

TECHNICAL OVERVIEW

Enabling Device Troubleshooting Network Emulation Solutions

Introduction

5G is moving fast. Accelerating 5G deployments globally are having a ripple effect throughout the mobile ecosystem. 5G also represents an exponential increase in technical complexity. Key challenges come from 5G new radio (NR), massive multiple input multiple output (MIMO), millimeter-wave (mmWave) frequencies, and over-the-air (OTA) test methods.

The complexity of 5G brings challenges to the development and market introduction of new devices. Device manufacturers and operators need to be able to effectively analyze the devices under development and troubleshoot found issues quickly to ensure go-to-market targets are met. Also, the quality and capabilities of new 5G devices must fulfill market and end-user requirements.

Keysight's 5G Network Emulation Solution portfolio addresses the entire device development workflow – from early design, to acceptance and manufacturing. With the troubleshooting capabilities offered by Nemo 5G Device Analytics and Nemo Outdoor, you will gain deep insight into your device quality and reach first-to-market status.

What is Device Troubleshooting?

Keysight's device troubleshooting solutions ensure your new high-quality 5G devices are first to market. With this chipset and device-agnostic solution, you can correlate data from multiple sources and effectively analyze and troubleshoot 5G devices under test. Automated correlation of device under test (DUT) data collected with Nemo Outdoor or QXDM and data from Keysight's UXM 5G Wireless Test Platform, together with an easy-to-use UI, improves efficiency and saves time in the customer workflow.

Device troubleshooting capabilities can be enabled with the following Keysight's 5G Network Emulation solutions:

- S8701A Protocol R&D Toolset
- S8702A RF Automation Toolset
- S8703A Functional KPI Toolset
- S8704A Protocol Conformance Toolset
- S8705A RF/RRM DVT & Conformance Toolset
- S8706A Protocol Carrier Acceptance Toolset
- S8707A RF/RRM Carrier Acceptance Toolset
- S8708A Advanced Performance Test Toolset
- S8709A Virtual Drive Test Toolset
- S8710A Device Benchmarking Toolset
- S8711A UXM 5G Test Application

In this document we will describe the troubleshooting functionalities and the hardware and software components in more detail.

Device Troubleshooting Features

The device troubleshooting features enable in-depth 5G device troubleshooting in labs with an easy-to-use UI. The solution offers:

- **Accelerated device troubleshooting**
 - End-to-end view between network emulation equipment and DUT for efficient analytics
 - Built-in, automated diagnostics based on machine learning/artificial intelligence (ML/AI) and rules for root cause analysis
 - Logs from Layer 1 – Layer 7 for in-depth analysis across entire stack
 - Processing, reporting and analytics automation for streamlined workflow
- **Single tool across device models and chipsets**
 - Same tool across devices and chipsets for consistent analytics and user experience
 - Enables seamless and objective comparison across devices and chipsets
- **Intuitive, friendly and data-rich graphical user interface (GUI)**
 - Rich set of GUI features for effective, correlated analytics
 - Clean, easy-to-use interface for enhanced user experience

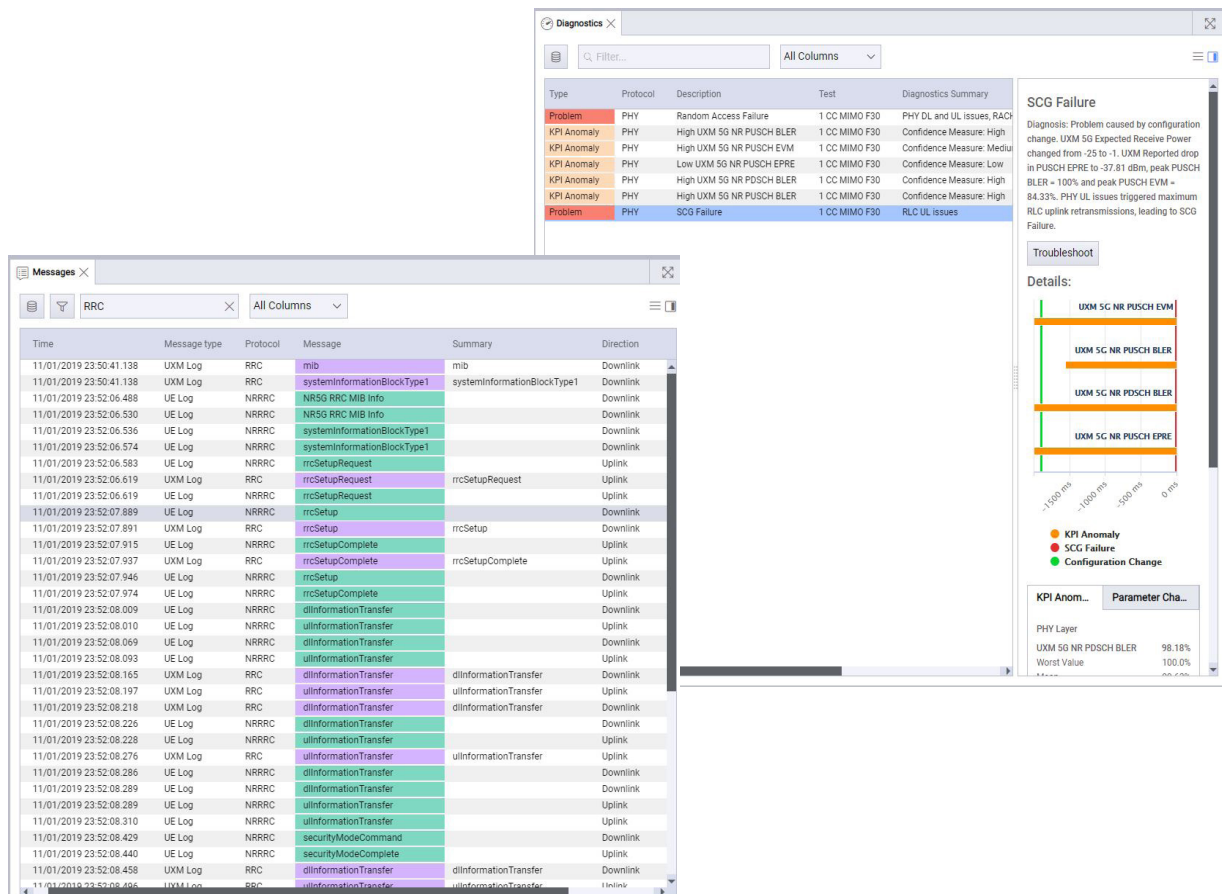


Figure 1. DUT-UXM log correlation and Automated problem detection in Nemo 5G Device Analytics.

Software and Hardware Components

The full device troubleshooting setup includes Keysight's Nemo 5G Device Analytics software for analysis and reporting, Nemo Outdoor software or QXDM for device control and diagnostics, and Keysight's UXM 5G Wireless Test Platform for network signal emulation. The device troubleshooting capabilities can be enabled in all Keysight's 5G network emulation solutions, across the entire device workflow.

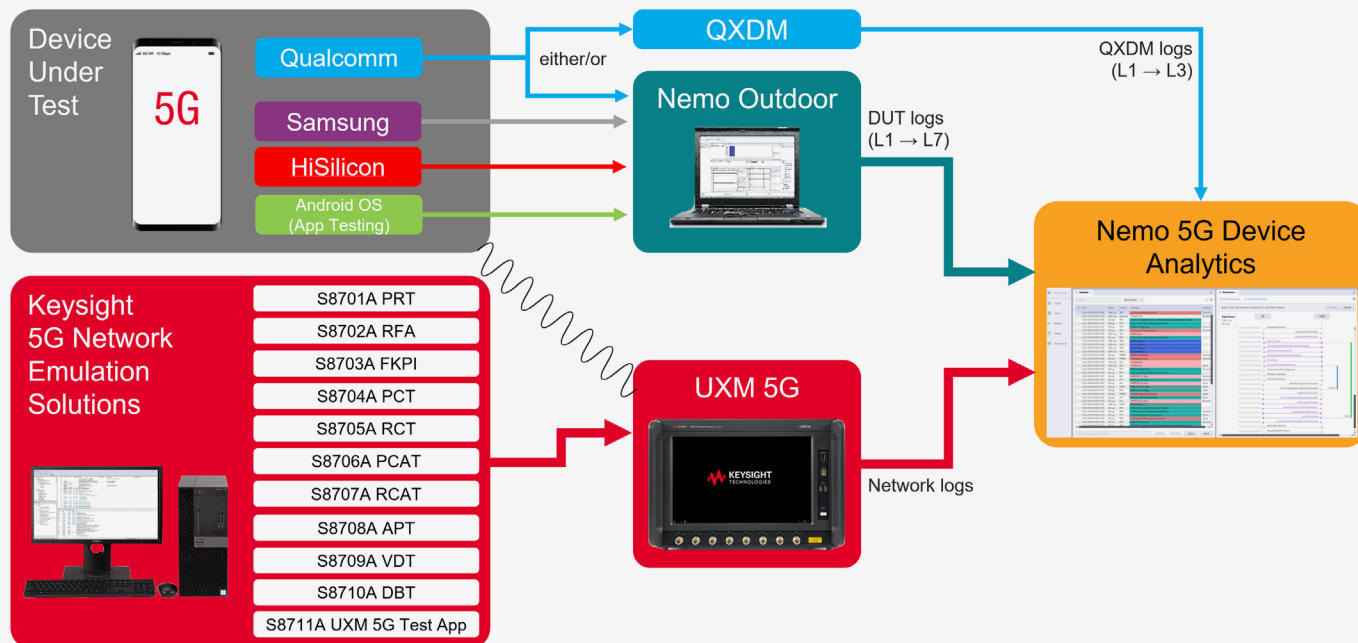


Figure 2. Keysight's device troubleshooting solution overview.

The solution is designed to fit different use cases and needs. For example, when testing with Protocol R&D Toolset, the device troubleshooting features can assist you in debugging and solving failures, such as protocol signaling failures and throughput issues. By correlating the DUT and UXM test logs, you can pinpoint the source of failures, such as parameter misconfiguration and KPI anomalies, while having access to rich analytics views for drilldown analysis. The solution also supports in-depth analytics of either the DUT or UXM test logs alone if both of them are not available.

In this setup, as illustrated in Figure 2, UXM test logs are produced by UXM, DUT diagnostics are collected with QXDM or Nemo Outdoor, and Nemo 5G Device Analytics is used to analyze the collected logs and troubleshoot issues.

Nemo Outdoor

Nemo Outdoor is a laptop-based measurement solution for 2G, 3G, 4G, and 5G NR mobile network/device testing supporting over 300 devices and scanning receivers, from various vendors, all the latest network technologies, and the latest smartphones. Nemo Outdoor offers a full test solution for wireless network testing, device testing, troubleshooting, and optimization.

Nemo Outdoor collects trace data from devices under test and provides chipset-agnostic KPIs for troubleshooting purposes. With the Qualcomm and Samsung diagnostics data logging capabilities of Nemo Outdoor, device test labs can also collect and analyze the raw data from the DUTs. Nemo Outdoor is an optional component in device troubleshooting setup as DTS can also be used with only UXM logs. However, to benefit from the correlation of DUT and UXM test logs, Nemo Outdoor is recommended.

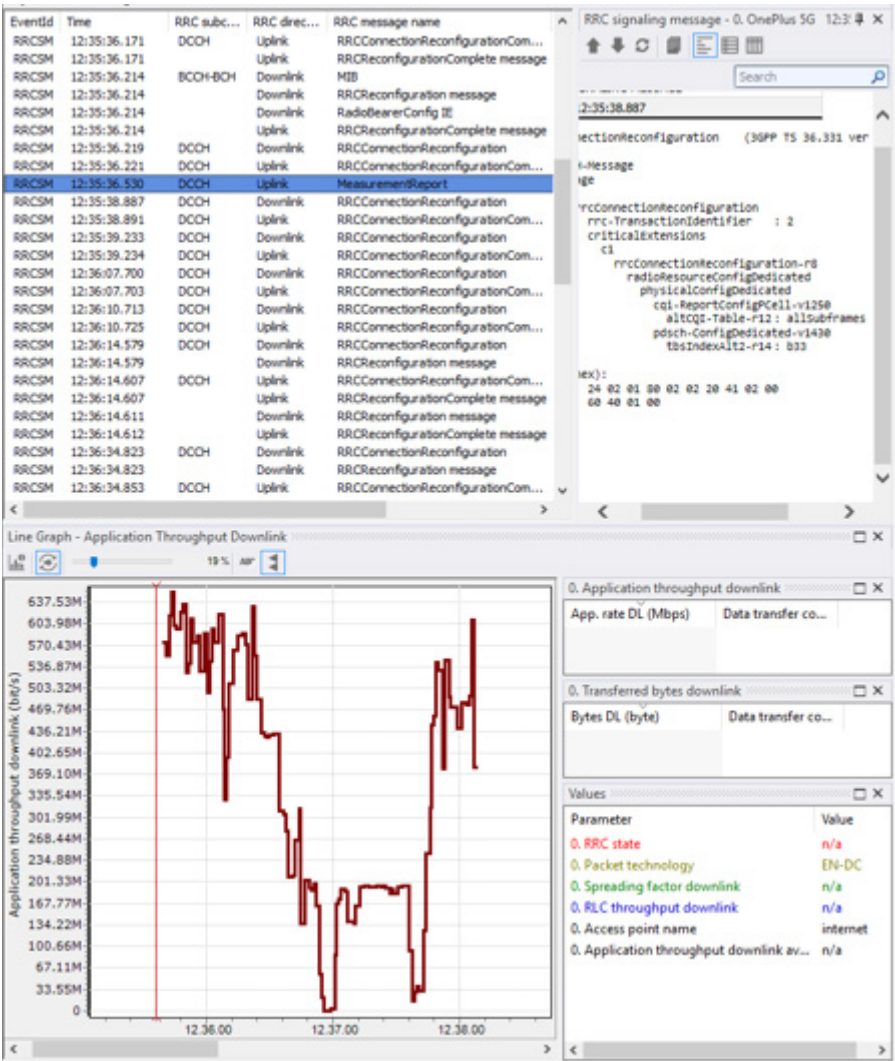


Figure 3. Nemo Outdoor RRC signaling and application throughput views.

UXM 5G Wireless Test Platform

The E7515B UXM 5G Wireless Test Platform is a highly-integrated signaling test platform with multi-format stack support, rich processing power and abundant RF resources. Supporting the latest 3GPP Release 15 and beyond, the UXM 5G enables you to establish a 5G call with a DUT in different 5G NR deployment modes (non-stand alone (NSA) and stand-alone (SA)) and frequency bands (FR1 and FR2) and perform signaling test in terms of device RF characteristics, protocol compliance and functional key performance indicators. It also supports LTE and C-V2X signaling formats.

Nemo 5G Device Analytics

Nemo 5G Device Analytics is an in-depth troubleshooting and benchmarking software for 5G devices in labs; an ideal solution for device manufacturers, network operators, device labs, and chipset manufacturers developing and testing 5G NR devices. Nemo 5G Device Analytics provides rich diagnostics and deep insight with capabilities such as detailed root cause analysis and drilldown.

Automated correlation of data from multiple sources together with an easy-to-use user interface improves efficiency and saves time in the customer workflow. Also, drilldown analysis of any issues found may be performed using the same software. Nemo 5G Device Analytics offers synchronized views and analysis of data from Keysight's UXM 5G Wireless Test Platform and/or DUT data collected with Nemo Outdoor or QXDM.

Device Troubleshooting Capabilities

Keysight's solutions offer various advanced device troubleshooting features:

- Correlation of UXM and DUT data
- Automated problem detection
- ML-driven anomaly detection
- Troubleshooting views for problem analysis
- Parameter change detection
- Metrics and event
- Message filtering and parameter comparison
- Automation workflows
- Analytics Builder

These features are explained in more detail in the following chapters.

Correlation of UXM and DUT data

Nemo 5G Device Analytics offers synchronized views of DUT data collected with Nemo Outdoor and data from Keysight's UXM 5G Wireless Test Platform providing end-to-end signaling and diagnostics for complete and efficient analysis.

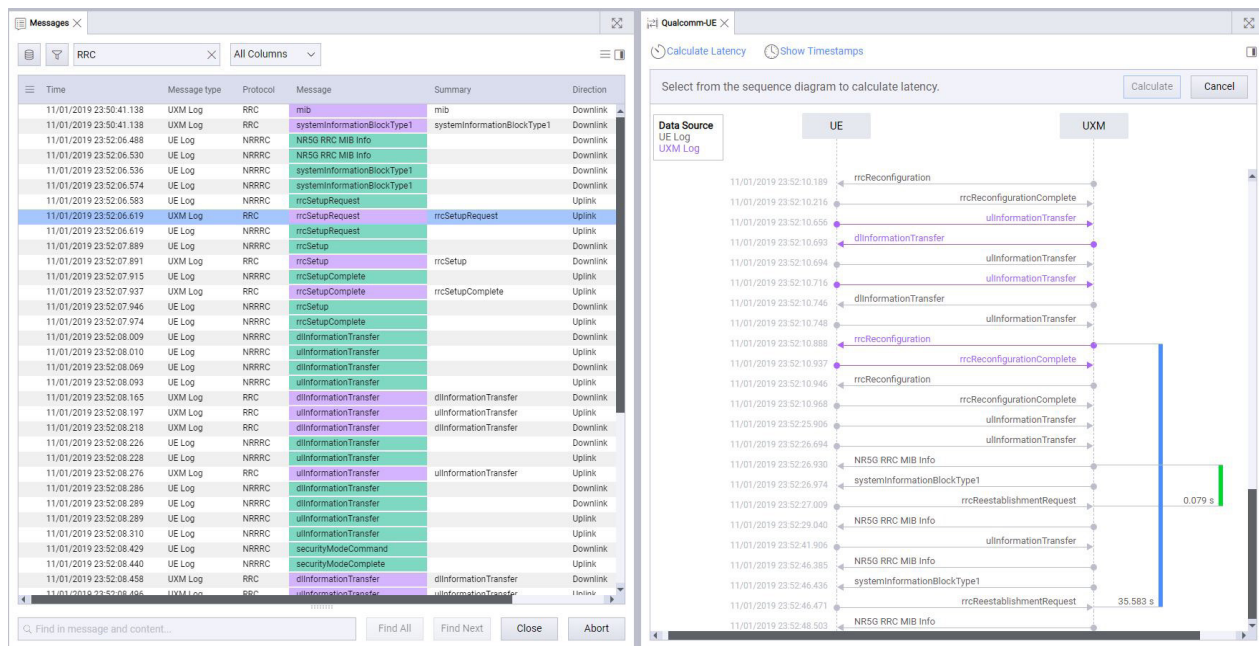


Figure 4. UXM 5G Wireless Test Platform and device under test (DUT) data correlation and latency calculation in Nemo 5G Device Analytics.

Automated problem detection

The diagnostics views in Nemo 5G Device Analytics offer detailed root cause analysis for problems. The friendly UI alerts you if some unusual behavior is observed during test case execution.

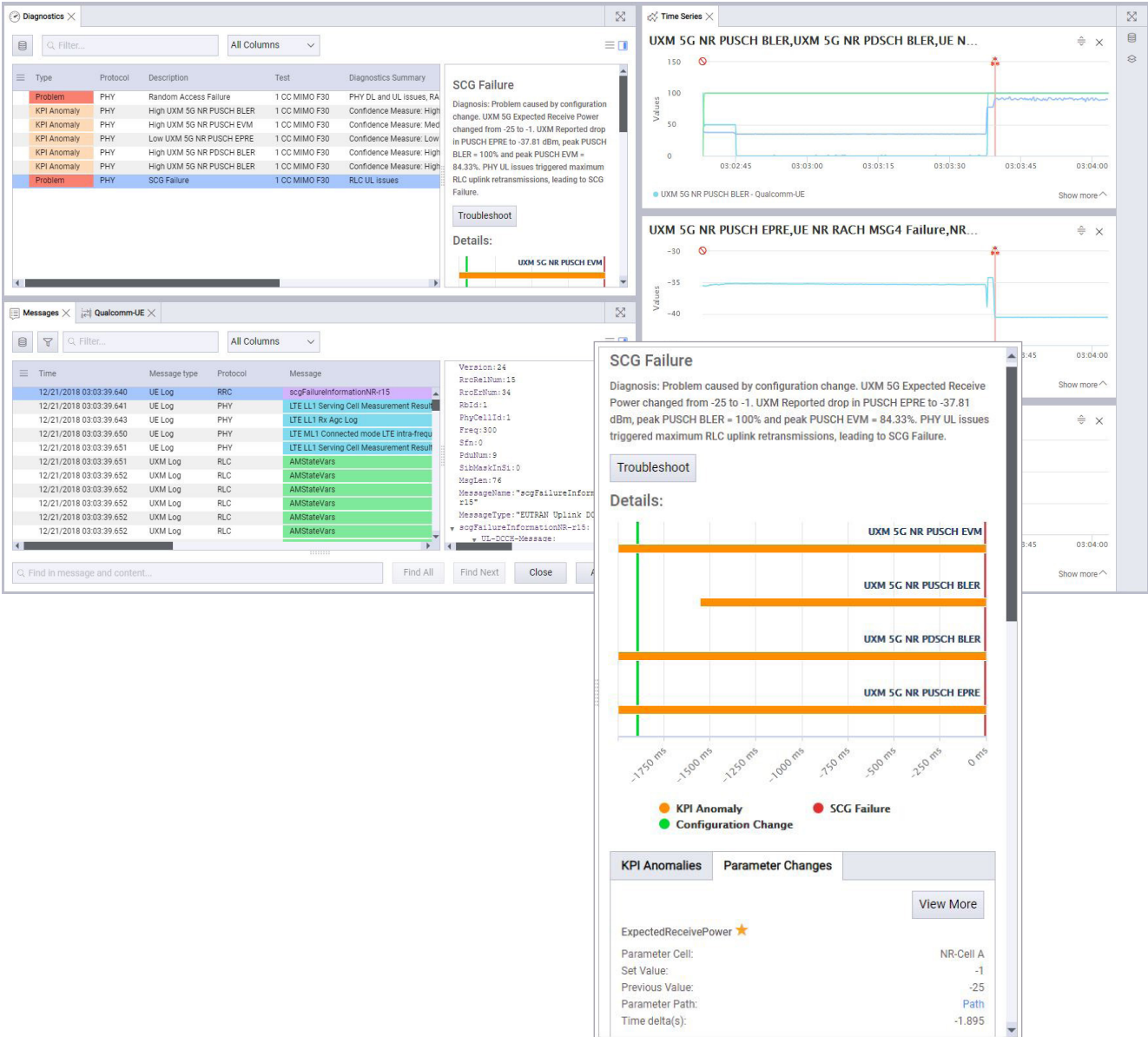


Figure 5. Diagnostics show problems observed during test case execution.

ML-driven anomaly detection

The KPI anomaly detection algorithms in Nemo 5G Device Analytics use the trained ML algorithms to detect and flag KPI problems in the test execution. KPI anomaly detection provides a confidence measure, which indicates the ML algorithm’s confidence in detecting the selected KPI anomaly. This is done for both UXM and DUT KPIs.

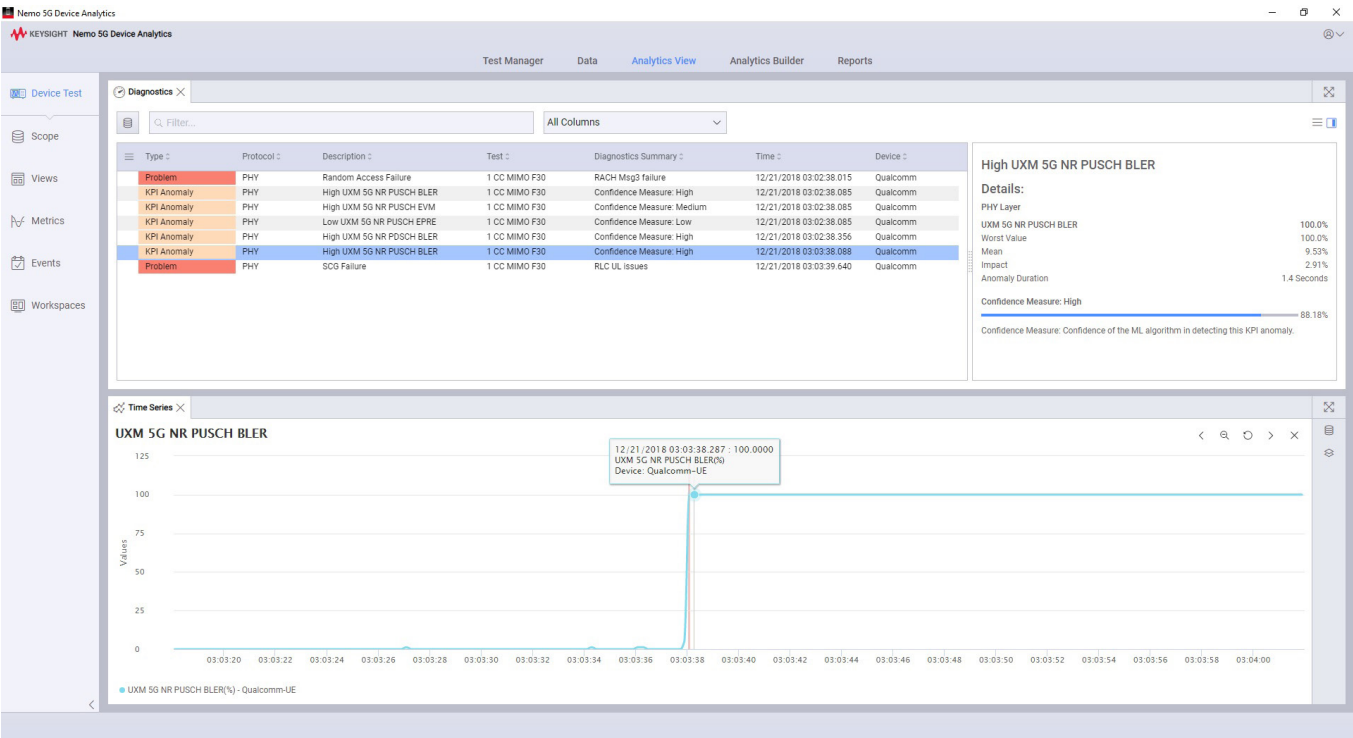


Figure 6. KPI anomaly detection algorithms use ML algorithms to detect and flag KPI problems in the test execution.

Troubleshooting views for problem analysis

Analytics views are designed as templates to offer you effective means for troubleshooting problems detected in the processed data. These templates enable a combination of different features, KPIs, and events that facilitate faster troubleshooting.

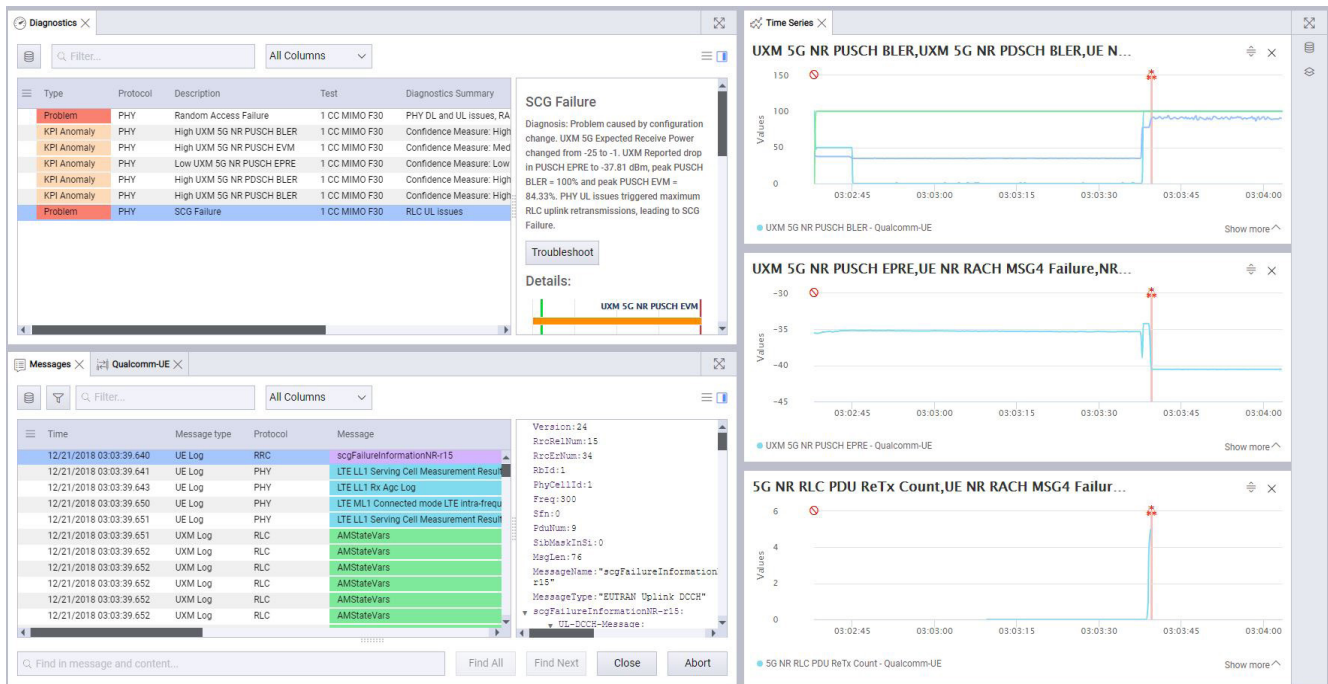


Figure 7. SCG failure troubleshooting template in Nemo 5G Device Analytics.

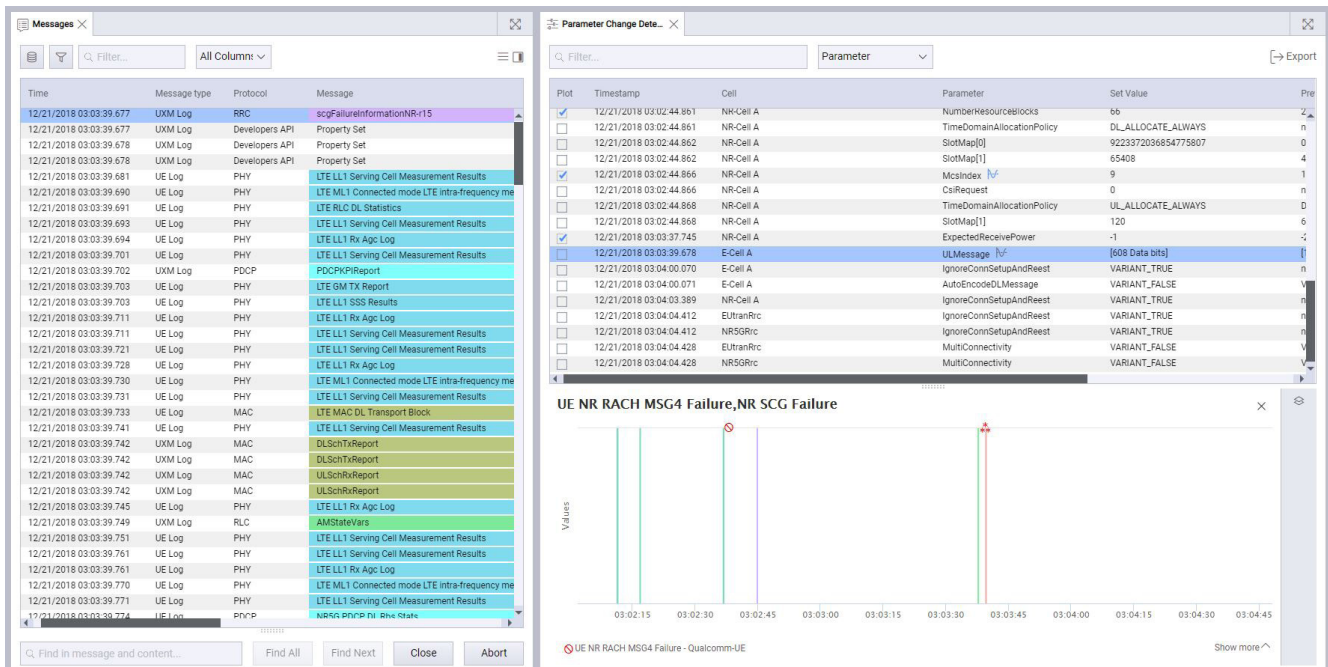


Figure 8. Parameter Change Detector template in Nemo 5G Device Analytics.

Parameter change detection

With the Parameter Change Detector feature in Nemo 5G Device Analytics, you can easily and efficiently track all parameter changes applied during the course of test execution on the network (UXM) side. You can provide the parameter before and after values for each change and then plot these changes in relation to problem events. Parameter Change Detector helps you track down incorrect values getting set and assess the impact of parameter changes to other problems.

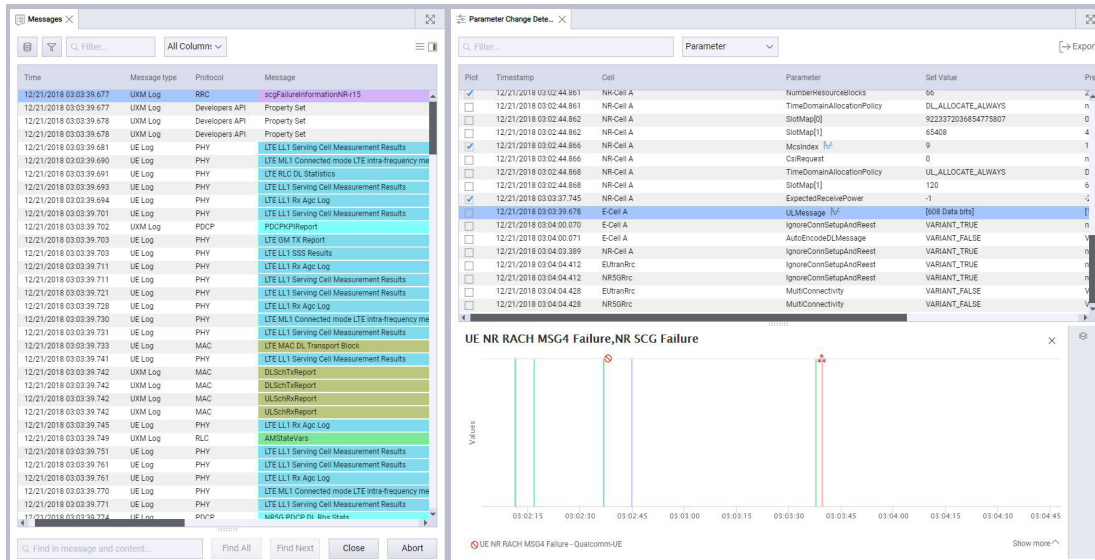


Figure 9. Parameter Change Detector view in Nemo 5G Device Analytics.

Metrics and events

Nemo 5G Device Analytics offers a comprehensive suite of metrics and system generated events from the processed data to enable extensive troubleshooting of both the UXM and DUT data. Metrics can be broadly classified as UXM (5G NR, LTE, test execution) and DUT (LTE, 5G NR, application layer KPIs, latency). The system generated events are triggered to give you more information about the events and procedures during the test execution, such as RACH Msg3 failure and SN addition failure.

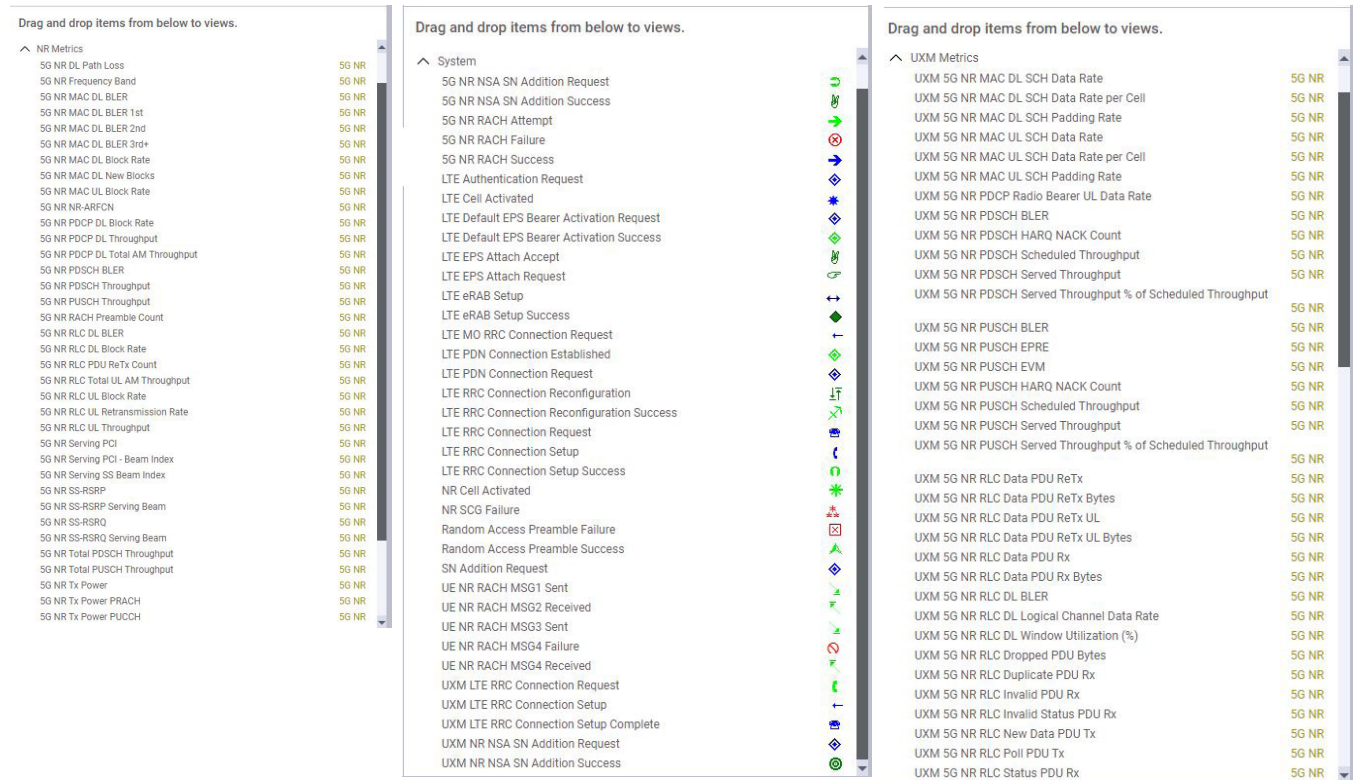


Figure 10. Metrics and events in Nemo 5G Device Analytics.

Message filtering and parameter comparison

The easy-to-use UI in Nemo 5G Device Analytics offers a wide range of troubleshooting features to gain intelligence-driven diagnostics and deep insight.

The Messages view in Nemo 5G Device Analytics displays all the messages logged in the data file. The message view can be filtered, message content is decoded, and you can search for a specific string within the message content.

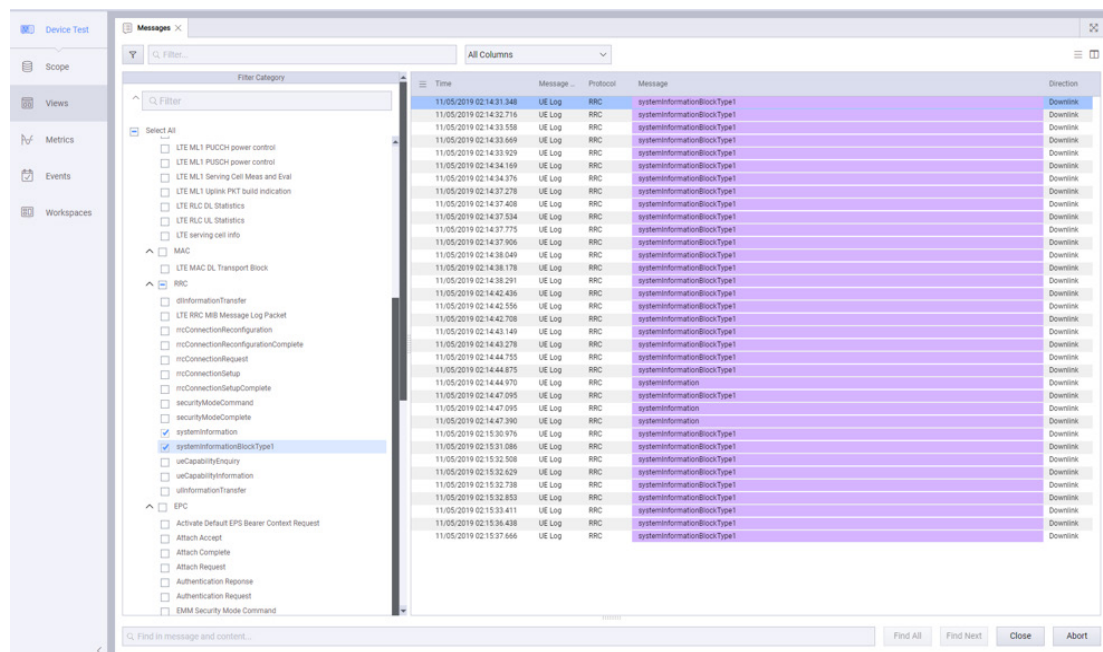
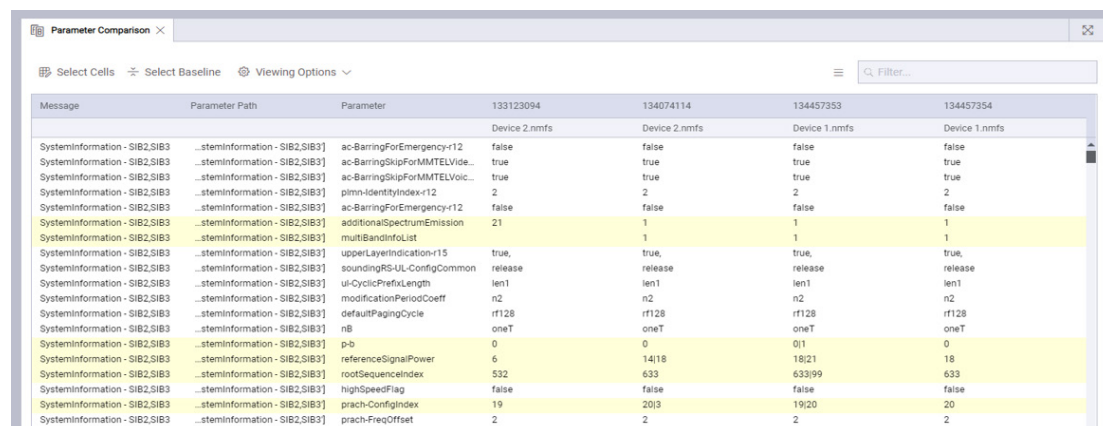


Figure 11. Message filtering in Nemo 5G Device Analytics.

The Parameter Comparison view helps you determine what sites from the drive test deviate from the parameters set in the lab and investigate those differences to see if the lab parameters need to be updated or the site parameters need to change.



Message	Parameter Path	Parameter	133123094	134074114	134457353	134457354
			Device 2.nmfs	Device 2.nmfs	Device 1.nmfs	Device 1.nmfs
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	ac-BarringForEmergency-r12	false	false	false	false
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	ac-BarringSkipForMMTELVoice	true	true	true	true
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	pimn-IdentityIndex-r12	2	2	2	2
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	ac-BarringForEmergency-r12	false	false	false	false
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	additionalSpectrumEmission	21	1	1	1
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	multiBandInfoList	1	1	1	1
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	upperLayerIndication-r15	true	true	true	true
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	soundingRS-UL-ConfigCommon	release	release	release	release
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	ul-CyclicPrefixLength	len1	len1	len1	len1
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	modificationPeriodCoeff	n2	n2	n2	n2
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	defaultPagingCycle	rf128	rf128	rf128	rf128
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	nB	oneT	oneT	oneT	oneT
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	p-b	0	0	0/1	0
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	referenceSignalPower	6	14/18	18/21	18
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	rootSequenceIndex	532	633	633/99	633
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	highSpeedFlag	false	false	false	false
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	prach-ConfigIndex	19	20/3	19/20	20
SystemInformation - SIB2.SIB3	..stemInformation - SIB2.SIB3	prach-FreqOffset	2	2	2	2

Figure 12. Parameter comparison in Nemo 5G Device Analytics.

Enabling automation workflows

With the auto data streams feature in Nemo 5G Device Analytics, you can enable automation workflows in data processing and reporting. This framework is highly adaptable to your needs and specifications, and enables faster data processing and reporting, and efficient troubleshooting as a consequence.

Data Stream NameAuto Data Stream 1✕☐ Enabled

Data SourceTagsDataView SettingsReports

Root Folder

Root Folder:

C:\Users\vtakkan\Desktop\Automation Test

Browse... ⓘ

Folder Level for Dataset:

2

▲▼

Source Folders

Level 1:

Date

Delimiters will be parsed from left to right.

Edit ⓘ

Level 2:

Run

Import files from this folder level. Delimiters will be parsed from left to right.

Edit ⓘ

Add

Source Files

Structure:

Delimiters will be parsed from right to left.

Edit

Formats:

Edit

Dataset

Definition:

BuildDateRunTestCase

Edit

Name:

DateBuildTestCaseRun

Edit

Source Data Disposal

Figure 13. Auto data streams to enable automation workflows.

Analytics Builder

Nemo 5G Device Analytics offers the flexibility to create your own events and latencies. With the Analytics Builder, you can set the message flow and create custom events and latencies for analysis and troubleshooting.

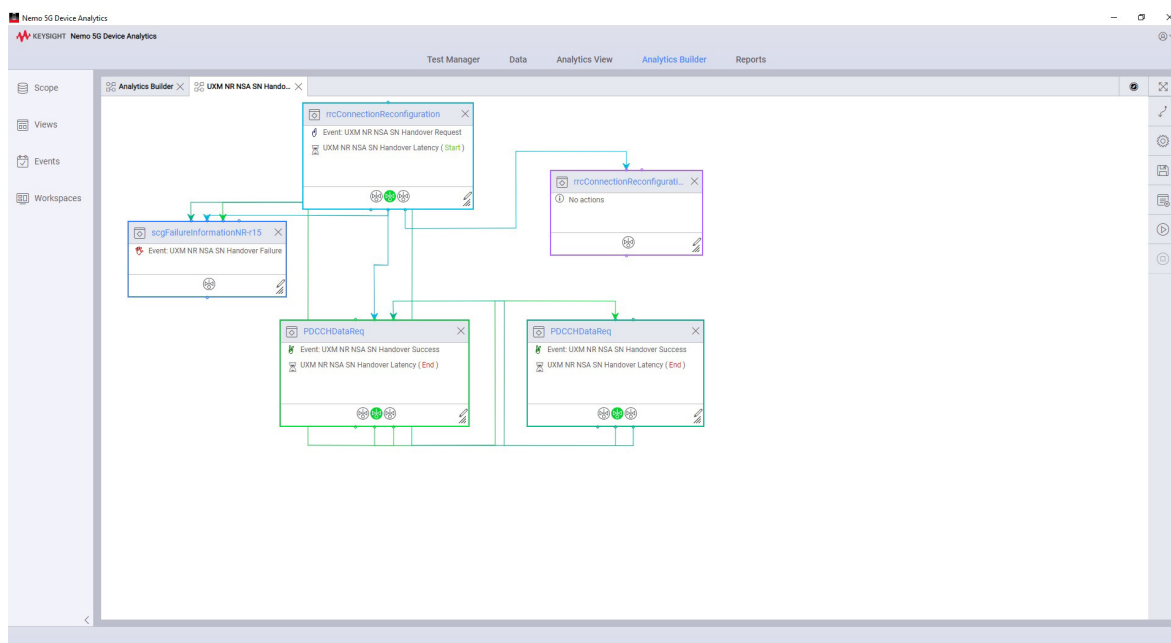


Figure 14. Analytics Builder view in Nemo 5G Device Analytics.

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