

OPTIMIZE AND TROUBLESHOOT RAN, VRAN AND O-RAN





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INTRODUCTION




It has been estimated that over 70% of all service degradations experienced by subscribers are due to issues in the Radio Access Network (RAN). These degradations can have a critical impact on the customer experience, including lack of connectivity, dropped calls, and slow download speeds. These service degradations can lead to a direct loss of revenue due to churn, increase operator costs in support and take time to resolve, so it's critical operators smartly monitor the RAN as part of their end-to-end monitoring of the customer experience.

RADCOM's RAN monitoring solution is used by telecom operators to smartly monitor both the Radio Access Network (RAN), Virtual Radio Access Network (vRAN) and Open RAN (O-RAN) to help resolve any RAN degradations as quickly as possible. Providing real-time and historical insights for operators to troubleshoot, and optimize RAN performance, while also utilizing built-in machine learning capabilities to save the operator time in performing root cause analysis, detecting anomalies in the RAN and gaining insights into encrypted traffic.

RADCOM's solution offers:

- Real-time visibility into the RAN
- Detects and executes root cause analysis utilizing AI and Machine Learning (ML)
- Includes RAN analytics as part of the end-to-end service quality monitoring

It's critical operators smartly monitor the RAN as part of their end-to-end monitoring of the customer experience

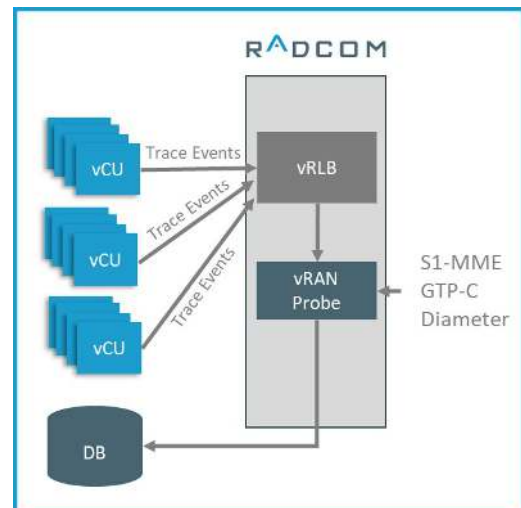


RAN MONITORING

As the gateway to mobile connectivity, delivering an optimized customer experience to subscribers depends on RAN performance. If there's an issue, it can have a direct impact on customers. Therefore, real-time monitoring of the RAN needs to be an essential part of an operators end-to-end, assurance solution.

RADCOM's solution receives TCP streams, or bulk data loads from all the Virtual Central Units (vCU): RRC, S1-AP, Xn (additional interfaces are also supported). RADCOM's solution consists of the following components:

- Virtual RAN Load Balancer (vRLB)
- RAN probe engine

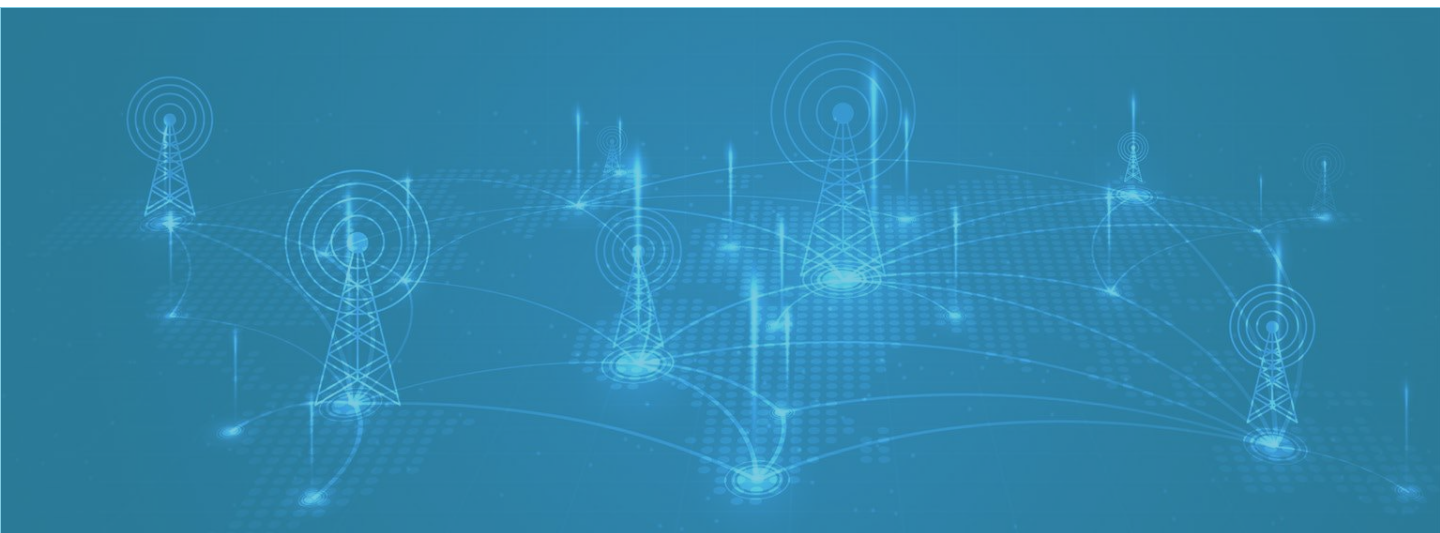


Using RADCOM's solution RAN data can be fully correlated to the subscriber (IMSI). With this correlation RADCOM supports hundreds of subscriber-centric metrics and KPIs for end-to-end network optimization and improved customer satisfaction. Correlation is achieved on 4G through data collection from three core protocols: S1-MME, GTP-C, Diameter and other SBI protocols from the 5G-SA core. RADCOM's solution correlates RRC/Xn/S1AP messages to the IMSI with an accuracy not less than **99.8%**. In addition, RADCOM's solution has built-in algorithms that recognize messages that are received out of order and reorganizes them, so the correct sequence of the call flow is maintained. RADCOM's solution generates user centric events on the fly method and can stream RAN data to other destinations/applications. Aggregation capabilities and session-based xDRs are also provided by RADCOM's solution.

RADCOM supports 100s of subscriber-centric metrics and KPIs

RAN MONITORING

Offering enriched and actionable RAN data, RADCOM's solution is used to diagnose RAN performance in real-time, understand customer demand and usage, support traffic pattern analysis for network capacity planning, and gain an end-to-end view from the radio to core.



Solution benefits:



Pinpoint RAN issues quickly

Identify RAN issues before they affect subscribers.



Understand the end-to-end service quality

Combine RAN and core data, to gain insights into the end-to-end service quality to enhance subscriber offerings.



Accelerate time to resolution for customer-affecting degradations

Probe-based assurance enables root cause analysis to be performed for RAN issues.



Enhance the customer experience

Ensure network performance is maintained at the gateway to the mobile network to ensure the customer experience.

USE CASES

RADCOM's solution for RAN monitoring is a lightweight, highly efficient virtualized solution that can ingest, process and analyse RAN streaming data and correlate it to core data, for multiple use cases.

Attach/Access issues

RADCOM's solution provides a detailed analysis on the “attach” process at different granularity levels. The lowest granularity is the individual IMSI level. Operators can examine the NAS procedure messages from the RAN to the Mobility Management Entity. From there the operator can drill to the Release Cause and further down to the packet level to troubleshoot issues.



Figure 1 - S1AP Attach



Figure 2 - Zoom into S1AP Attach Success Rate KPI

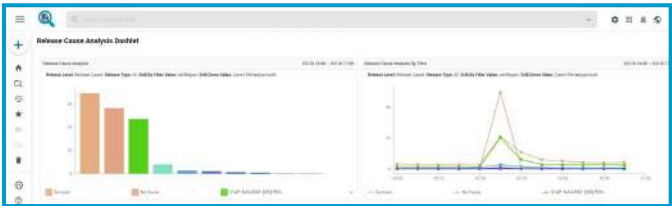


Figure 3 - Drill to Release Cause Analysis

Release cause observed:
S1AP: NAS-EMM:
[015] No Suitable Cells In tracking area

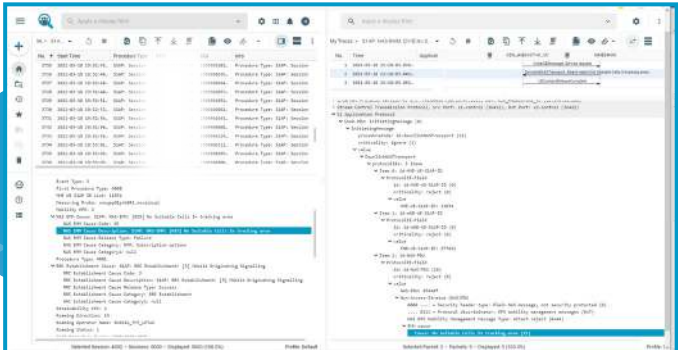


Figure 4 - Drill to Session and Packet Analyzer

USE CASES

UE analysis

RADCOM's solution for RAN monitoring, maps all the device types and quantities to understand device support for MIMO capabilities before new service rollouts:

- BAND 3 (4G - 1800 MHz) with 4 Layer MIMO
- BAND 3 (4G - 1800 MHz) with 2 Layer MIMO

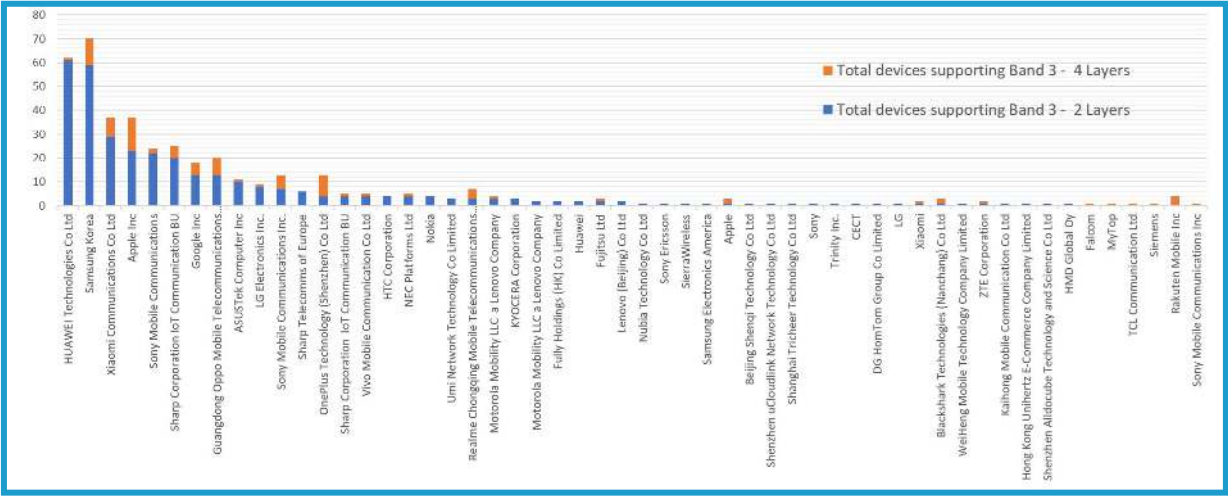


Figure 5 - Device MIMO Capable Band 3 (2 Layers vs 4 Layers)

For support and troubleshooting issues RADCOM's solution can analyse different device types and how they perform on the network:

- Device brand comparison between Samsung and Apple
- Shows the better performers in terms of signal coverage on a specific triggered event
- A drill to list can allows to investigate further device type or versions

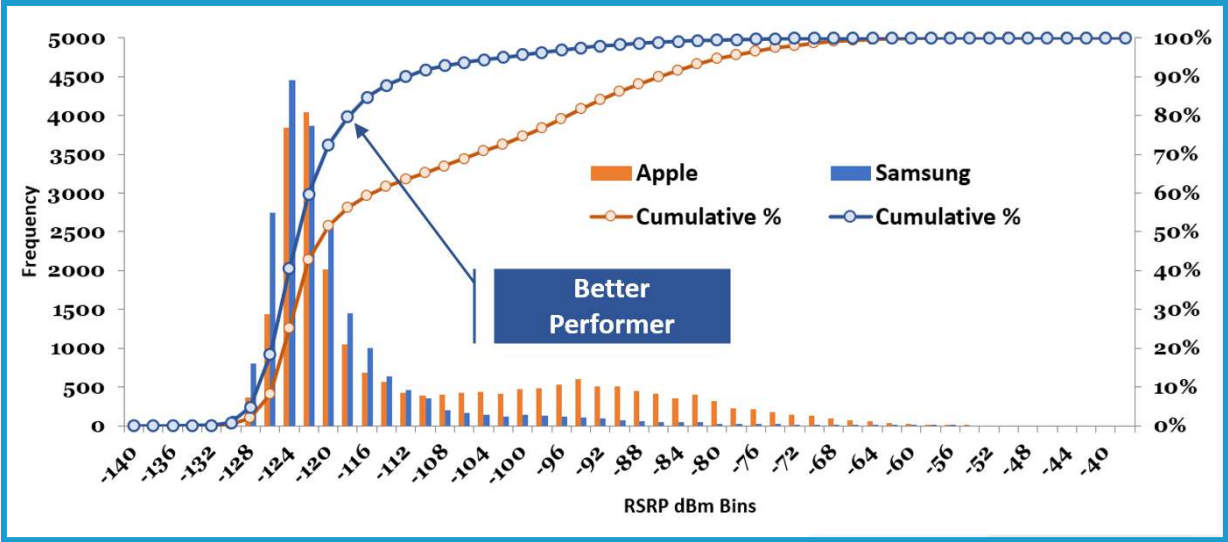


Figure 6 - Device comparison (signal coverage)

The figure displays a Wireshark packet capture analysis. The left pane shows a list of 30 packets. The middle pane shows the details of the selected packet (No. 1, Time 0.000000, IMSI 2406, Info NRConnectionRequest). The right pane shows the packet bytes and hex data.

No.	Time	IMSI	Info
1	0.000000	2406	NRConnectionRequest
2	0.000000	2406	NRConnectionSetup
3	0.000000	2406	NRConnectionSetupComplete, Tracking area update request
4	0.000000	2406	InitialUplinkMessage, Tracking area update request
5	0.001185	2406	DownlinkNASTransport, Ciphered message
6	0.001185	2406	DLInformationTransfer, Ciphered message
7	0.001185	2406	UEContextReleaseCommand [UE-context-normal-release]
8	0.004549	2406	UEContextReleaseComplete
9	0.207781	2406	NRConnectionRelease [cause=other]
10	168.784773	2406	NRConnectionRequest
11	168.784773	2406	NRConnectionSetup
12	168.890271	2406	NRConnectionSetupComplete, Attach request, PSM connect
13	168.891311	2406	InitialUplinkMessage, Attach request, PSM connectivity req
14	168.951920	2406	DownlinkNASTransport, Ciphered message
15	168.955247	2406	DLInformationTransfer, Ciphered message
16	168.955247	2406	UplinkNASTransport, Ciphered message
17	168.955247	2406	ULInformationTransfer, Ciphered message
18	169.065487	2406	DownlinkNASTransport, Ciphered message
19	169.069310	2406	DLInformationTransfer, Ciphered message
20	169.115310	2406	UplinkNASTransport, Ciphered message
21	169.115310	2406	ULInformationTransfer, Ciphered message
22	169.538225	2406	InitialContextSetupRequest, Ciphered message
23	169.542195	2406	CallTransferTrace
24	169.542626	2406	SecurityModeCommand
25	169.578626	2406	SecurityModeComplete
26	169.578626	2406	UECapabilityEnquiry
27	169.615626	2406	UECapabilityInformation
28	169.615626	2406	UECapabilityEnquiry
29	169.675626	2406	UECapabilityInformation
30	169.675626	2406	UECapabilityInformationIndication, UECapabilityInformation

Selected Packet: 1 • Packets: 200 • Displayed: 200 (100%)

Figure 7 - Investigating an individual user session

- Performance by cell
- Performance by IMSI
- Performance by neighboring cell
- Handovers that do not take place even though the candidate cell signal is higher than the serving cell.

Success rate - SR (%)

X2 handover attempts and successes are counted from the X2AP protocol events to draw performance metrics. These handover failures can then be investigated for root cause analysis.

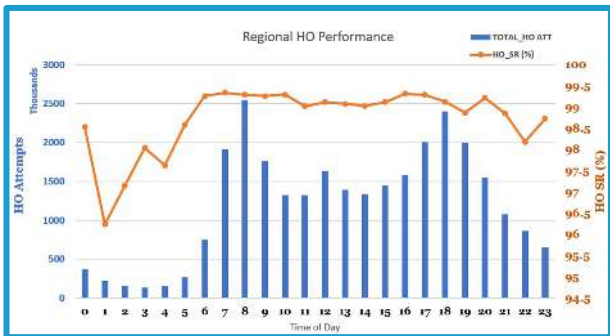


Figure 8 - Investigating handover failure

USE CASES

Handover failure (cont'd)

A handover metric that counts problems combined from several triggers:

Examples:

- dB-delta="3" time-delta="5"
- dB-delta="4" time-delta="5"
- dB-delta="5" time-delta="5"

In the example, the neighboring cell received a signal that is higher than the serving cell (dB-delta) for 5 seconds (time-delta).

The graph on the right shows the defined triggers above and shows this is a clear case of handover (HO) delays during the busy hour.

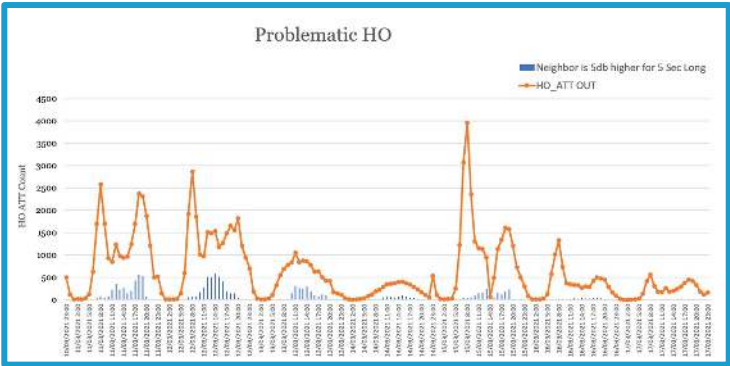


Figure 9 - Investigating handover problems

Subscriber journey

RADCOM's solution combines radio and core data that provides operator business intelligence and network optimization in a graphical user interface. In this example the subscribers' journey through serving cells and their coverage level can be viewed and investigated



Figure 10 – Viewing the subscribers' journey through serving cells

USE CASES

End-to-end assurance

As part of an end-to-end monitoring solution, RADCOM's RAN solution enables the operator to gain complete network visibility. Providing an understanding of the root cause for a given subscriber or area or group of subscribers or even a manufacturer, and leads the operator to the corrective actions required to resolve them. RAN data includes core metrics such as Packet Jitter, Packet Loss, Timeouts, VoIP Out of Order packets, Throughput, and Connection Release Cause that can be collected and measured. These metrics, combined with the core data, helps the engineer investigate a problem and improves the customer experience.



Figure 11 – Viewing RAN and core data combined for end-to-end assurance

Monitoring a sleepy cell

RADCOM's solution can quickly analyse mass amounts of data to identify a sleepy cell (a cell that is not taking traffic from subscribers even though the cell is on air). This is recognized by RADCOM's solution by observing events at a 5 second granularity.

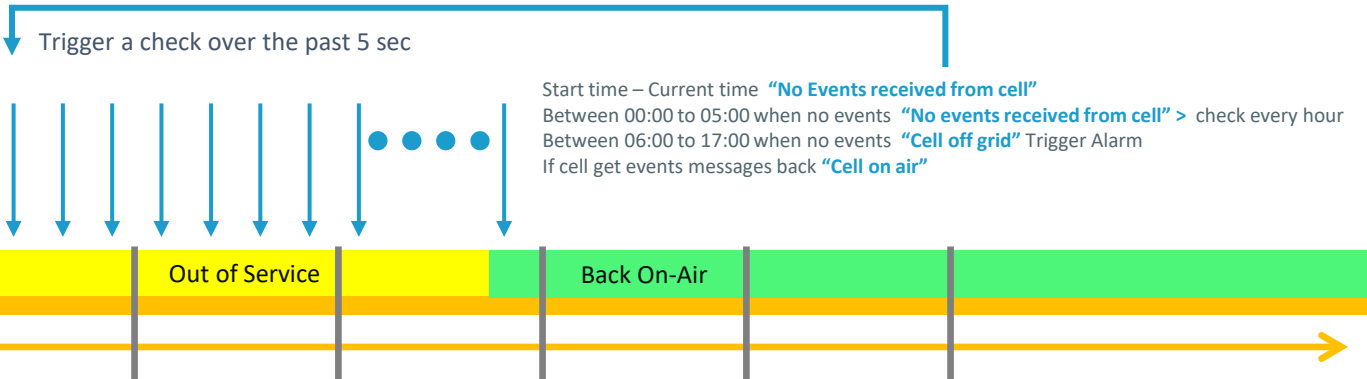


Figure 12 – Recognizing a sleepy cell

USE CASES

Good RF performance vs. satisfied subscribers

A cell with an average serving level of $\sim -100(\text{dBm})$ would assume to be performing well. However, the cell also has a significant number of unsatisfied subscribers with measurement reports below -120dBm .

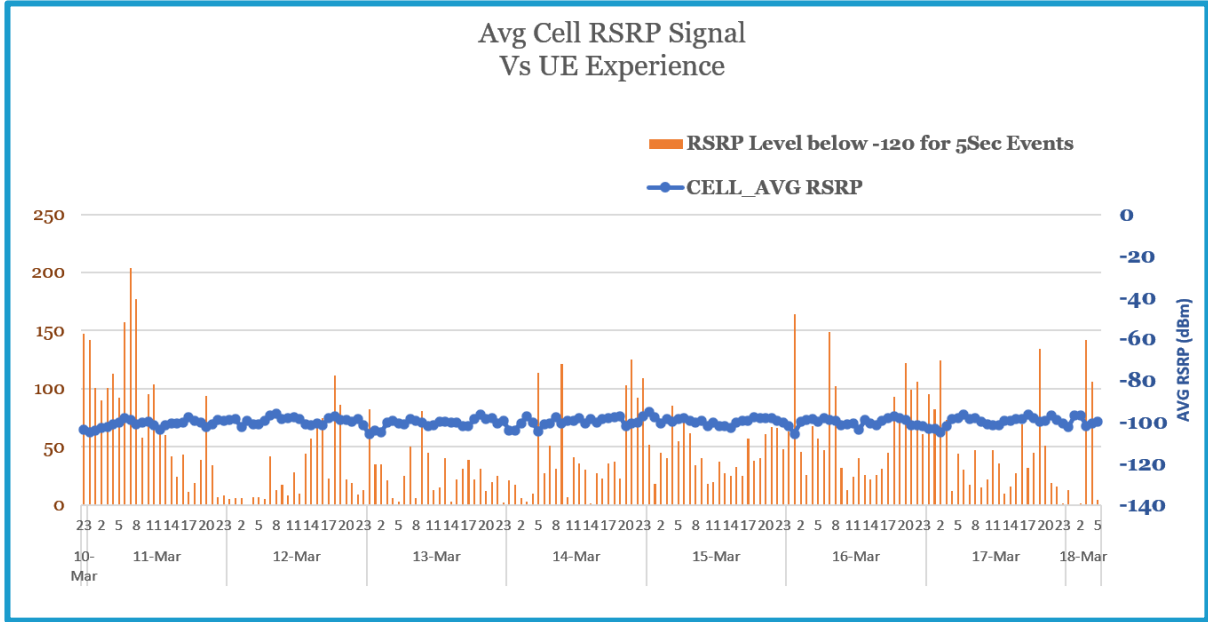


Figure 13 – Recognizing cells that are not delivering a good customer experience

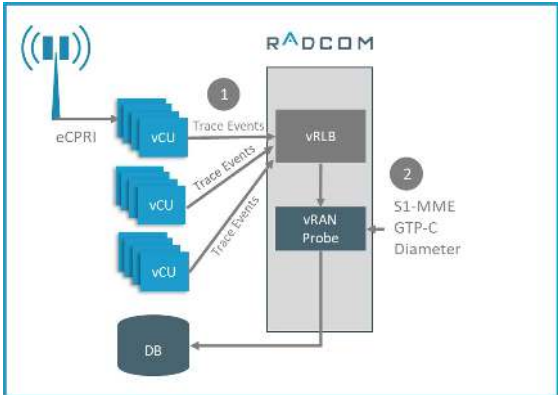
In this example the cell average is good, but there are a lot of subscribers with a bad experience.

Predicting cell outage

RADCOM's solution identifies that the cell is not sending messages, and triggers an alert: The solution identifies messages from two main sources:

- Trace Events: RRC/X2/VSE 1
- S1AP, GTP-C from MME 2

If there any of the sources in reference to a specific Cell is not O.K the solution triggers an alarm or any pre-defined action.



Trace Events:

- Layer 2 Information (PHR, TPC, CQI)
- RRC protocol information (All RRC Msg)
- X2 protocol information (HO Msg)

SUMMARY

RADCOM provides the operator with end-to-end visibility into the RAN. With drills down to the packet level as well as root cause analysis, RADCOM's solution enables the operator to smartly monitor their RAN technology (running low, mid, and high-band spectrum). RADCOM's solution offers dynamic, on-demand service assurance and network troubleshooting at a macro and micro level so customer-affecting network (RAN and core) degradations can be resolved quickly with minimal efforts.

Our probe-based solution fully supports RAN/vRAN/O-RAN/O-vRAN and offers real-time subscriber analytics and advanced end-to-end troubleshooting capabilities by monitoring both the control and user plane. **RADCOM** provides Key Performance Indicators (KPIs), and Key Quality Indicators (KQIs) for 5G RAN (running low, mid, and high-band spectrum), enabling the telecom operator to optimize RAN deployments.

As part of an end-to-end monitoring solution, **RADCOM's RAN solution** enables the telecom operator to gain complete network visibility and understand the root cause of an issue and take the corrective actions required to resolve it. RAN data includes core metrics such as Packet Jitter, Packet Loss, Timeouts, Throughput, and Connection Release Cause that can be collected and measured. These metrics, combined with the core data, help the telecom operator to optimize the customer experience level. **RADCOM** provides visibility into the customer experience level and not just at the service-level to ensure a smooth rollout of greenfield RAN technologies and ensures an enhanced user experience.


RADCOM also utilizes built-in machine learning capabilities to deliver RAN insights automatically, saving the operator's time in performing root cause analysis and detecting anomalies. Some use cases are:

- Identify data "hoggers"
- Cell outage predictions
- Discover coverage holes
- KPI / KQI Anomaly Detections
- Automated Root Cause Analysis

RADCOMize your

RADIO ACCESS NETWORK (RAN)

For more information about RAN monitoring, visit: <https://radcom.com/solutions/ran-monitoring/>



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