and highly resource-efficient. RADCOM Network Insights takes the raw data from the RADCOM Network Visibility, and RADCOM Service Assurance layers from the RAN to the Core. Using smart correlation, RADCOM converts it into actionable customer-centric insights to increase the end-to-end user experience, optimize service quality, and reduce operational costs.

RADCOM Network Insights makes extensive use of Artificial Intelligence (AI) and Machine Learning (ML) to provide visibility into the customer experience even when the network traffic is encrypted for such use cases as video streaming and tethering. AI/ML is also utilized by RADCOM Network Insights to enable automated assurance. For example, a critical part of end-to-end monitoring is the RAN, and RADCOM provides operators with automatic anomaly detection and root cause analysis to rapidly resolve customer-impacting issues proactively.

As more and more operators transition to 5G, AI/ML-driven insights will be needed to ensure service quality and enable operators to adopt a closed-loop approach to service assurance. It will also significantly reduce operational costs and improve network operations efficiency.

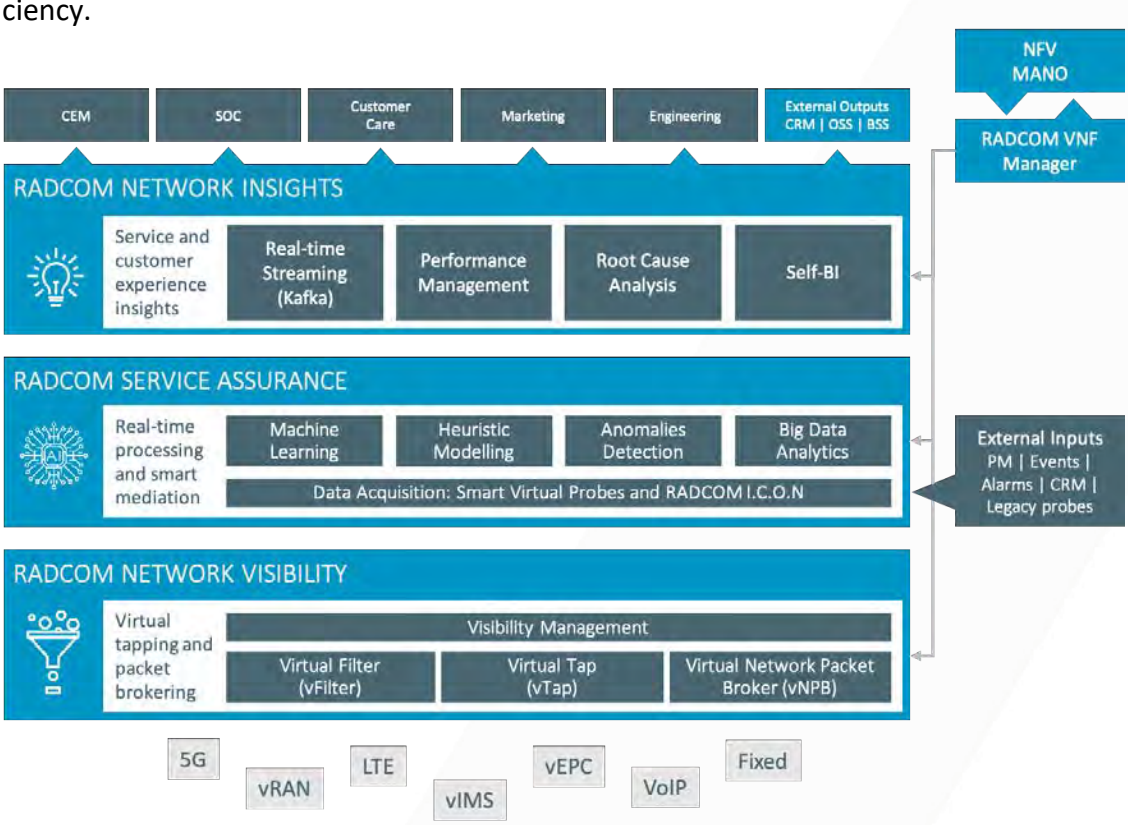

Figure 1 - RADCOM's solution architecture

RADCOM Network Insights covers a wide range of use cases that provide the operator with an end-to-end understanding of the service quality and customer experience. Also, RADCOM Network Insights offers next-generation tools for network optimization and root-cause analysis, such as call tracing and in-depth packet analysis.

RADCOM Network Insights correlates the network intelligence into revenue-generating business insights for multiple departments across the organization such as engineering, customer care, Network Operators Center (NOC), Service Operations Center (SOC) and Customer Experience Management (CEM). Using this intelligence, operators can prioritize customer affecting issues, execute corrective actions, and rapidly troubleshoot any performance issues.

Ensuring a superior customer experience

In such a highly competitive market, operators must increase their focus on delivering superior customer experiences to differentiate themselves, boost brand loyalty, and gain new customers. Excellent customer experience will be essential for the success of 5G and could open a window of opportunity in which operators can redefine their relationship with their customers.

In an Analysys Mason's "*Connected Consumer Survey: mobile customer satisfaction in Europe and the USA*" report it showed that operators in Europe and North America had Net Promoter Scores (NPS) between –5 and 40 compared to companies like Amazon, Google, and Netflix, typically scoring 50 or above. To change customer perceptions and reach the same level of customer experience and brand loyalty that web-first companies attain, operators need to put the subscriber first. As operators transition to 5G, they have a chance to design their network infrastructure and cloud platforms with the customer experience in mind from the outset and make the shift from being a Communication Service Provider to a Digital Service Provider.

Cloud-native networks are dynamic, altered on-demand, and software-controlled, so they introduce lots of complexity. In legacy networks, everything was physical, and so either worked or didn't work, which means that operators used a bottom-up approach to monitoring the customer experience. If the underlying network worked, then the customer experience was assumed to be high. In cloud-native networks, operators need to adopt a top-down approach that monitors the end-to-end service quality and customer experience and then drills down to the underlying network to focus on resolving issues that affect the customer and their received service quality.

RADCOM Network Insights provides operators with this top-down approach to ensuring the end-to-end service quality and customer experience. RADCOM also makes extensive use of AI/ML to provide visibility into the customer experience even when the network traffic is encrypted for such use cases as video streaming and tethering and to provide automated insights.

Deep Packet Inspection (DPI)

With over 60% of all network data traffic is encrypted, operators have challenges in understanding their subscribers' Quality of Experience (QoE). This means that service degradation can occur and go unnoticed by the operator. When this happens in OTT applications, subscribers will blame the operator and could churn even though a 3rd party provides the overall service.

Figure 2 - RADCOM's sophisticated DPI engine recognizes over 3000 applications

Therefore, the operator must gain insights into encrypted traffic, and DPI is a method used by RADCOM to provide these QoE insights so that operators can monitor service quality and ensure a great customer experience. RADCOM uses multiple technologies, including heuristics and statistical analysis, to classify and detect traffic, allowing the operator to understand which applications are sending the data that is traveling through the network. By utilizing signature mapping for DPI analysis, RADCOM can provide TCP based quality metrics for the QoE, giving the operator key insights into the network, which applications are being used, and how the traffic is flowing through the network.

RADCOM's Enhanced DPI engine is fully integrated and embedded within the software engine. The DPI engine can identify with high classification granularity in which services are being used for popular OTT applications, such as WhatsApp, Skype, BitTorrent, Viber, YouTube, etc., as well as distinguish between particular services (like Gmail and Google Meet).

RADCOM currently classifies over 3000 apps and service categories with more and more being added. This includes country/regional specific applications and services that are also continually added through customer requests and covers a broad range of services. These services include latency-sensitive applications that customers need for critical business communications such as Skype, WebEx, and Zoom to video streaming analysis of Netflix, YouTube, and Amazon Prime.

These insights can be used by the operator across a range of departments from customer care to engineering and enable the operator to understand what OTT (and operator-specific) apps the subscribers are using and the QoE being experienced. So, services can be improved, or marketing can be used to push adoption of the operator's services

RADCOM uses multiple technologies to classify/detect traffic;

- Classification of networking protocols and applications based on
- Flow pattern matching
- Bi-directional flow correlation
- Heuristics
- Statistical analysis

With regular protocol plugin releases that support In-Service Software Upgrade (ISSU) as well as country/region-specific apps being added, each operator can keep taps on essential services and applications in their network. This data enables the operator to assure the quality of experience for these specific services, so they run efficiently whatever the demand.

Video Streaming

It is estimated that by 2021, video services will account for 82% of all the traffic on the internet. With 60% of all video data being encrypted and the expectation that this figure will rise, operators are facing the challenge of extracting insights from the network and understanding the customer's QoE.

Figure 3 - Using AI/ML RADCOM provides insights into encrypted video streaming services

Operators recognize that video streaming is a potential area for growth and often offer their streaming platform, which they can monetize and sell alongside existing video streaming services. However, to be able to provide and monitor these services, the operator must gain critical insights into an area that is almost entirely encrypted.

RADCOM Network Intelligence utilizes AI capabilities and cutting-edge ML and heuristic modeling to provide an understanding of the perceived Quality of Experience (QoE) for encrypted HTTPS and QUIC based video streaming such as Netflix, YouTube, Facebook, Amazon Prime and regional specific services (like Iflix and Viu).

With these insights, operators can gain visibility across encrypted networks and understand the QoE across their network, which is critical, with different regions being affected in different ways and traffic usage varying. The data provided by RADCOM's solutions enable the operator to understand whether video streaming is a high enough quality that can be consumed and enjoyed by customers while not overburdening the network.

RADCOM provides the following metrics for encrypted adaptive streaming:

- Minimum time to play – heuristic approach to estimate the elapsed time until the video starts to play
- Video rebuffering count and duration – AI heuristic modeling is used to estimate real occurrences of the rebuffered video segments that are detected in the network
- Video resolution duration – The video segment download duration based on four resolution levels measured in the segment level (mSec)

  RADCOM estimates the video resolution as a time series problem and considers the historical download data of the user to provide results with the highest levels of accuracy. The four-level video resolution durations may be used to calculate the relative duration of each tier during the streaming video.
- Video Duration and byte count – duration of the video and DL byte count for the played video
- Effective Throughput – DL throughput based on the aggregated video flows and discarding idle time.

VoLTE

Operators continue migrating their voice services to VoLTE. VoLTE subscriptions are estimated to reach 3 billion at the end of 2020 and projected to reach 6.4 billion by the end of 2025 as VoLTE services continue to evolve and transition to 5G. First via Voice Over New Radio (VoNR) delivered over NSA 5G using LTE-NR dual connectivity, Evolved Packet System fallback and voice-over NR, and then to Vo5G.

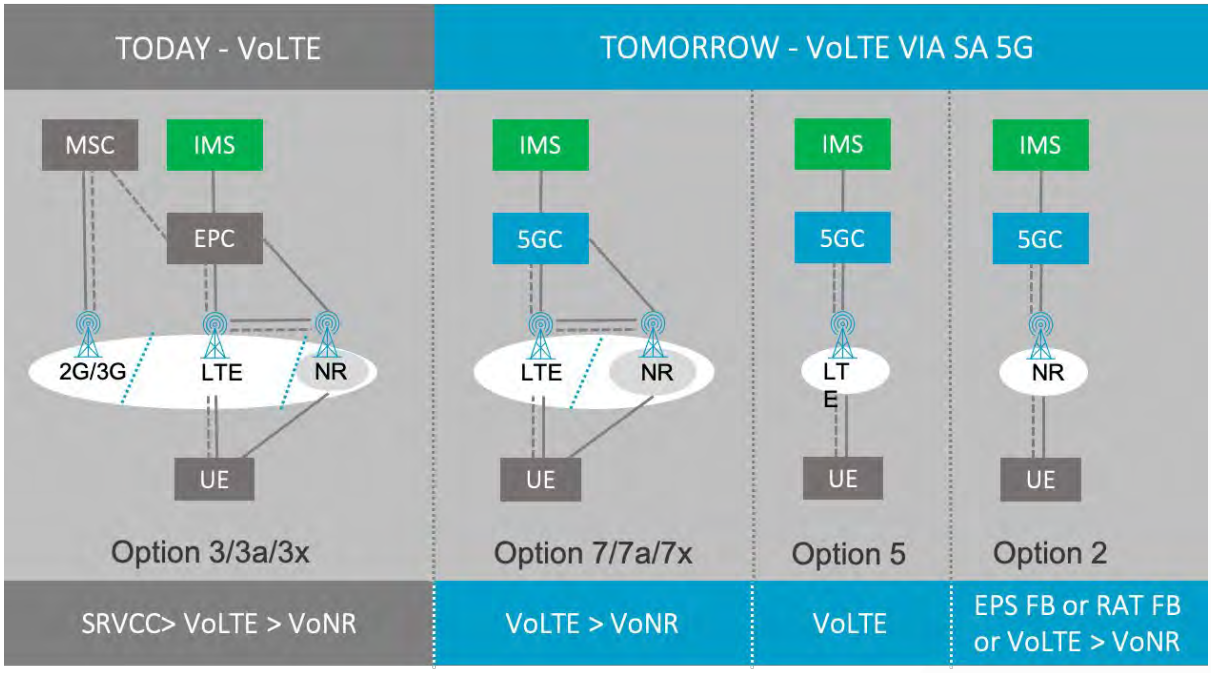

Figure 4 - Evolution of voice services from VoLTE to Vo5G

There are also more and more mobile operators offering VoWi-Fi services that complement VoLTE by utilizing IMS technology to provide a packet voice service over IP via a Wi-Fi network. VoLTE calls are seamlessly handed over between LTE and Wi-Fi and vice versa as the subscriber arrives in the office or to his home.

In VoLTE, the performance of the radio network is critical, and with RADCOM's end-to-end solution, operators gain visibility across the complete VoLTE service.

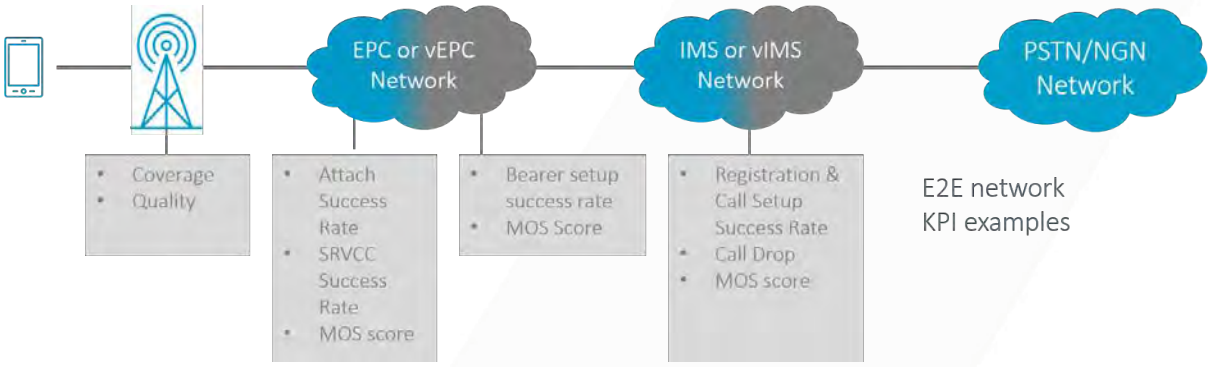

Figure 5 - Monitoring VoLTE requires end-to-end monitoring

Figure 6 - Pinpointing customer-affecting VoLTE service issues

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
- Present network element issues on a map with quick drill-downs to KPI analysis over time, and accessible 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
- 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

Figure 7 – RADCOM's end-to-end VoLTE monitoring

RADCOM Network Intelligence detects and classifies the different flow types within the operator's VoLTE & IMS service offering 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 preventive troubleshooting and network planning.

RADCOM's voice quality engine for VoLTE and VoWiFI uses an extended ITU G.107 E-model. The 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 subscriber, perceived quality operators can identify issues and optimize their VoLTE and VoWiFi services to ensure high customer satisfaction.

Proactive Customer Care

Maintaining a high level of customer service has never been more critical, and as subscriber ARPU's have leveled out, operators need to find new ways to differentiate themselves. To deliver a superior customer experience, operators need to take proactive actions to repair any network issues before the customer is even aware of them.

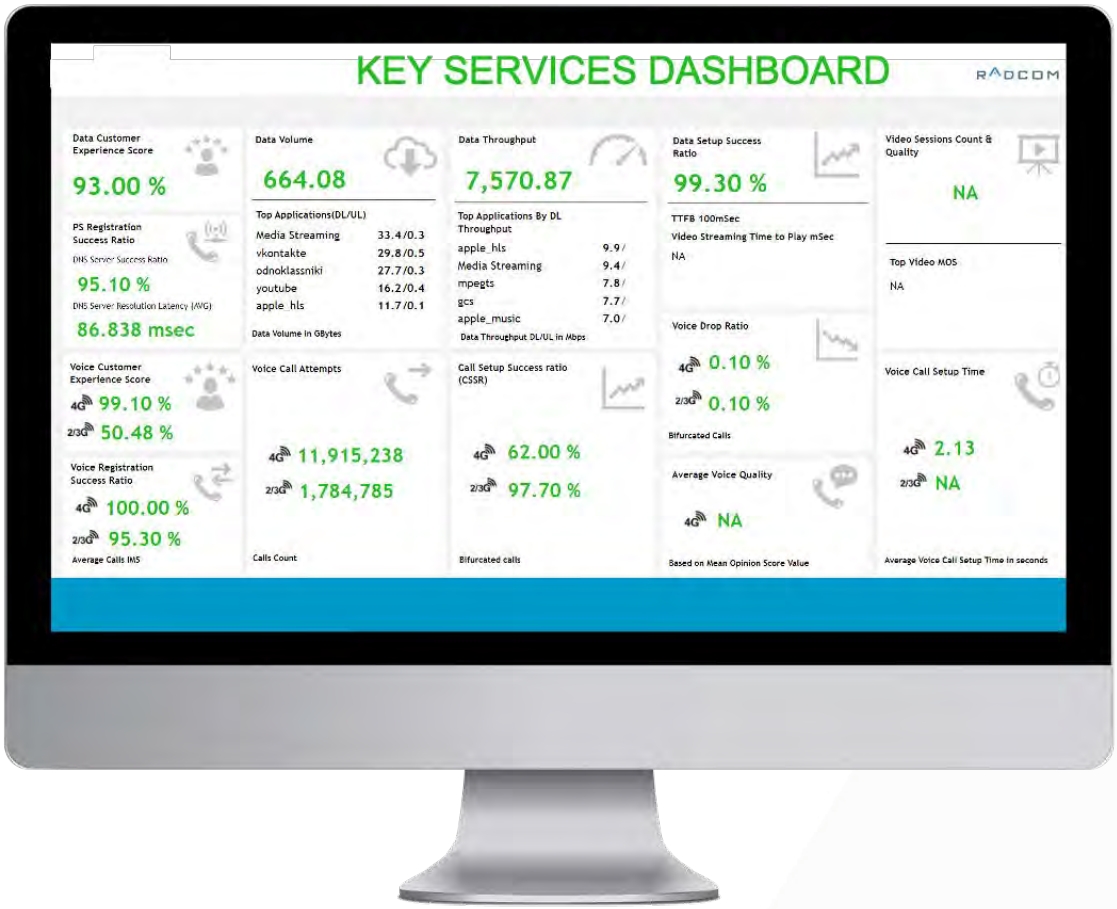

Figure 8 - Proactively monitoring end-to-end service quality

To deliver services as the customer expects, operators must take a proactive stance in assuring and continuously improving the service levels and overall QoE. This proactive approach especially applies to any premium services being utilized by the subscriber, such as VOD, VoIP, LTE, VoLTE, and 5G.

RADCOM Network Insights is a powerful combination of probe-based data from RADCOM Service Assurance and RADCOM Network Visibility, keeping a constant eye on the network, ensuring a VIP service, to a range of devices, at all times. The solution will automatically trigger actions for resolution if the service quality drops below a predefined threshold so the operator can take proactive steps to resolve the issue before they affect the VIP.

Using the insights provided, the operator can understand which apps and services receive the most substantial usage and concentrate efforts in ensuring a continuously high level of service. This consistently high QoE fosters the loyalty of the VIP. Operators can capitalize on this by influencing brand perception, which in turn will contribute significantly to revenue streams. The smart probe-based solution enables operators to analyze and troubleshoot traffic on the fly, per customer, service, or session.

Roaming

Operators have the potential to generate significant revenues from subscribers who are roaming—managing those customers who are roaming in as well as roaming out pose their opportunities and challenges. Operators have the potential to generate significant revenues from customers who are roaming in and out of their networks.

By gathering and analyzing subscriber traffic, location, and movements in real-time, roaming data can be leveraged to improve and increase these pockets of revenue. However, before an operator can generate roaming revenues, they must first assure the quality of experience for both inbound and outbound roamers.

RADCOM Network Insights provides analysis and statistical performance indicators on the roaming traffic over the operator's network. Enabling operators to gain a comprehensive view of the status, quality, and user experience per country and operator of roamers, both roamers in (visitor subscribers from other networks who are using the network) and roamers out (subscribers who are traveling abroad and using other networks). Also, it will identify if a customer fails to connect when roaming out, offering proactive troubleshooting to resolve issues before the customer can complain.

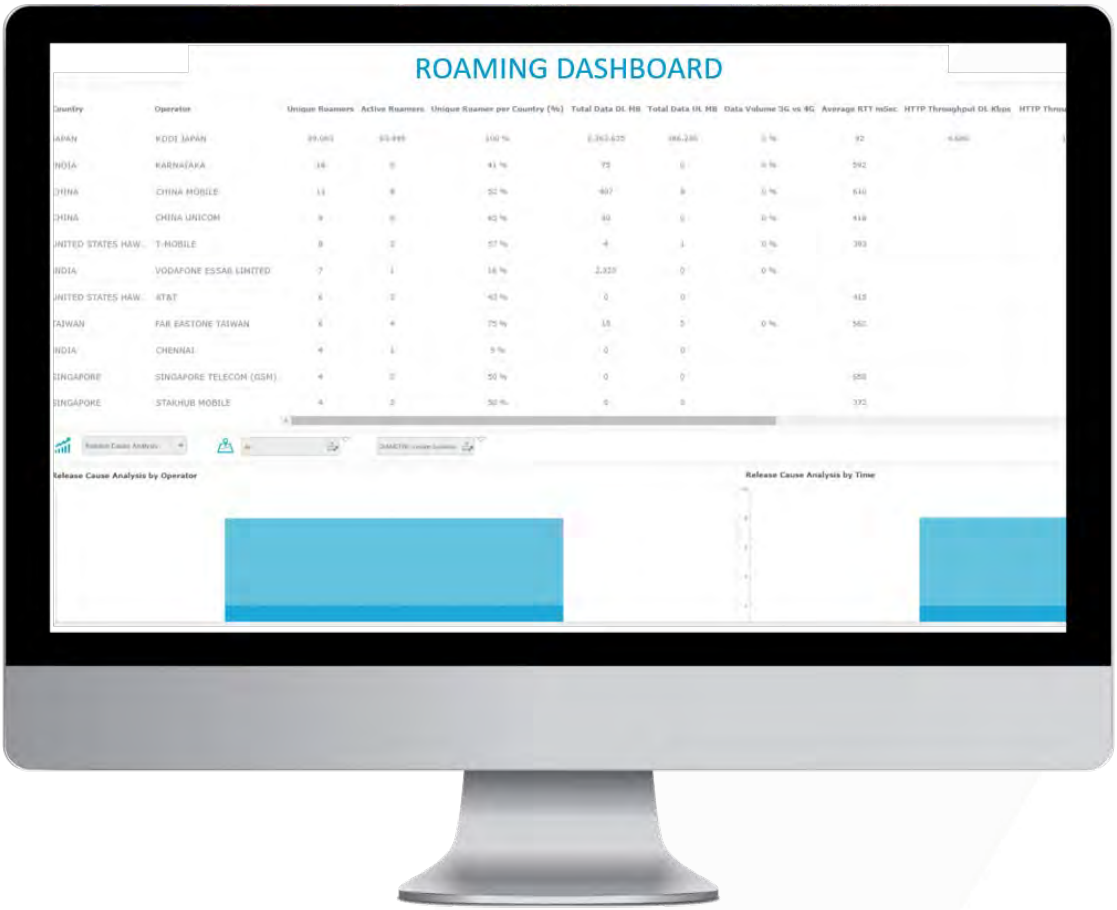

Figure 9 – Ensuring roaming subscribers receive a high customer experience

RADCOM's solution takes a targeted approach to inbound roaming. By segmenting the customers, operators can build a user profile, which will enable them to customize their plan to the subscriber and focus their marketing efforts.

RADCOM Network Insights offers the following available roaming information:

- Quality Indicator Reports
- Quality Distribution
- End Cause Distribution
- Top Parameters
- Procedure Distribution
- Session Details
- Subscriber Details

Tethering

Many smartphones and PC devices connect to the internet via a host device. For mobile networks, this could be a hotspot or smartphone. For fixed-line broadband, this would be via a Wi-Fi router, and there may be other devices connected via a Wi-Fi or Bluetooth connection. The challenge for operators is to understand how many devices may be tethering to the host device so that they can gauge the volume of traffic being carried through tethering.

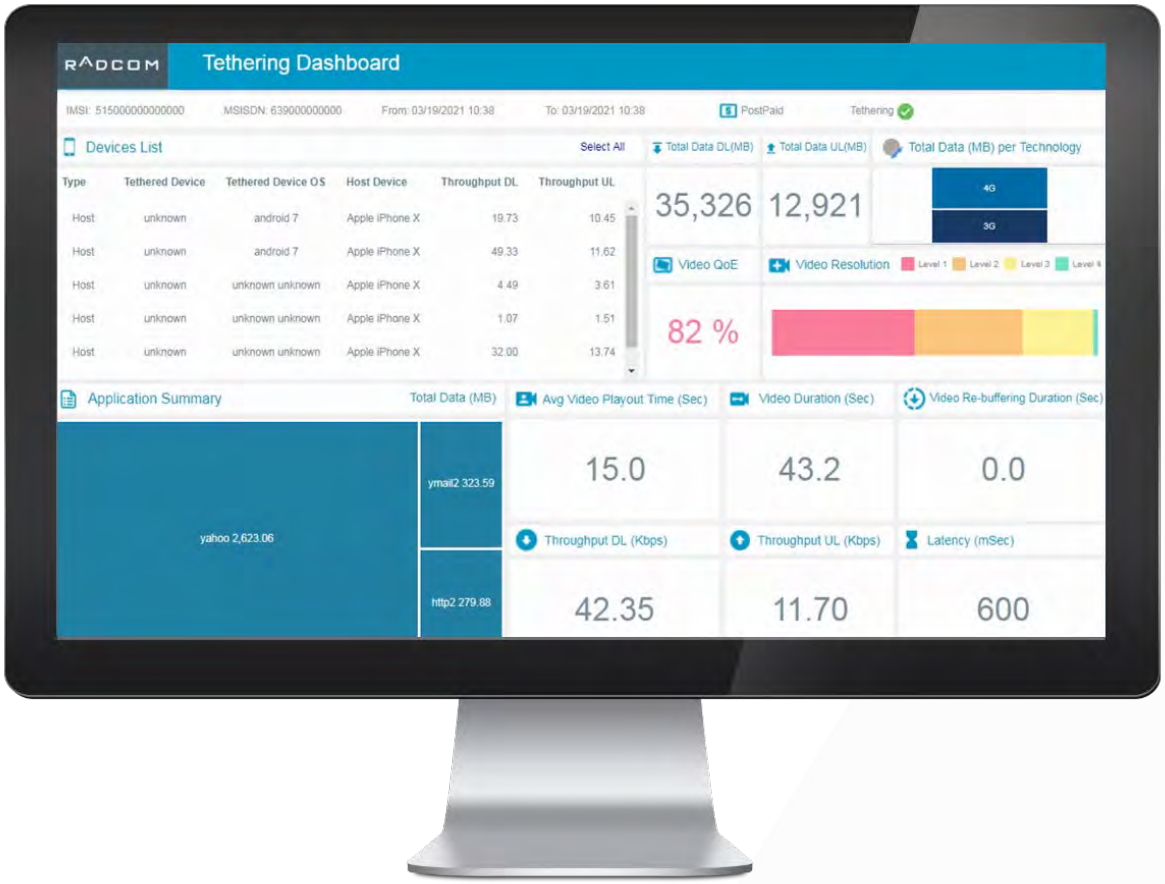

Figure 10 - Gaining insights into tethering usage on the network

RADCOM employs ML and heuristic modeling, helping to identify where the traffic is originating from, and what type of traffic it may be, whether mobile, fixed-line, or Wi-Fi/ Bluetooth. The operator can then tailor the solution to the user behind the tethering device and offer them a personalized plan to encompass their needs. Also, operators can see which Over-The-Top (OTT) applications are being used to tether, providing further insights on what demands are being placed on the network and customer usage patterns.

RADCOM's tethering solution offers insights for a single subscriber including when they activate tethering, the number of tethered devices, total data, session duration, speed and the Quality of Experience (QoE) for all
tethered devices.

Highway Mobility

The number of connected devices is growing at an exponential rate, and customers want to be assured of a smooth connection for audio and video services, even when they are on the move. RADCOM Network Insights can deliver smart insights into the service quality across the entire customer journey. So, operators have complete analysis for their subscribers across multiple cells and different service measurements.

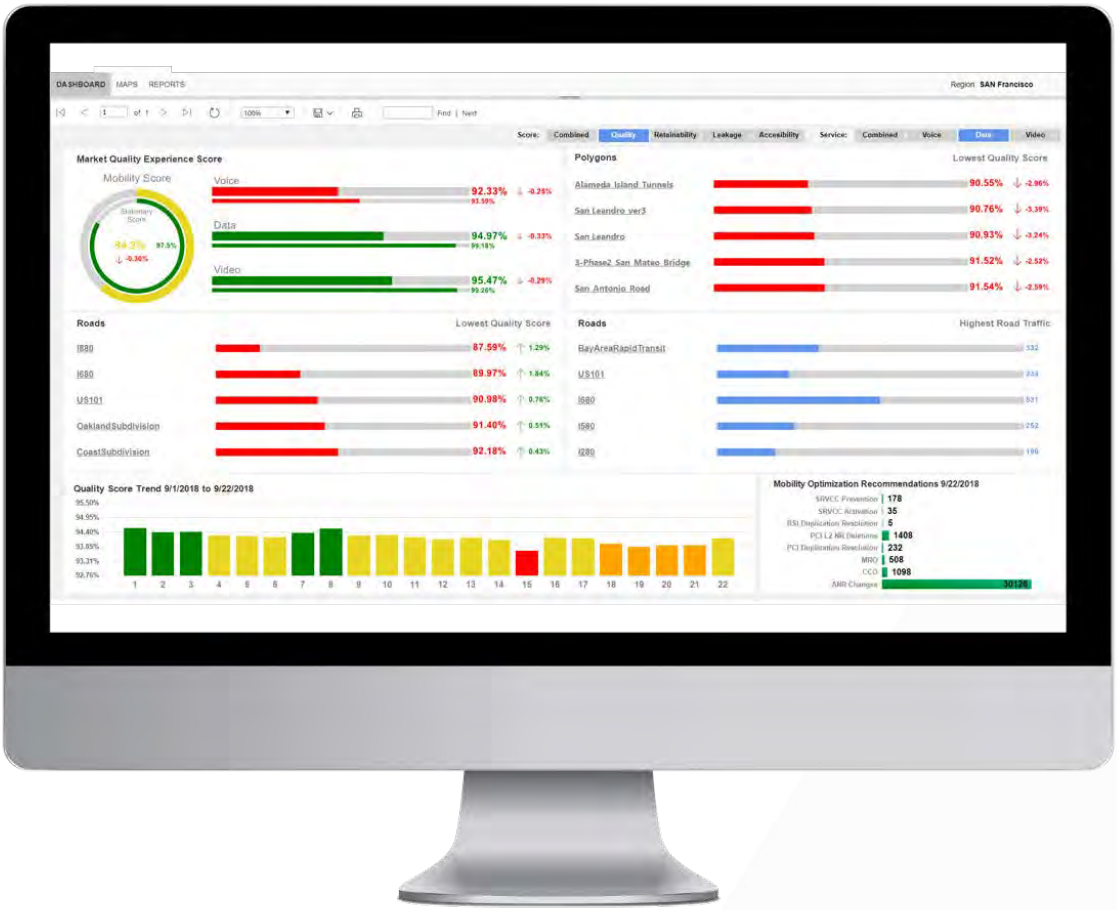

Figure 11 - Understanding the highway mobility customer experience

Ensuring a consistent quality service when subscribers are moving around is a significant challenge for operators who want to detect if there is poor service around specific cell towers or lesser coverage in certain regions.

Looking ahead to when there will be connected vehicles on the road, assuring a strong connection between the car and the network with ultra-low latency will be crucial for the safety and success of the car.

Additionally, highway mobility experience can refer to mobility gear optimization. This is based on data relating to surrounding traffic, improving the driver, and passenger experience. The vehicles will also be able to feedback information to a central point regarding their journey and the conditions on the road, providing insights on the move and up-to-date insights for end-to-end journey coverage.

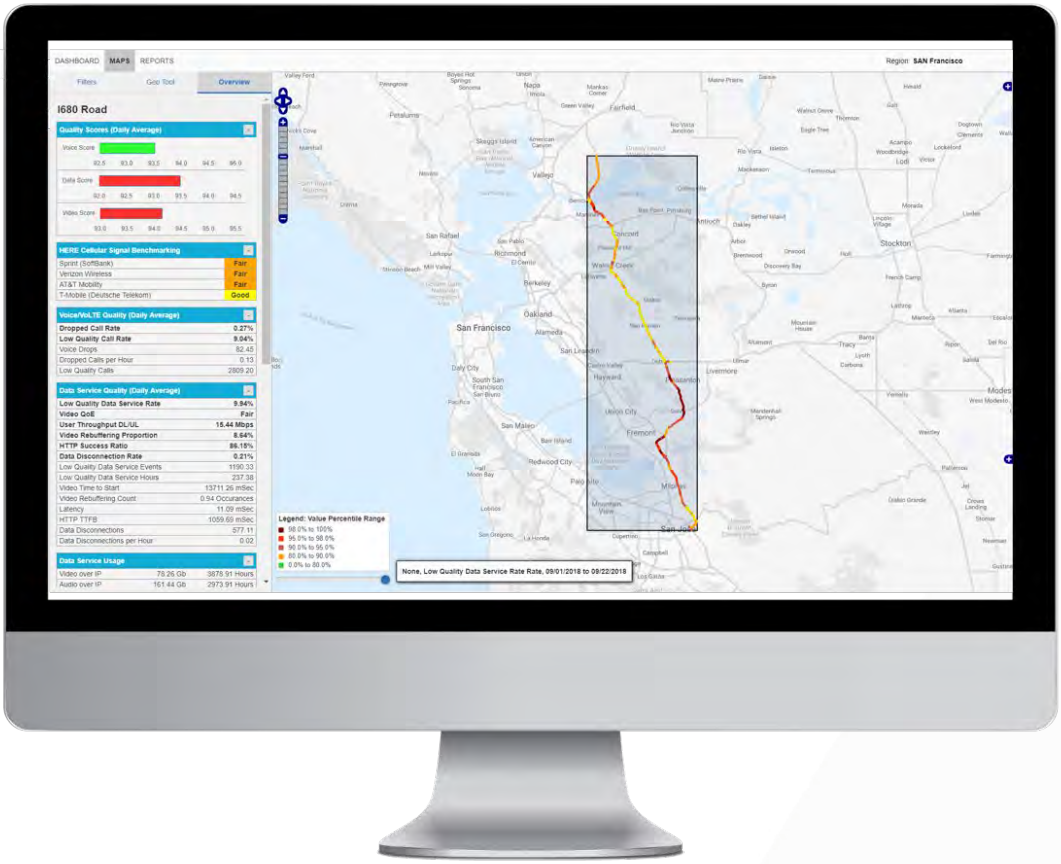

Figure 12 - Smart monitoring of the highway mobility journey

RADCOM's intuitive dashboard will display KQI's segmented by vehicle, road, and overall market view. This will help the operator identify problematic cells or cars in addition to offering tailored packages to those customers who are frequently on the road and require a strong network connection. Having these insights will improve the service delivered and overall customer experience.

Fixed Broadband

For fixed-line services, RADCOM enables the operator to understand the end-to-end quality of experience, and when service degradations occur to optimize and troubleshoot service performance rapidly. Operators can also gain an understanding of network usage and trends. Using insights into encrypted traffic, RADCOM provides operators with KQIs for gaming (such as RTCP over UDP and update rate), tethering (to see what applications subscribers use, data usage, etc.), and video streaming (such as Amazon, Facebook, Netflix, YouTube, and others). With built-in DPI, RADCOM's solution classifies over 3000 apps & protocols that subscribers use on their fixed broadband network and provide quality of experience metrics for encrypted OTT apps.

Covering both control plane and user plane traffic, operators can drill down from the service level to the individual subscriber or packet level to troubleshoot and receive event-driven notifications for connection issues (RADIUS, Diameter). Troubleshooting can be applied to the user plane traffic with drill-downs to view call/session traces. RADCOM Network Intelligence enables operators to proactively analyze their fixed-line services, detect any network default, and optimize the network performance.

RADCOM's solution monitors DSL and GPON at these points within the network:

- User plane traffic over PPPoE or IPoE between the access network and BNG
- Radius traffic between the BNG and AAA
- Diameter traffic between the BNG & PCRF

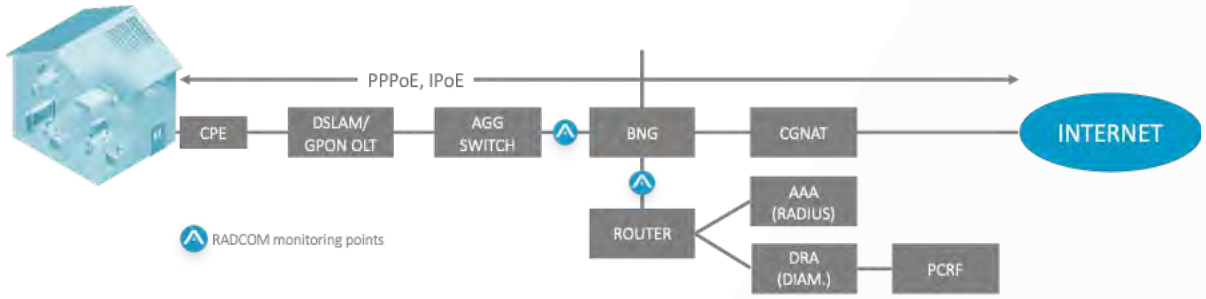

Figure 13 - RADCOM monitoring points in fixed broadband

Using the data collected and correlated from these monitoring points, RADCOM Network Intelligence enables the operator to understand the overall network and service performance, know the quality of experience and perform root-cause analysis to rectify any subscriber-affecting issues. Alarms can also be assigned to specific service levels so that if thresholds are breached, engineers are automatically alerted.

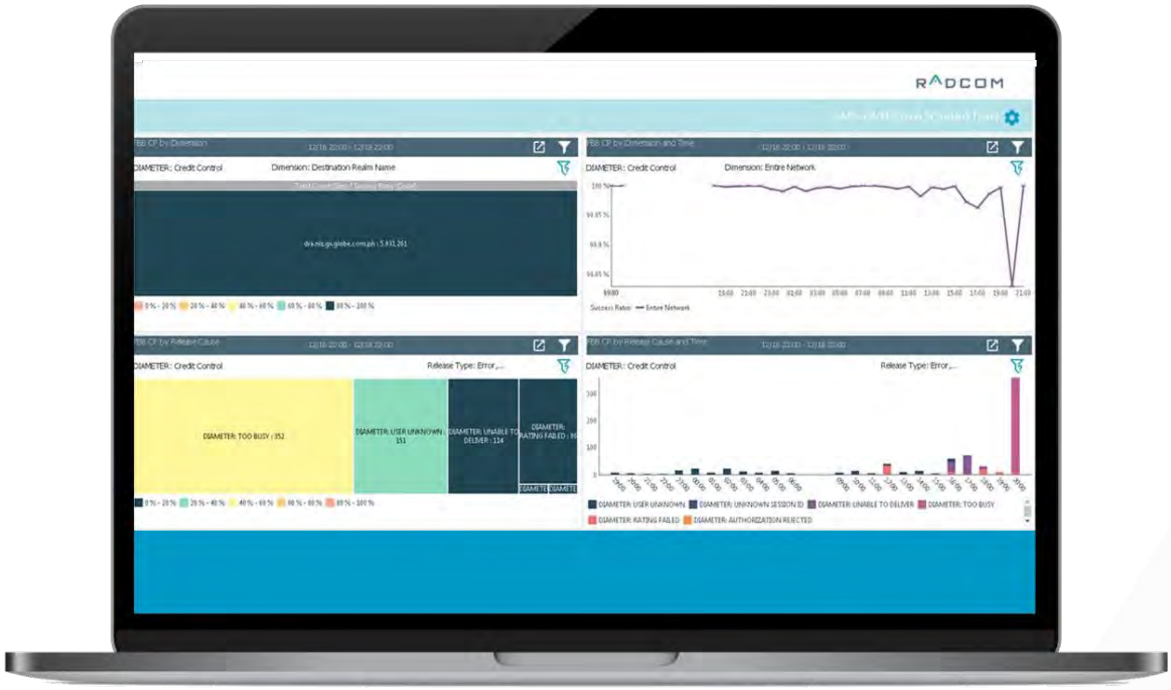

Figure 14 - Monitoring the fixed-line control plane

For control plane traffic, RADCOM provides operators with the following KPIs;

- Total Count
- Success Count
- Success Ratio
- Average Duration
- Release Cause Distribution

These are available in the following dimensions:

- Entire Network
- Application ID Name (DIA)
- Destination Host Name (DIA)
- Destination Realm Name (DIA)
- Origin-Host Name (DIA)
- Origin Realm Name (DIA)
- Source NE
- Destination NE
- Time

RADCOM also provides operators with a customer care application for subscriber support (QiCare) that is targeted at the Customer Service Assurance Group and provides control plane and user plane metrics per subscriber. Additionally, RADCOM also offers a proactive care application for subscriber groups (VIP).

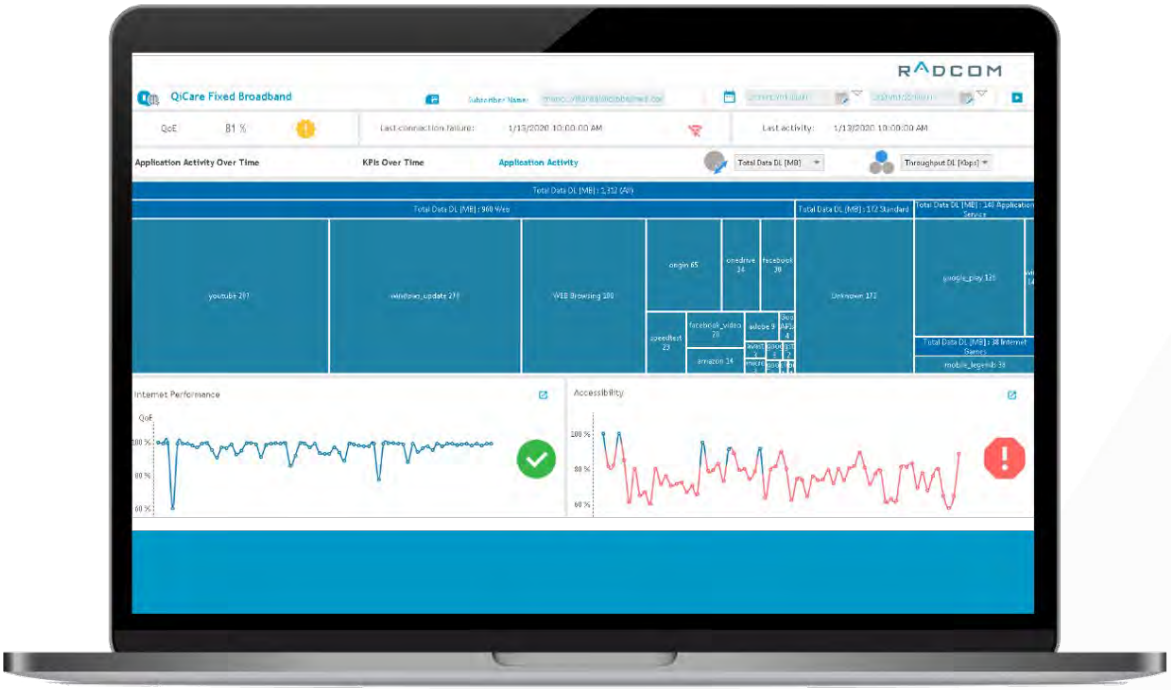

Figure 15 - Monitoring application usage on fixed broadband

For the user plane RADCOM provides the following KPI's:

- General: Data volume, success rate, throughput, duration, latency, retransmission, etc.
- Encrypted Video: Video rebuffering ratio, average video rebuffering count, average playout VMOS score, video resolution, average minimal playout time, average video duration, total data DL, average download throughput (kbps)

These are available in the following dimensions:

- Entire Network
- Time
- DSLAM, Aggregation switch, BNG (based on customized network classification – e.g., VLAN)

RAN Analysis

With industry estimates stating that problems in the RAN cause over 65% of subscriber issues, RADCOM RAN Analytics provides real-time and historical insights for operators to resolve congestion rapidly, troubleshoot, and optimize RAN performance. Insights into the RAN are an integral part of RADCOM Network Insights that provides operators with a single, unified view of their end-to-end service quality. So, operators gain visibility across their entire network (from the RAN to the Core), thus quickly being able to root cause service degradations. Increasing this network-wide visibility to the RAN is critical as service monitoring can indicate that the network core is performing well. Yet, the access network can cause significant Quality of Experience (QoE) issues. RADCOM also utilizes built-in ML capabilities to deliver insights quickly and save the operator time in performing root cause analysis and detecting anomalies. RADCOM RAN Analytics provides:

- Real-time visibility needed to troubleshoot RAN issues effectively
- Smart monitoring of RAN performance to detect and determine the root cause of service degradations
- Includes important RAN analytics in your end-to-end service monitoring

Some examples of the use cases that RADCOM RAN Analytics supports:

IMSI journey – Serving Cell and Signal Levels

Tracking a journey of an IMSI by Serving Cell and Signal Levels during RRC connection. The user can drill into a 5-minute level of resolution to view signal levels at any time during the day, e.g., during office hours and after office hours.

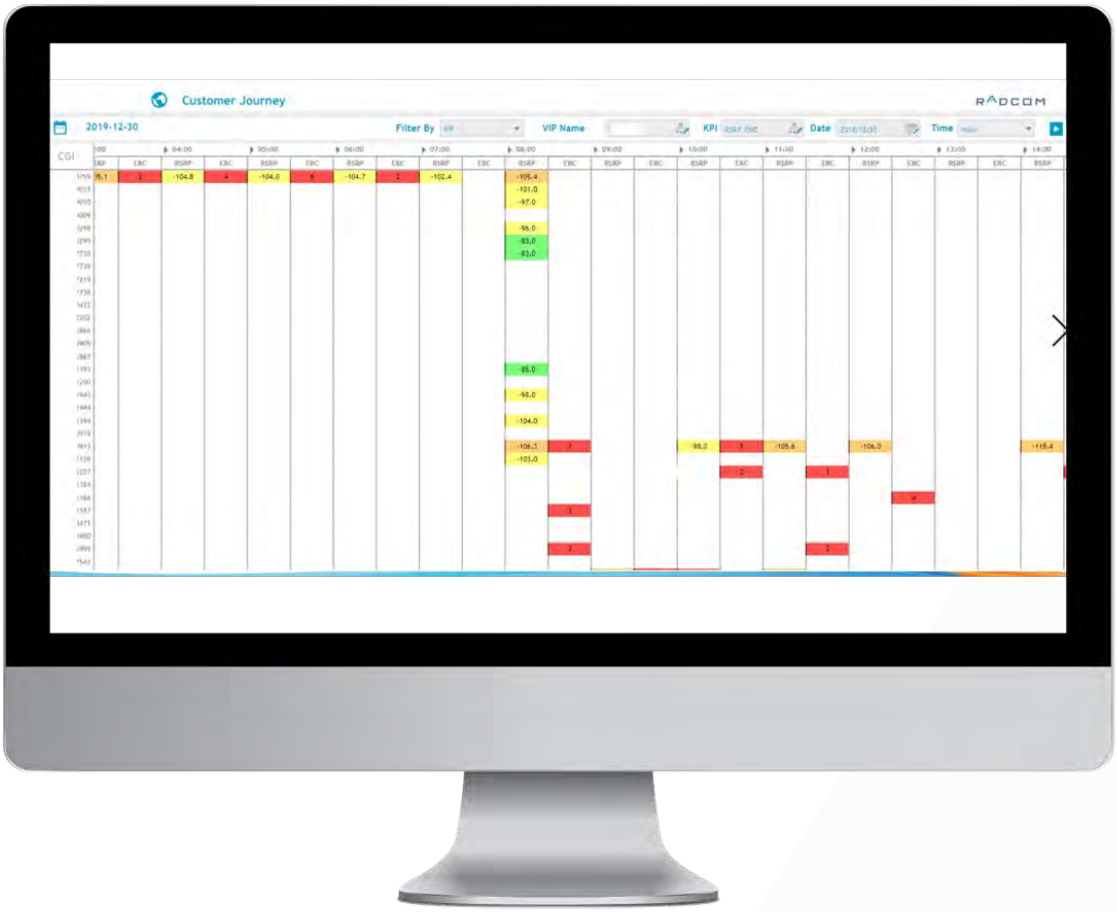

Figure 16 - An end-to-end view of the customer's journey from the RAN to the Core

Identify data hoggers and spammers

The top 2-5% of network subscribers are often found to be consuming 80% of the data payload. Subscribers in stationary mode usually do data hogging. The closer the distance to the cell (PD/localization), the higher the interference to other connected subscribers on the cell. The effect can cause drops to cell edge subscribers. These scenarios can be mapped to a cell and further localized to an area.

Cell outage predictions based on machine learning

The purpose is to identify a cell that is not sending messages and trigger alerts. The process starts with RADCOM's solution identifying messages from two primary sources that refer to a cell:

- Trace Events: RRC/X2/VSE
- S1AP, GTP-C from MME

The trigger event that measures that no incidents have arrived at the probe will trigger a CDR that is sent to the database and alert engineers that there is an issue with a particular cell that needs to be investigated.

Discover coverage holes and their impact on service

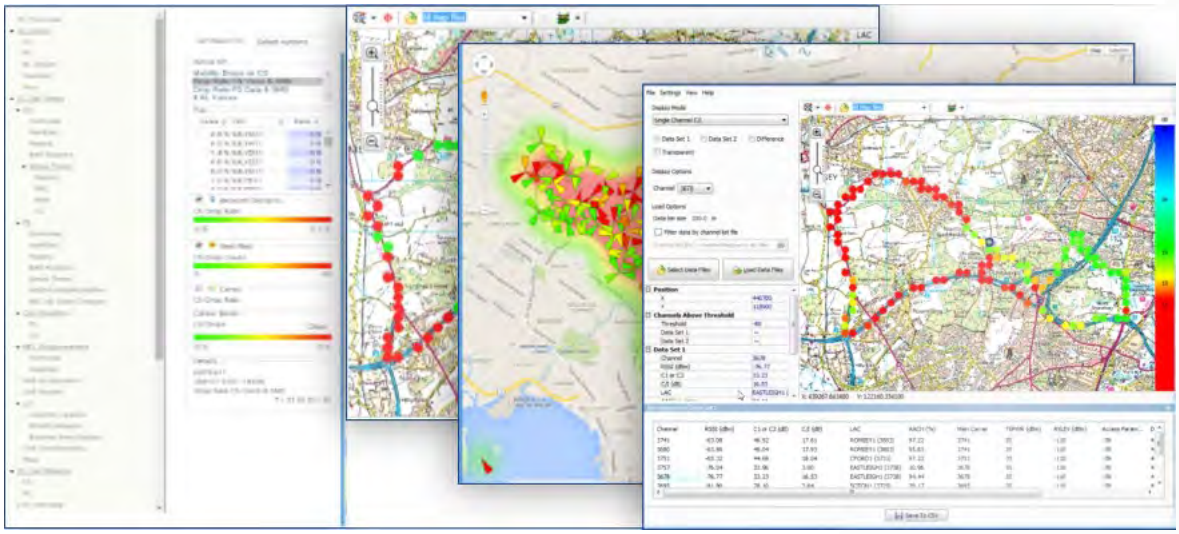

Figure 17 - RADCOM provides cell coverage on a map for easy detection of issues

Machine learning anomaly detection

RADCOM RAN Analytics utilizes ML algorithms to detect RAN anomalies. Some examples include:

Tying the RF performance to the UX

- Anomaly patterns: A correlation of signal levels creating cell patterns to subscriber services. (VoLTE, low-level streaming video/sound, simple data throughputs against KPIs: Data drops, Call drops, Radio link failures)
- Drill into individual subscriber measures to see the effect on service experience
- Subscriber profiling by creating a more precise score combining both RF environment and service experience

This type of use case is only possible because RADCOM monitors the network end-to-end from the RAN to the network core.

Cell behavior to service analysis

- Signal quality (RSRQ) and Channel Quality (CQI) vs. Distance patterns to identify a bad user experience (UX)
- A demonstration of cell patterns to generalize cell behavior and the effect on UX

Root cause analysis based on KPIs and anomalies

Generate analytics out of assembled KPIs and combine them with a process of monitoring incidents. During the input stage, all KPIs are defined and analyzed on a per Cell/UE problem basis. The output stage will represent a “normal” or “abnormal” behavior of clusters that will be further investigated to allow best practices. A few algorithms will be used to achieve the best valid conclusions of yet undiscovered problems.

- View and review UX on a map together with Cell Radio Coverage
- Usage of Propagation delay from Cell (RRC Protocol)
- While RRC messages are covering the access side, it will be combined with the Core network to review:
  - User Experience by service
  - HO impact on User Experience

Customer Experience Management (CEM)

For an end-to-end CEM solution, RADCOM Network Insights is correlated with BSS and OSS data to generate a Customer Experience Index (CEI), so operators can smartly monitor the entire customer experience journey with easy access to end-to-end troubleshooting, trend analysis as well as churn and Net Promoter Score (NPS) prediction.

By deploying end-to-end CEM solution operators can improve customer retention, reduce OPEX, and differentiate their customer experience. By correlating data from various touchpoints, the operator can truly understand the customer experience and troubleshoot the service performance to ensure the delivery of high-quality services to their subscribers.

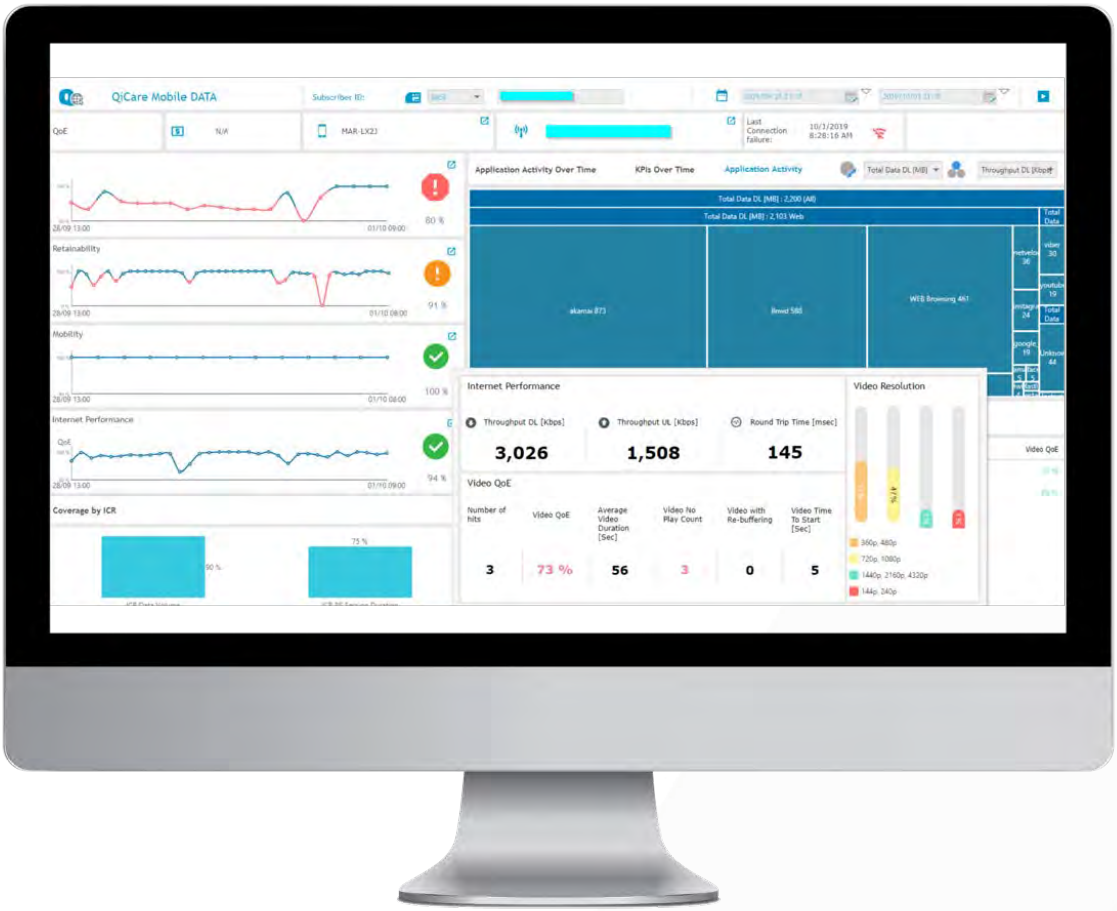

Figure 18 - Providing detailed information on the subscriber's customer experience

Taking a comprehensive view of the customer experience and breaking down silos by ensuring different departments are communicating, and all focused on the customer experience is a critical part of delivering superior customer experience. The CEI calculates the customer's satisfaction levels though correlating multiple parameters, which can be defined by the operator. These can include, but are not limited to;

- Product experience
- Bill satisfaction
- Customer service experience
- Complaint handling experience

Service Operations Center (SOC)

For a comprehensive SOC solution, RADCOM Network Insights is correlated with BSS and OSS data enabling operators to monitor the overall service quality and rectify service degradations that impact subscribers from the RAN to the network core.

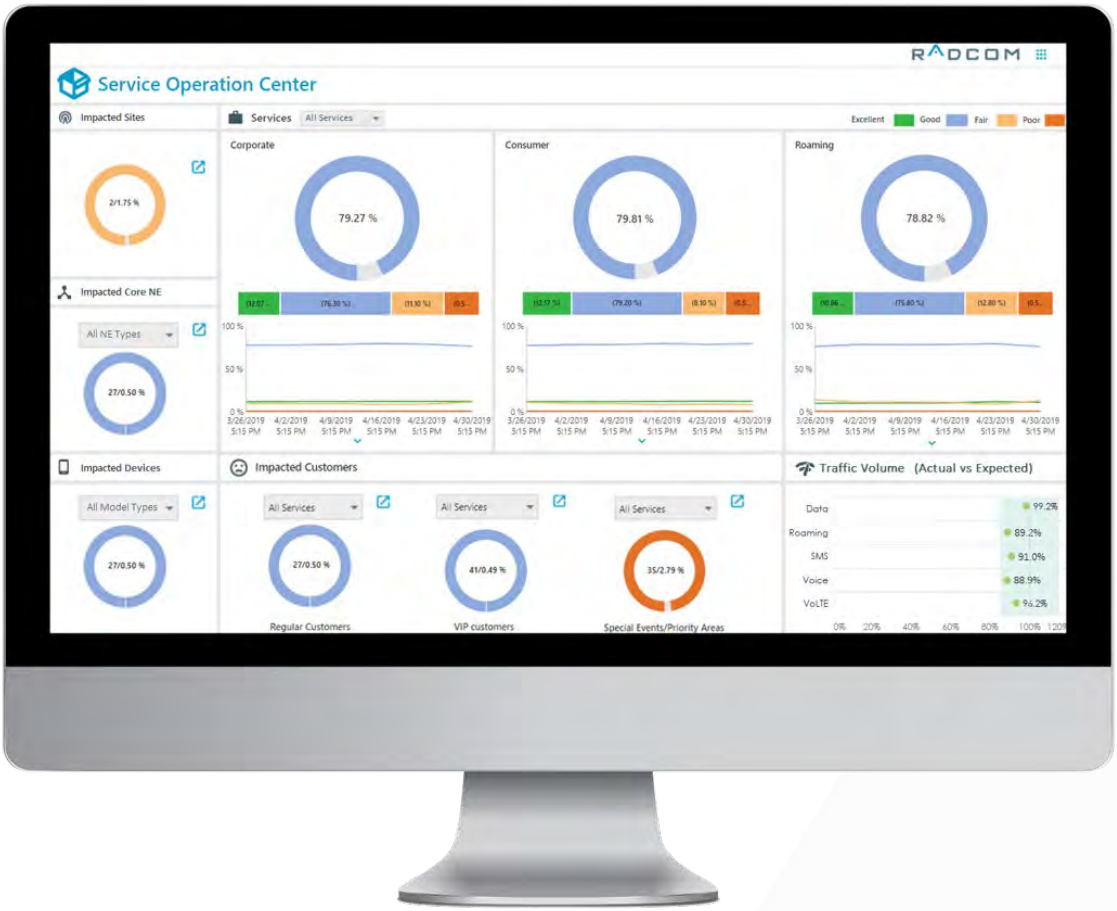

Figure 19 - Ensuring the delivery of high end-to-end service quality

The SOC solution takes in numerous data sources from RADCOM Network Insights to OSS data (such as Performance Management, Fault Management, Trouble Ticketing Systems, Call Trace Records and Inventory), as well as BSS data (such as Billing and Customer Relationship Management - CRM). The data is then correlated via RADCOM Smart Mediation to calculate the KQI's and KPI's, triggering alarms when service quality drops below a certain threshold, or when there are anomalies in the data. Taking an end-to-end view of the network ensures that rapid action is taken when there is any degradation or outages which may affect the subscriber.

By utilizing probe-based data as the cornerstone of their SOC solution, the operator can perform troubleshooting drill-downs from an aerial view of the network right down to a single transaction or network packet. This means the operator can analyze and troubleshoot traffic on a per customer, per service, per network element, or session-level.

Deploying a probe-based SOC solution helps operators prioritize network issues based on their impact on the customer, troubleshoot the root cause, and delivers suggestions for the next best actions.

Service Availability

Service availability relates to the ability of the subscriber to receive the required services and stay connected to the service. RADCOM's solution covers both the connection to the network and the availability of the service, such as video streaming and VoLTE. RADCOM Network Insights show short calls or call back to indicate that there is an issue with service availability, such as one or both channels being muted.

RADCOM Network Intelligence provides operators with the capabilities to assure both service availability, service quality, and customer experience. RADCOM's solution monitors the end-to-end service availability for all domains, including fixed, mobile, as well as VoLTE, as well as CS voice. RADCOM's solution provides automated alarms for service availability issues and drills down for troubleshooting and root-cause analysis to quickly rectify service degradations and restore service availability.

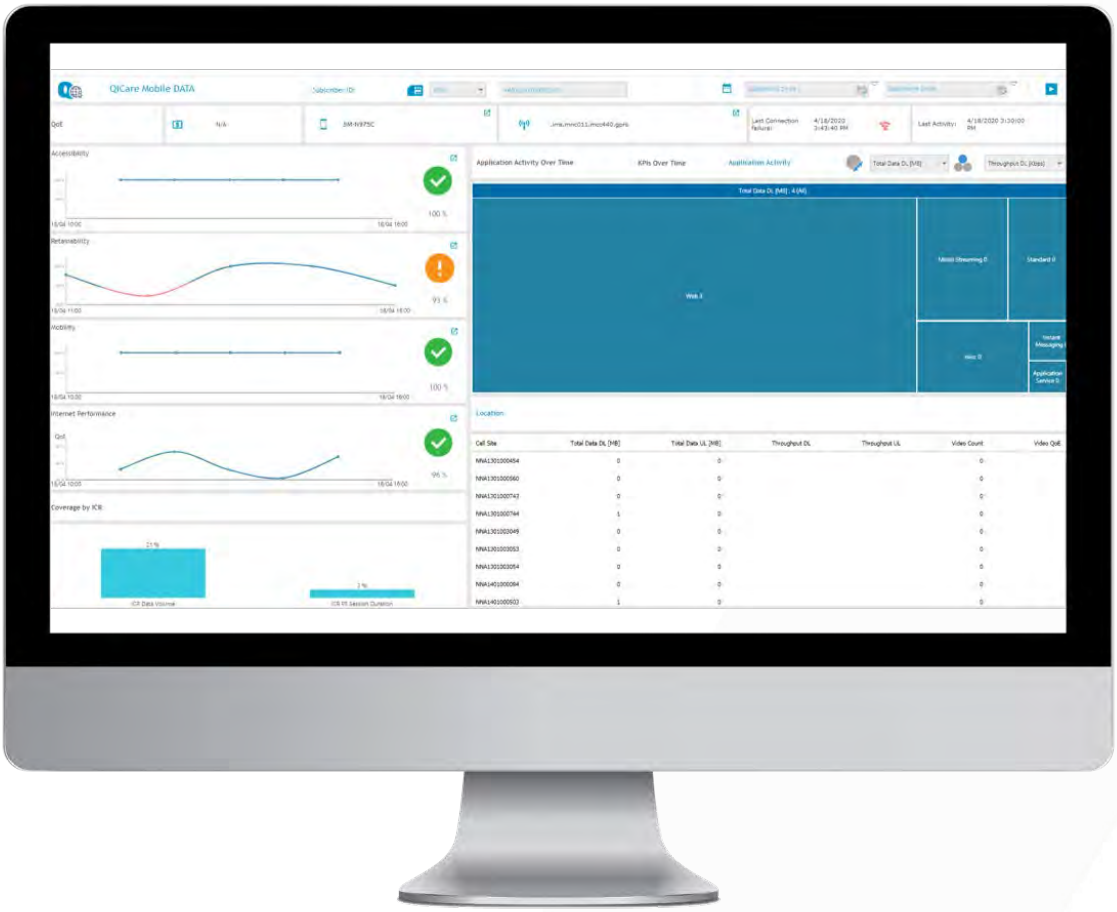

Figure 20 - Monitoring service availability with RADCOM Network Insights

Network service availability

Both 3G and 4G accessibility is determined by the end to end analysis of the control plane signaling. Once the subscriber has connected to data or voice services, further investigation is performed to determine whether the subscriber remains connected to the service (Retainability).

Mobile Data

RADCOM's advanced AI/ML is utilized to provide complete visibility into the service availability for encrypted OTT applications. For services based on encrypted video streaming, such as VOD, RADCOM's ML model is utilized to determine whether the subscriber successfully viewed the video streams.

VoLTE

RADCOM Network Intelligence correlates end-to-end calls and indicates whether the call registration and setup was successful and whether there was a drop in the voice service during the call. 'Short call and repeat call analysis' is utilized to determine whether one or both voice channels were always available (mute calls).

Figure 21 - Resolving service availability issues with RADCOM Network Insights

End-to-end Network Analysis, Troubleshooting, and Root-Cause Analysis

Operators need next-generation, container-based solutions that provide them with low-level tools such as call tracing and packet analysis to perform network troubleshooting for the new underlying network architectures. Also, operators need to understand the overall customer experience and end-to-end service performance with the ability to drill down to the lower level to perform root cause analysis.

RADCOM's next-generation suite has an intuitive, unified UI built for monitoring dynamic next-generation networks that can be changed on-demand and is built for collaboration between engineering teams. The suite is web-based, and so there is no need to install a client, and the system can run on Windows, UNIX, or Linux. It is blistering fast, supports multiple users out of the box, and offers full administrative control while adhering to security and user content privacy.

RADCOM's network troubleshooting portfolio can be used by multiple departments such as network planning, network operations, NOC, customer care technical support, equipment vendors experts, as well as subject experts such as Roaming, Revenue Assurance, and Fraud.

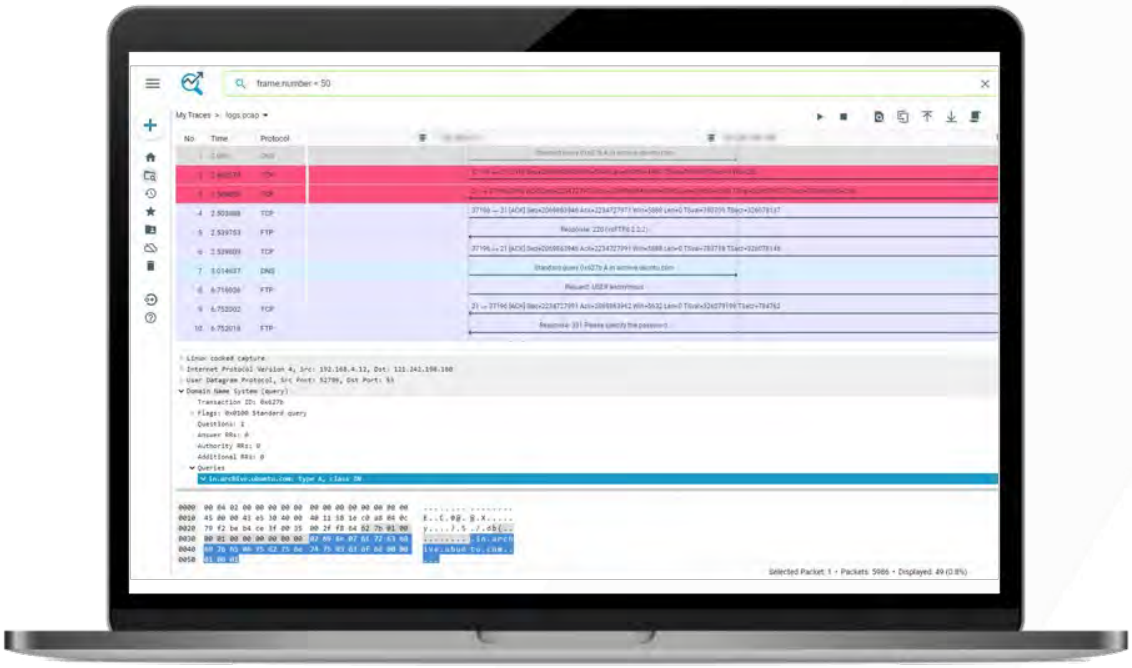

Figure 22 – RADCOM's cloud-based, next-generation troubleshooting tools

RADCOM's network troubleshooting portfolio includes the following network analytics and troubleshooting applications:

RADCOM Packet Analyzer

RADCOM Packet Analyzer is a packet and protocol analyzer used to view any packet flowing through the network for any selected subscriber or time. It can produce a full user-plane PCAP trace that is perfect for drive testing new technology rollouts and in-depth troubleshooting. RADCOM Packet Analyzer is used to monitor traffic at all levels, both all/session-related and non-call/session-related, as well as online or historical data, with all protocols displayed in a single view.

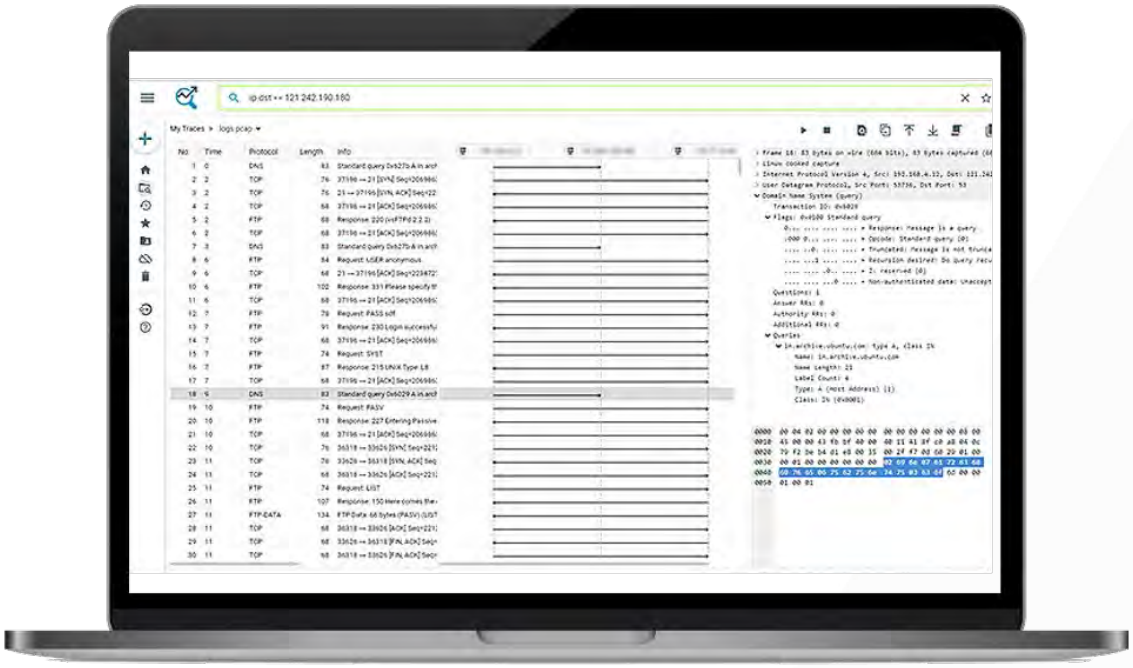

Figure 23 - Deep-packet analysis using RADCOM Packet Analyzer

Operators can filter protocol data separately or in combination with network element ID, transport layer parameters, protocol types, and additional filters RADCOM Packet Analyzer extracts what is needed from the source. With the smart capture of filtered raw packets the Packet Analyzer uses in-depth and flexible protocol analysis on the raw packet level, covering any protocol type and traffic type, troubleshooting network elements as well as filtering/searching by 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.

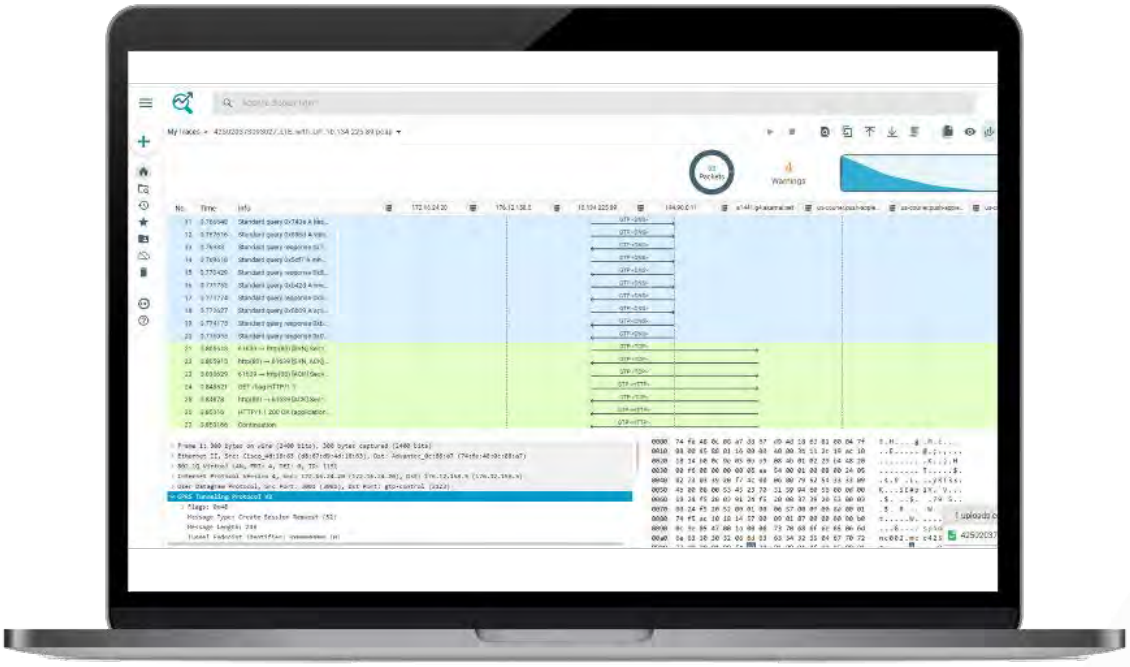

Figure 24 – Viewing the full decode of the captured frame

RADCOM Packet Analyzer has the following features built-in:

- Perform packet analysis (packet list, packet details, packet bytes)
- Display filters
- Find packets
  - in packet list, packet details, and packet bytes
  - by String, Hex, Regular expression, display filter
- Coloring rules by the filter expression
- Ladder diagram
- Analysis tools (graphs, tables, and dashlets)
  - Trace properties, I/O graphs, Expert Information, Protocol Hierarchy, Endpoint, Conversation, Packet Lengths, etc.
- Execute packet operations (comment, compare, export, remove duplication, split, edit, etc.)
- Run rule-based correlation
- VoIP calls and RTP analysis
- Display filter wizard
- Network topology-based provisioning
- Run online, historical, combined and scheduled modes
- Enable cyclic buffer and trigger-based capture
- Run multi-trace operations (display filters, find, compare, merge, etc.)
- Find call sessions (drill up to RADCOM Session Analyzer)

RADCOM Session Analyzer

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

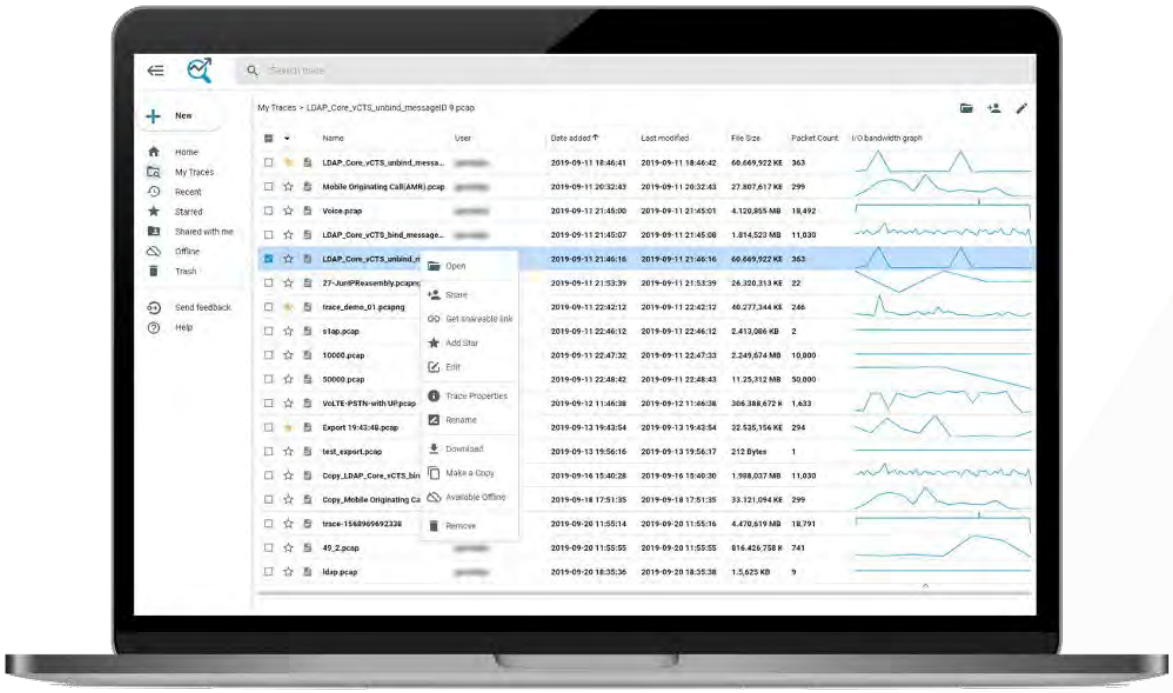

Figure 25 - RADCOM Session Analyzer for end-to-end call tracing

RADCOM Session Analyzer offers a wide range of perspectives to explore the signaling and detailed decode data. Including a protocols tree, dynamic flow arrows chart with detailed tooltips, the possibility of searching for text in the decode data, and RADCOM I.C.O.N. to display different network elements.

Using RADCOM Session Analyzer, troubleshooting becomes a simple task, and engineering work becomes more efficient with rapid root-cause analysis and resolution. RADCOM Session Analyzer enables operators to see calls or transactions as they happen, view detailed call data, define queries quickly, and follow the changes in an open call in real-time. Session traces can be run immediately or be scheduled ahead of time. Color coding highlights any potential abnormal or errored transactions within the session. For a more detailed analysis of transactions, users can view the full decodes of the individual messages by selecting any message on the tracing display.

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. For example, RADCOM Session Analyzer can be used to look at the release cause for iPhone 11 handsets in a specific neighborhood of a large city, based on internet APN, and return results in seconds to resolve issues that affect multiple subscribers rapidly. 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
- Run in online, historical, combined and scheduled modes
- Resolve complex network and subscriber issues
- Enable cyclic buffer and trigger-based capture
- Run rule base correlation
- Analyze user plane and perform DPI analysis
- Correlate full voice and data sessions in real-time for comprehensive troubleshooting
- Record and analysis voice media 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
- Drill up/down to/from RADCOM Packet Analyzer
- Drill up/down to/from RADCOM Network Analytics

RADCOM Network Analytics

RADCOM Network Analytics application enables operators to monitor KPI trends smartly and drill down for network troubleshooting. Supporting multi-technologies (2G, 3G, 4G, and 5G), and multi-network environments, the application offers a series of network KPIs that reflect performance across all domains, including mobile data, mobile voice, IMS, VoLTE, VoWiFi, OTT applications, fixed-line data, and fixed-line voice.

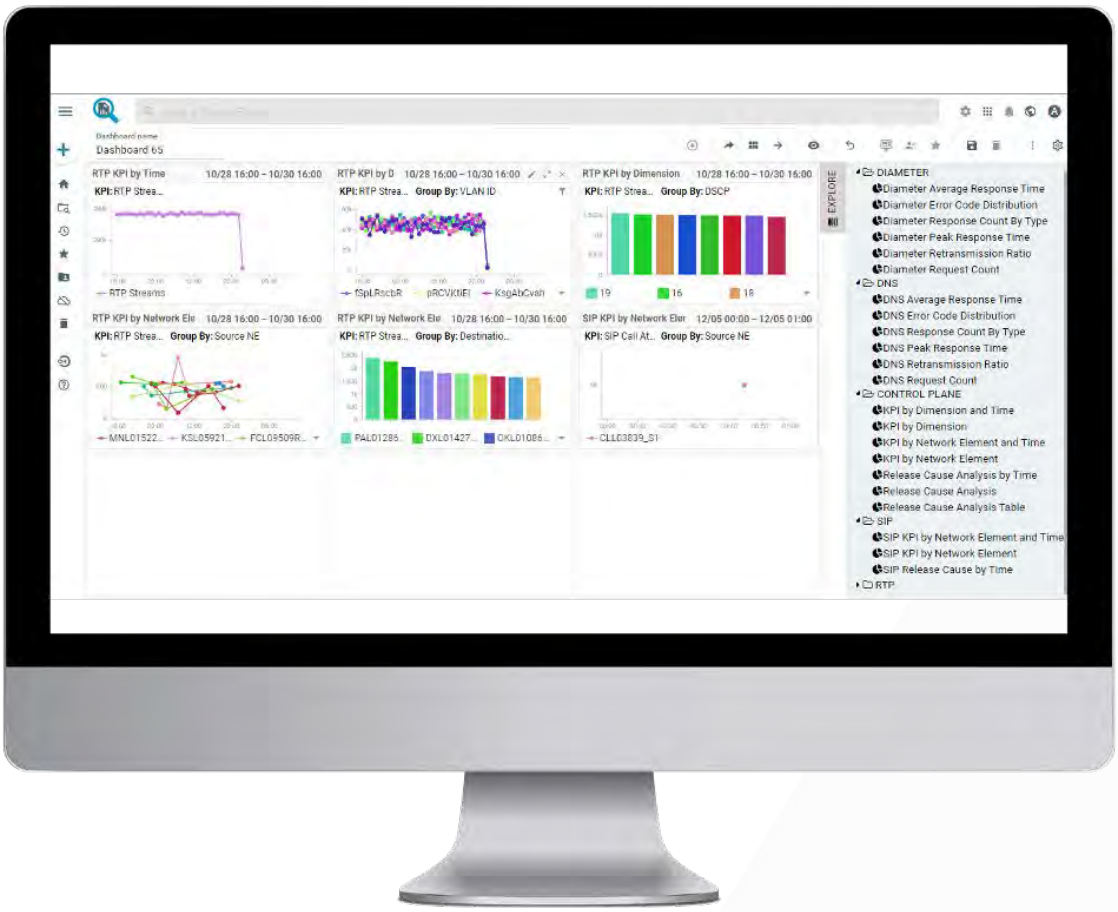

Figure 26 - Monitor KPI trends and drill down for network troubleshooting

RADCOM Network Analytics has an intuitive UI built for monitoring dynamic next-generation networks that can be changed on-demand built for collaboration. The solution is web-based, and so there is no need to install a client, and the system can run on Windows, UNIX, or Linux. It is blistering fast, supports multiple users out of the box, and offers full administrative control while adhering to security and user content privacy. Permissions and roles are defined by application (application, functions & operations, etc.) or traffic (traffic type, traffic groups, network segment). System logs are created for system debugging, troubleshooting (levels), access Logging as well as user activity monitoring.

RADCOM Network Analytics has the following features built-in:

- Multi-technology, multi-dimension KPI dashboard capabilities
  - Drag and drop dashlets to dashboard interface
  - Ability to define grouping and filtering rules for each dashlet
- Dashlet types
  - Predefined and user-defined KPIs
  - KPI per element and overtime
  - Release Cause distribution over time
  - Unique IMSI
- Drilldown to RADCOM Session Analyzer and RADCOM Packet Analyzer
- Schedule dashboard updates
- Enable data-driven dynamic notifications with baselining
- Share dashboards with colleagues
- Export to PDF, Excel, PNG

Ensuring the Internet of Things

Narrowband IoT (NB-IoT) and LTE-M (LTE Machine-type Communications) - previously known as LTE-MTC or LTE-eMTC - are cellular technology standards specified by 3GPP Release 13 (finalized in June 2016) to address the market for low power wide area connectivity and the Internet of Things. Both NB-IoT and LTE-M technologies will continue evolving as part of the 5G specifications, meaning that operators can leverage their current investments in IoT today and build on them as part of the 5G evolution.

The main differences between the standards are the latency and speed. NB-IoT is designed more for static sensor applications and LTE-M for mission-critical applications (with a latency of 10ms vs. 1.6-10 seconds) as well as enabling an increased data throughput compared to NB-IoT. Both standards will also coexist in the same networks as other 5G New Radio (NR) components, like enhanced mobile broadband and critical communications, which means that the long-term status of these technologies is established.

Most of today's cellular IoT connections generate relatively small amounts of data traffic. The typical data size for a sensor-based service is about 100–150 bytes, with a payload comprised of a device ID, timestamp, and reported data values. Currently, IoT technologies are capable of supporting data rates of approximately 170 kbps (DL) and 250 Kbps (UL) for NB-IoT and 1 Mbps for LTE-M (DL/UL). However, this data volume is expected to increase as a broader range of use cases evolve along with the continued rollout of 5G and edge networks. These new use applications will include traffic safety, automated vehicles, drones, and industrial automation, which will have strict requirements on availability, latency, and reliability and will generate significantly more data traffic.

IoT covers a broad spectrum of use cases and applications. From smart metering and asset management that require significant numbers of low-cost devices to send small amounts of data, to drones and VR/AR applications that have high throughput, low latency, and large data volumes. In the future, use cases will expand to include autonomous cars and traffic safety that require ultra-low latency, ultra-reliability, and high availability, as well as smart electrical grid automation and industrial automation that are time-sensitive and require precise positioning. These differing requirements mean that for operators, no one technology will fit all use cases, which is why most operators are deploying multiple IoT networks.

Today, over 120 operators worldwide are known to be actively investing in NB-IoT, Cat-M, or both. Operators are rolling out major IoT initiatives in areas such as smart homes, agriculture, robotics, smart cities, and intelligent energy that are all leveraging the potential of IoT. At the end of 2019, there were approximately 10 billion IoT connections worldwide. Next year, the first Critical IoT deployments are expected to be introduced on 5G networks used for time-critical communications that require guaranteed data delivery with specified latency targets. Typical use cases will include AR/VR, robotics, autonomous vehicles, advanced cloud gaming, and real-time control of machines and factory processes.

Operators recognize significant revenue opportunities across a diverse range of new IoT applications and offer a wide range of services, from basic IoT connectivity and service management right up to complete end-to-end solutions and vertical-specific offerings. This generates value for industry customers, and the operators can acquire higher revenue streams. However, as operators offer this as an end-to-end solution, they also need to assure that connectivity is maintained, and SLAs achieved.

RADCOM provides operators with a comprehensive IoT Service Assurance solution with a range of capabilities that help alleviate the challenges and ensure that customers receive IoT services that meet stringent SLAs. From assuring the service connectivity, optimizing network performance, monitoring security, to delivering automatic anomaly detection for both connectivity assurance and security.

Figure 27 - Assuring IoT service connectivity with RADCOM Network Insights

RADCOM Network Insights displays real-time intelligence on the behavior of the network, highlighting any issues in connectivity as well as device and network performance.
The operator can then drill down to a specific device or location, pinpointing the root cause of any network issue, ensuring smooth connectivity and maintaining SLA's. While the "things" in IoT are essential, how devices relay information and perform are equally important.

So, as well as individual devices or device types, the operator can also examine the overall service performance. As well as network/device performance and connectivity, RADCOM's solution provides the geolocation of devices.

For some IoT devices, this is important as specific devices are expected to be static, and so if they move, this means there could be an issue. The new IoT standards introduce several new paths for data to transverse through the network in which the user plane data is sent encapsulated inside the NAS protocol on the S1 MME. Then the MME can send it over to the application server (AS) in several different ways:

- The MME can send the user plane over the S11-U (a new interface) to the SGW, then to the PGW, and out to the AS. The S11-U interface is used for small data transmissions between the MME and S-GW. Based on the existing GTP-U architecture.
- To encapsulate the user plane traffic inside the diameter message and send it on the T6a to the SCEF and then to AS.
- Another option (if it is an SMS message) is to send it to the Short Message Service Center (SMSC) and then out to the AS (carried over a diameter-based protocol).

RADCOM supports the correlation between the S11-U and the S11 control plane and the new protocols and interfaces that include user plane captured in the control plane, several new diameter interfaces, and the new S1-MME messages and new encapsulation options for sending data over NAS.

In working with leading operators worldwide, most are looking to monitor the traffic around the MME, which provides the majority of the required information from a single monitoring point. RADCOM also tracks and correlates IoT traffic that goes through different paths through the network, such as via the SGW/PGW and the SMSC. RADCOM's solution provides operators with KPI dashboards for IoT and supports the new IoT messages (for KPIs like success rate, average duration, etc.).

RADCOM also provides operators with a comprehensive call tracing application - QTrace - both for session tracing and drilling down from the KPI Dashboard for troubleshooting purposes. In QTrace, data sessions are correlated between S11 and S11-U to provide an end-to-end session based on the device IMSI.

Automatic Anomaly Detection

With more and more IoT devices connecting to an already complex network using ML, it will be crucial for mass deployments of IoT devices, identifying baselines, and then automatically detecting anomalies.

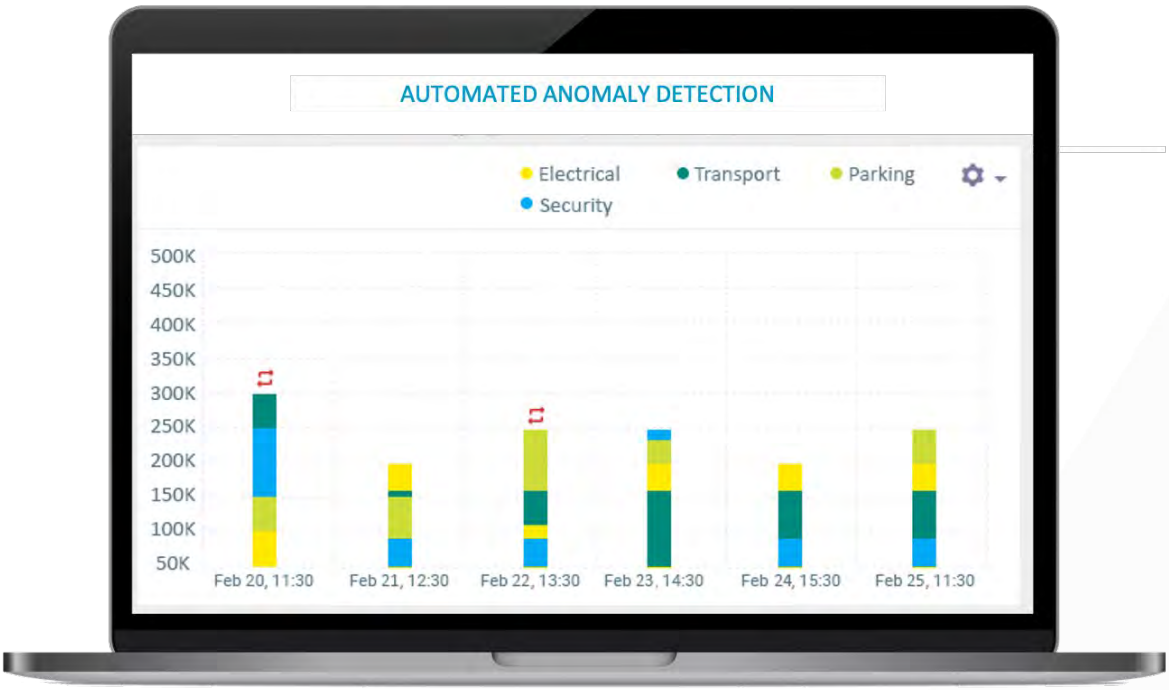

Figure 28 - Utilizing AI/ML to provide automatic anomaly detection for IoT services

When a device fails to connect to the network, it is unable to notify the operator as a regular human subscriber would. So to ensure IoT service connectivity and performance, IoT devices need to be continually analyzed to provide operators real-time alerts and lower time to detection and resolution.

RADCOM gives operators built-in anomaly detection as well as near real-time feeds to 3rd party tools. RADCOM detects IoT anomalies by utilizing ML to define a baseline per device and then automatically generate alarms if the baseline threshold is crossed.

Automated anomaly detection can also be used to detect and resolve security issues as well as for connectivity and service performance.

RADCOM's solution sets the baseline and monitors anomalies according to the following categories:

Data volume

Typically, a machine will send the same amount of data (~100-150 bytes) at the same frequency. If the device suddenly starts sending significantly more data, this would be considered abnormal and could mean that someone has hacked the device or there is a malfunction.

Traffic destination

An IoT device sends the data to a specific application server using a particular IP address, and RADCOM's solution will learn this address automatically. If the device starts sending it to a new server, then RADCOM will sound an alarm.

Data transmission frequency

RADCOM determines how often and when data is sent per device and so if the schedule or rate changes, an alert will be generated by RADCOM's system.

Operators need to deploy an efficient assurance solution for managing millions of IoT devices that generate data in different patterns and varying regularity to analyze and understand what's happening in the network in real-time. Only then can they optimize their IoT service performance and ensure their most demanding customers, such as government agencies, municipalities, and large enterprises, are receiving the expected service.

RADCOM IoT Service Assurance provides a comprehensive end-to-end view of the overall IoT service with troubleshooting capabilities that enable operators to meet stringent SLAs with their customers across a wide range of IoT implementations and use cases. With automated anomaly detection, RADCOM ensures service performance, device functionality, security, and connectivity in a more efficient and viable way for operators to deliver quality IoT services to customers while providing a secure and fully optimized network.

Conclusion

RADCOM Network Insights uses data from both RADCOM Network Visibility and RADCOM Service Assurance to provide rich, actionable insights for multiple use cases and departments across the organization (engineering, customer care, Network Operations Center, Service Quality). By correlating RADCOM Network Insights with various data sources using RADCOM Smart Mediation, RADCOM SOC and CEM provide operators with a modular and cost-effective solution to understand the customer experience and troubleshoot service performance.

To provide insights into encrypted traffic, RADCOM utilizes cutting edge technologies such as ML and heuristic modeling. These technologies are deployed to find and recognize patterns in the network traffic that build up an understanding of the quality of experience. Once these patterns are understood, ML develops algorithms that enrich the operators' KQI's and further enhance the operator's ability to understand the customer experience even when traffic is encrypted.

RADCOM Network Insights delivers a smart end-to-end view of the overall user and service experience, enabling operators to deploy a customer-centricity approach to service assurance that will boost the end-to-end service quality while increasing customer satisfaction and brand loyalty.