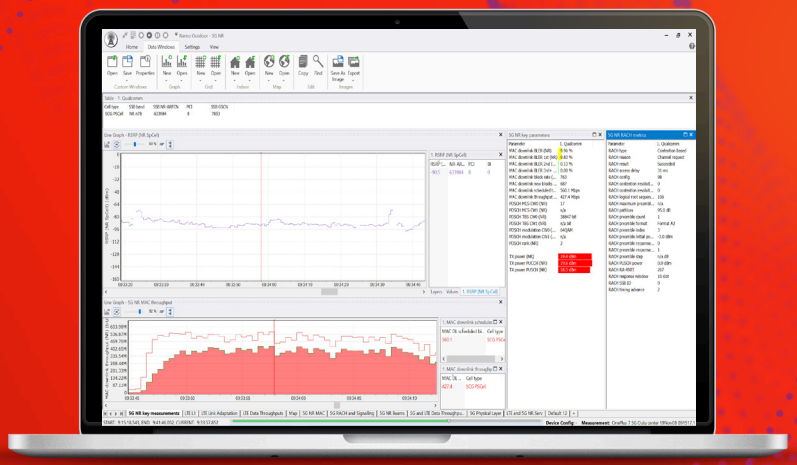


TECHNICAL OVERVIEW

Nemo Outdoor

Introduction

Nemo Outdoor from Keysight Technologies, Inc. has an established position as a pioneer and leader in drive test measurement and optimization solutions for perfecting the air interface of wireless networks. You can gather valuable information for network planning, roll-out, tuning, verification, optimization, maintenance, and benchmarking purposes by collecting measurement results and geographical coordinates. Nemo Outdoor is always among the first-to-market with support for the very latest technologies, currently supporting measurements on 5G NR, NB-IoT, LTE-M, LTE-A, LTE, WiMAX™, HSDPA, HSUPA, HSPA+, TD-SCDMA, CDMA2000, 1xEVDO (Rel. 0, Rev. A and Rev B.), TETRA, iDEN, cdmaOne, GSM, GPRS, EDGE, and WCDMA networks.

Nemo Outdoor is a centralized solution built on a single, powerful platform. Its expandable, modular structure supports not only drive testing, but also QoS and benchmarking measurements on every standard network technology and on multiple simultaneous data connections. Through its diverse set of options, Nemo Outdoor can be tailored to the specific needs of the customer. This empowers the operators to reach both optimal network performance and time- and cost-effectiveness.

Nemo Outdoor is extremely easy to set up, configure and use. Nemo Outdoor‘s customizable user interface offers you the possibility to customize data views and workspaces for any given purpose or need that arises in use. Measurement data can be directly imported to Nemo Analyze as well as to various third party post-processing/ analysis tools. In addition, Nemo Outdoor’s import/export feature allows for the transfer of all user settings to or from another computer.

KEYSIGHT TECHNOLOGIES

Through our close cooperation with several mobile and scanner manufacturers, we ensure that our customers always get to select amongst the latest test equipment. Currently Nemo Outdoor supports more than 300 test terminals, 5G NR devices and scanning receivers, a figure which is constantly increasing to meet rapidly changing customer needs.

Measurement options

- IoT testing using NB-IoT and LTE-M technologies
- CS and PS data measurements
- Voice, voice quality PESQ and POLQA (ITU-T P.862.1, WB-AMR, P862.2, ITU-T P.863)
- VoLTE voice call support (Qualcomm IMS, Samsung IMS client, HiSilicon IMS)
- EVS voice codec
- ViLTE support
- VoWiFi and ViWiFi measurements
- Video quality monitoring with VQmon (with NATA, former NMR)
- Multimedia Broadcast Multicast Service (eMBMS) measurements and scanning
- Video call, video call quality, video streaming, YouTube video streaming, Netflix video streaming, and video streaming analysis measurements (PEVQ-S)
- Multi measurements with Nemo Intelligent Device Interface, Nemo Backpack and Nemo Carrying Case
- Indoor measurements
- Frequency, pilot, eMBMS, WLAN, CW, and band scanning measurements
- Spectrum analyzer measurements
- Dynamic spectrum sharing measurements
- SMS, MMS, and USSD measurements
- FTP testing for file transfers (multithreaded)
- SFTP testing for file transfers (download and upload)
- Multithreaded SFTP data transfer
- HTTP/S testing for file transfers (download and upload)
- HTTP/S testing for web browsing
- SMTP/POP3/IMAP for email testing
- Iperf for UDP/TCP testing
- Voice quality testing
- PTT call testing (QChat and Kodiak InstaPoC)
- Facebook, Twitter, Instagram, WhatsApp, Viber, and Dropbox testing
- Voice quality testing for WhatsApp calls
- Touchscreen simulation and screencasting for automated testing of Android applications
- Native Ookla speedtesting
- IP packet capturing and playback

Supported technologies

- 5G NR
- NB-IoT, LTE-M
- LTE/LTE-A (FDD/TDD, carrier aggregation 3CC and 7CC)
- HSPA+ Dual Cell / HSPA+
- GSM, cdmaOne, AMPS
- TETRA, iDEN
- HSCSD, GPRS, EDGE
- WCDMA
- cdma2000 1xRTT, CDMA2000 1xEVDO (Rel. 0, Rev. A, Rev. B)
- HSDPA, HSUPA, DC-HSUPA, TD-SCDMA
- WiMAX (802.16e)

- Missing neighbor detection for GSM, WCDMA, and CDMA
- LTE downlink allocation analysis
- CDMA, EVDO, and WCDMA pilot pollution analysis
- GSM interference analysis
- LTE ANR CGI reports
- Diagnostics and raw data logging (Qualcomm and Samsung)
- Emergency call testing
- File sharing with Nemo Cloud Basic and remote controlled measurements with Nemo Cloud Premium

Nemo Outdoor Key Benefits

- Powerful platform-based tool – All the latest customer needs can be met by adding options to the utterly flexible and expandable Nemo Outdoor platform
- Comprehensive and cost-effective – Drive testing, Quality of Service (QoS) and benchmarking measurements can all be carried out on a single platform. Nemo Outdoor Multi software allows the simultaneous use of up to eight test terminals and two scanners
- Centralized solution – All of the test devices among the extensive selection can be connected to a single laptop
- Extremely easy to set up, configure and use – The time from receiving the product to using it is only a matter of a couple of hours. Hence, the customer is able to focus on the actual task at hand
- Latest technologies – Nemo Outdoor is always among the first to market with support for the newest technologies
- Fully customizable user interface – You can tailor the user interface to suit your specific needs at a given time

Nemo Outdoor Key Features

- Multiple simultaneous data transfers on a single terminal – Nemo Outdoor enables you to perform multiple data transfers on each test mobile in use simultaneously
- Benchmarking for better performance – Measurements can be carried out on multiple networks and even on multiple technologies simultaneously for ultimate network performance. The Nemo Backpack and Nemo Carrying Case options offer variety in terms of size and weight, with the possibility to take them as carry-on baggage on an aircraft
- Advanced analytics for easy comparison of terminals, IoT devices and networks
- QoS measurements – Voice quality (PESQ and POLQA), streaming video analysis (PEVQ-S) video quality, and video call quality measurements are supported
- Simultaneous PESQ and POLQA measurements
- Extensive scripting – With Nemo Outdoor scripting is made diverse and extensive with, for example, time- and technology-based conditional blocks, loops, multiple

script synchronization groups, and more

- Measurement file uploading – Measurement files can be sent directly from the Nemo Outdoor user interface to an FTP server, Dropbox or Nemo Cloud for storage
- Automatic device detection – Multiple devices can conveniently be added to the system in user-defined order
- Nemo Outdoor measurement units can be remotely configured and controlled with Nemo Cloud. Nemo Cloud allows a single user to remotely operate Nemo Outdoor test units in the field, tracking their location and status.
- Indoor option – It is also possible to use Nemo Outdoor with the Indoor option on a Tablet PC, and to view the results on an indoor map along with base stations. Also iBwave floorplans with BTS sites are supported, including real-time small cell and DAS anomaly analysis.
- Instant playback functionality – See the measurement results immediately after a measurement through Nemo Outdoor's playback function and user-configurable data views and work space
- Grids, graphs, and map windows can be colored based on user-defined criteria. Graphs support multiple layers for viewing results in a single graph. Another example of the customizability of Nemo Outdoor's data views saving measurement route, or route plan, for later use, and to follow the measurement route through waypoints in real time during measurements
- Extensive application testing features, including YouTube, Netflix, Facebook, Twitter, WhatsApp, Viber, Instagram, Line, Snapchat, any application testing with touchscreen simulation and screencasting, native Ookla Speedtesting, Push-To-Talk (QChat, Kodiak), email, MMS, SMS, and voice call testing
- Emergency call testing for logging the location of the test UE with different positioning techniques
- LTE-A 7CC carrier aggregation testing up to Cat 18
- User-defined parameters from signaling messages can be searched and displayed in info view and graph side panel
- Forcing features – Channel/cell (BSIC/scrambling code/PCI) locking, band locking, handover control, timeslot testing, airplane mode, cell barring, carrier aggregation forcing, and AMR codec mode forcing are available in Nemo Outdoor
- Cell testing – The surrounding cells of a location can be tested through an automated list of test calls that are locked to a cell at a time
- Missing neighbor detection – Detect both GSM and WCDMA missing neighbors in real time.
- Pilot pollution analysis – Nemo Outdoor enables pilot pollution analysis measurements in real time using UE or a scanning receiver. Available for WCDMA, CDMA and EVDO technologies.
- GSM co-channel and adjacent channel interference analysis
- Google Earth map – Nemo Outdoor maps can be exported to Google Earth maps

Nemo Outdoor supports

- e-mail (SMTP, POP3, and IMAP protocols)
- SMS/MMS
- USSD
- Iperf for UDP/TCP testing
- Ping trace route testing
- FTP
- SFTP
- HTTP
- HTTPS file transfers
- HTTP/HTTPS browsing
- PEVQ-S video streaming analysis (HTTP/HTTPS)
- Huawei u-vMOS video streaming analysis
- HTTP/HTTPS streaming (YouTube)
- Netflix video streaming
- RTSP streaming
- Video streaming
- Video streaming quality
- Video call quality
- Voice quality (ITU-T P.862.1, ITU-T P.863, WB-AMR, P862.2)
- ICMP ping
- Ping trace route
- PTT calls (QChat and Kodiak InstaPoC)
- Twitter, Instagram, Dropbox, Facebook, WhatsApp, Viber, Line, Snapchat, BiP Messenger, LinkedIn
- Voice quality for WhatsApp
- Ookla Speedtest

Working with Nemo Outdoor

Reliable and accurate measurements

Nemo Outdoor is a comprehensive solution offering you a broad selection of options all on the same platform. Yet Nemo Outdoor has been designed to offer you a pleasant experience with its highly intuitive user interface. The Nemo Outdoor measurement system consists of test mobiles and/or scanning receivers and a GPS receiver with antennas, a PC or a tablet with the Windows operating system and the Nemo Outdoor measurement software, and connecting cables between the mobiles/scanners/GPS and the PC. With the Nemo benchmarking solutions - Nemo Intelligent Device Interface, Nemo Carrying Case, and Nemo Backpack - it is possible to connect 8-24 devices to the test system.

Hardware and software requirements

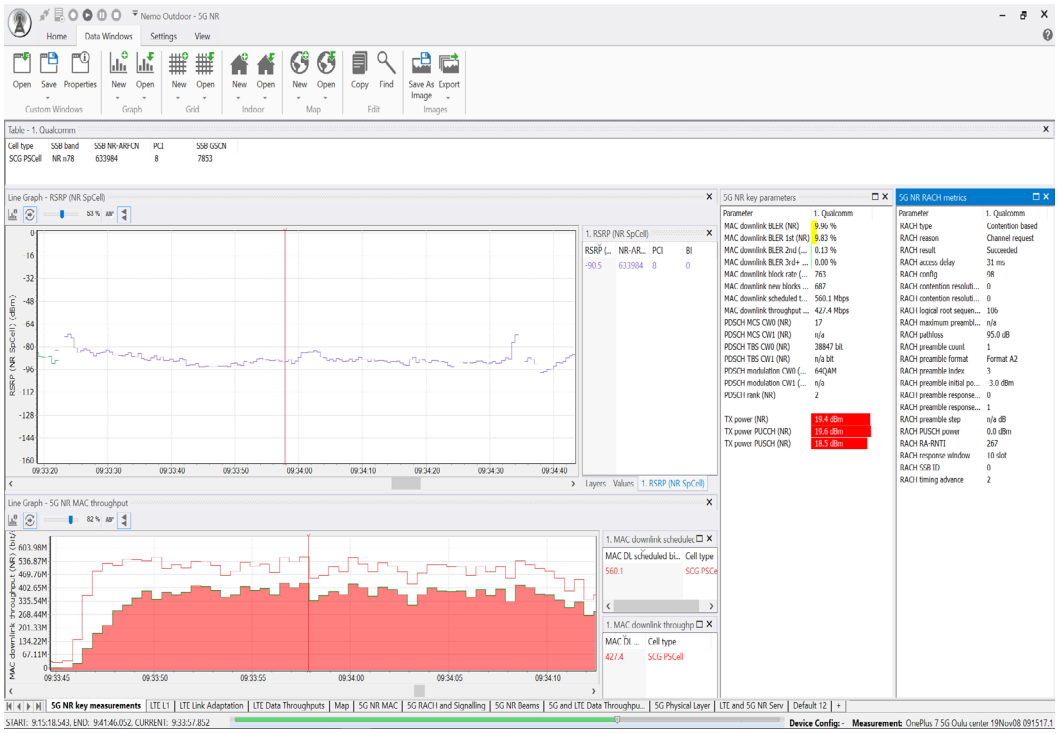
- PC (Lenovo or Dell recommended) with Windows 7 Professional (32/64 bit), Windows 8 or Windows 10 on a PC (Lenovo or Dell recommended)
- Processor Intel Core i7 2.66 GHz or higher
- SSD drive recommended
- 500 MB of free hard disk space for installation and use; 4 GB recommended
- One USB port for copy protection module
- One USB 3.0 port for test device
- Ethernet port RJ45
- Display resolution 1400 x 900 recommended
- Memory 4 GB RAM minimum, 8 GB recommended

5G Measurement Solution

5G deployments have begun and rollout announcements from mobile network operators are multiplying. Mobile network operators around the world are investing in 5G and launching networks to capture new business models. 5G requires new technologies and performance improvements that challenge the way engineers test the network.

Nemo Outdoor supports real 5G NR field measurements. The solution combines Nemo Outdoor with Qualcomm X50/X55, Samsung Exynos 51xx, and HiSilicon Balong 5000 based devices, 3rd party scanning receivers, and FieldFox handheld spectrum analyzer. The collected metrics include RACH information, TX power, rank (MIMO mode), modulation, MAC throughput and BLER, signal strength, and quality metrics of the SSB beams.

In addition, we collect QoS measurements including throughput, and latency. The 5G NR test system can be used to perform real 5G NR measurements with demodulation of the 5G NR reference signals and it enables simultaneous 2G, 3G, 4G, and 5G NR spectrum scan and frequency scan (CW) measurements.



Features

- Perform real 5G NR field measurements with Qualcomm X50/55, Samsung Exynos 5100/5123, and HiSilicon Balong 5000 based devices
- Widest range of supported 5G NR KPIs in the market
- Measure and verify sub 6 GHz and mm-wave frequency spectrum, reflection and penetration for indoor and outdoor environments
- Perform 5G NR measurements with demodulation of the 5G NR reference signals
- Easily align the transmitter and receiving directional antenna
- Measure accurate total channel power level over the measured bandwidth
- Visualize the measurement results with maps

Application Testing

Test your networks and verify end-user experience

Nemo Outdoor enables network operators to test their network using the same application protocols as their customers and, therefore, provides results that correspond with the end-user experience. The information provided by Nemo Outdoor assists in the verification and troubleshooting of new services reducing the time-to-market.

Perform application tests either manually or automatically by taking advantage of user-definable scripts. For all protocols, key performance indicators, such as data throughput, access time, and success rate can be recorded simultaneously with full radio network information.

All services are supported in a single product, Nemo Outdoor, providing an easy-to-use, consistent interface for configuring different applications. Different applications, such as voice, SMS and packet-switched data can be launched in one measurement session to simulate end-user behavior.

Nemo Outdoor supports single and multi (parallel) SFTP transfers and single, multi (parallel) and multithreaded FTP transfers. In single SFTP/FTP transfer, one file is either sent or received. In multi SFTP/FTP transfer, one or more files are either sent or received or both simultaneously. In multithreaded FTP transfer, the transferred file is split into smaller fragments. You define the number of threads. Each thread creates a new FTP session and transfers a fragment of the file. Multithreaded FTP transfer mode is supported in the receive direction.

Social networking

Facebook, Twitter, WhatsApp, LinkedIn, Instagram, Snapchat, and Dropbox are some of the most popular social networking applications, and they produce significant amounts of traffic on cellular networks. With Nemo Outdoor it is possible to test the most common functions with these applications and the logged parameters include connection and transfer attempt/success/failure statistics and success rates. Also voice quality testing for WhatsApp calls is available.

Application testing with screencasting

The screencasting and touchscreen simulation offer an automated way to test almost any application running on an Android smartphone. For example, with screencasting you can test video calls, Netflix, Google Play, WhatsApp messages, native Ookla Speedtesting, and voice calls.

The screen of the handset can be viewed in Nemo Outdoor in real time. You can send virtual touch commands to the device based on user interaction with the screencasting view. These sequences of touch commands and physical button commands are recorded to separate screencast macro files that you can save and reuse.

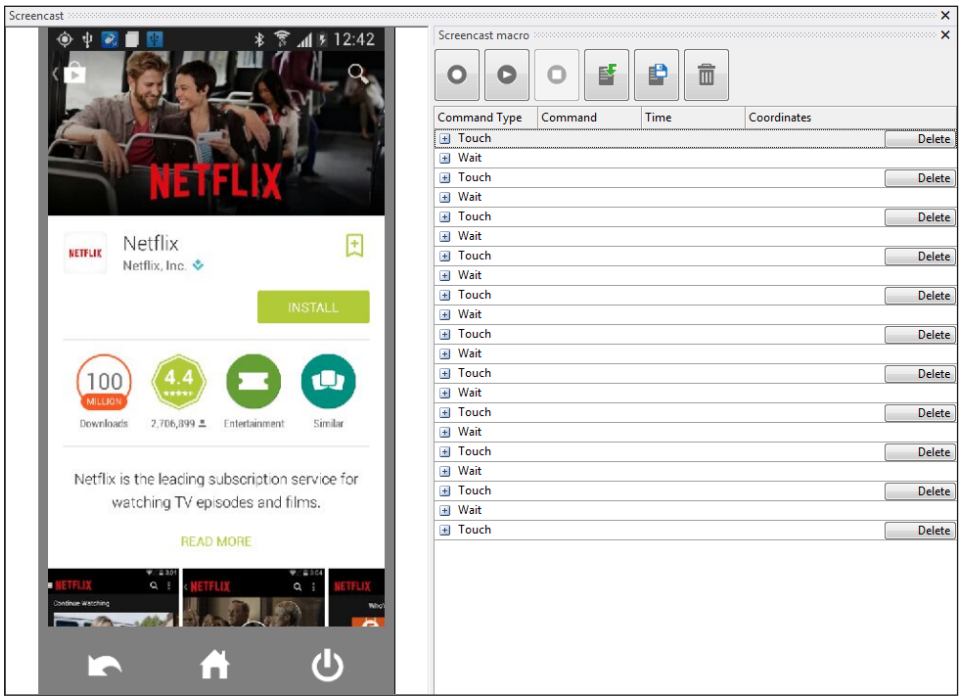


Figure 2. Screencast view in Nemo Outdoor

Nemo Active Testing Application

Nemo Active Testing Application (NATA) is Keysight's proprietary communications interface and application developed for Android-based smartphones. NATA supports on-device measurements with Android-based devices: both rooted and non-rooted devices. With the NATA interface, smartphones communicate with PC-based applications, such as, Nemo Outdoor and Nemo Invex II, enabling, for example, voice quality measurements, data transfers, video streaming, and application testing on smartphones without any additional hardware. In some cases no permanent installation is needed due to much lower overall power consumption.

NATA is cost-effective, and ideal for benchmarking and running up to 12 devices simultaneously on a single commercial laptop. As the measurements are running on a smartphone, there are no issues with PC CPU load lowering the data rates.

Feature	NATA with Nemo firmware	NATA for non-rooted phones
Voice	x	x
Voice quality (PESQ & POLQA)	x	x
FTP/ SFTP (FTP multi thread)	x	x
Ping	x	x
HTTP/ HTTPS	x	x
HTTP put	x	x
HTTP browsing	x	x
HTML browsing	x	x
YouTube	x	
Facebook testing	x	
Instagram testing	x	
WhatsApp testing	x	x
Ookla Speedtest	x	
Packet capturing	x	
SMS, MMS	x	x
PEVQ-S streaming analysis	x	
Huawei u-vMOS video streaming analysis	x	
Touchscreen simulation & screen casting	x	
TeamViewer remote connection	x	
VoLTE/ ViLTE	x	
VoWifi/ ViWifi	x	
Max number of simultaneous phones per CPU with voice connections	12	12
Max number of simultaneous phones per CPU with data connections	12	12

Voice and video quality

Both PESQ and POLQA voice quality algorithms are still commonly used by operators, therefore, a side-by-side comparison of these two algorithms is necessary. With Nemo Outdoor both algorithms can be tested simultaneously. Furthermore, when Nemo Outdoor is coupled with the Nemo Intelligent Device Interface hardware, you can test the voice quality of OTT services with any device that supports analog or Bluetooth audio.

PEVQ-S is an advanced framework algorithm developed by OPTICOM for full-reference video quality analysis in adaptive streaming environments. It combines FR high accuracy video quality measurements with real-time measurements, even on mobile devices. With PEVQ-S, network operators and service providers evaluate their streaming video service levels more accurately from the subscriber's point of view. PEVQ-S measurements can be performed on the Nemo Outdoor PC or on the PEVQ-S client probe in Nemo Active Testing Application which enables real quality of experience (QoE) measurement of the YouTube and Netflix services.

U-vMOS is Huawei's objective criteria for measuring video experiences based on the actual user experience. The U-vMOS scores include the U-vMOS overall score and the scores of three sub-items: sQuality (video quality), sInteraction (interaction experience), and sView (viewing experience).

U-vMOS SDK supports two application scenarios: real-time monitoring and network planning. Real-time monitoring a.k.a instant scoring is supported with collection tools.

The KPIs provided by U-vMOS are

- Video quality MOS (U-vMOS): Huawei's proprietary formula for calculating video quality. Evaluates the overall score of the video watching experience in the current segment.
- Video quality sQuality (sQualityInstant): an absolute MOS score where the codec and the resolution of the video affect the result. Evaluates the quality score of the video segment currently played.
- Video quality sStalling (sView): a MOS score related to video interruptions during the playback. Evaluates the score of the watching experience with the current video segment.
- Video quality sLoading (sInteraction): a MOS score related to the initial loading time before the playback starts. Evaluates the score of the interactive operation experience with the current segment.

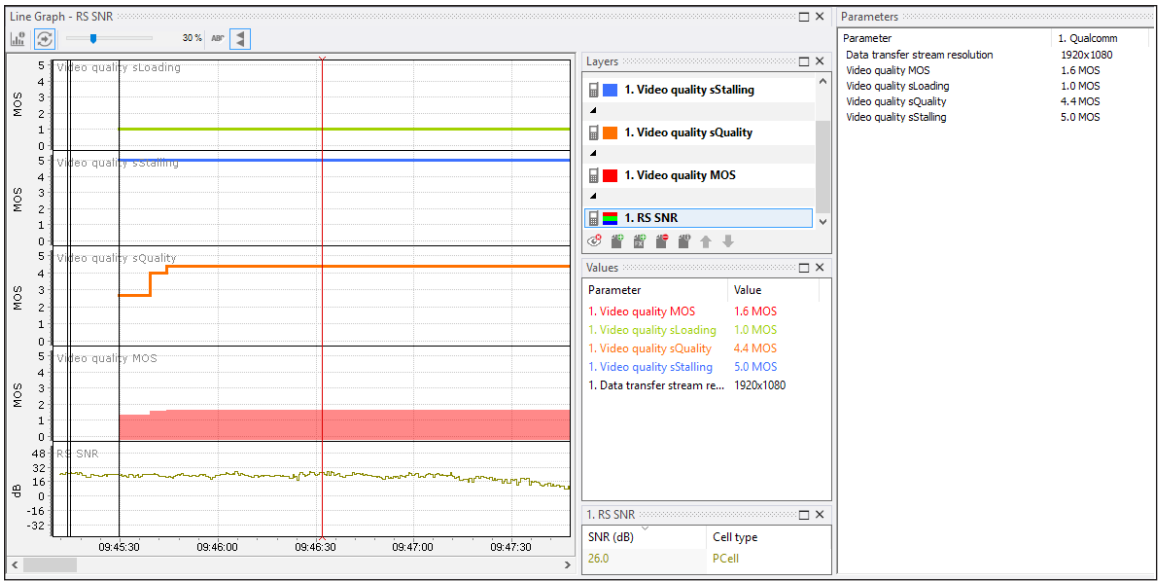


Figure 3. Example of U-vMOS test results in Nemo Outdoor.

IMS Test Features

VoWiFi and ViWiFi testing

WiFi offload offers a new way for operators to increase the coverage and capacity of LTE networks. WiFi hotspots are available almost everywhere at low cost and all new smartphones include WiFi support. Especially in high-traffic areas, such as shopping malls and sports arenas, WiFi coverage is usually available.

With VoWiFi (voice over WiFi) and ViWiFi (video over WiFi) voice and video information can be sent over the wireless broadband network in digital format. The technology uses the IEEE 802.11 set of specifications for transporting data over wireless local area networks and the internet.

With Nemo Outdoor customers can test the interoperability of LTE and WiFi networks for voice and video call services using Qualcomm and Samsung Shannon chipset-based devices. Detailed information about the main Key Performance Indicators (KPIs) and trigger points are logged, including WiFi serving cell information, WiFi SIP registration events and statistics, call events and call statistics, such as WiFi voice call success rate, LTE to WiFi and WiFi to LTE interworking information.

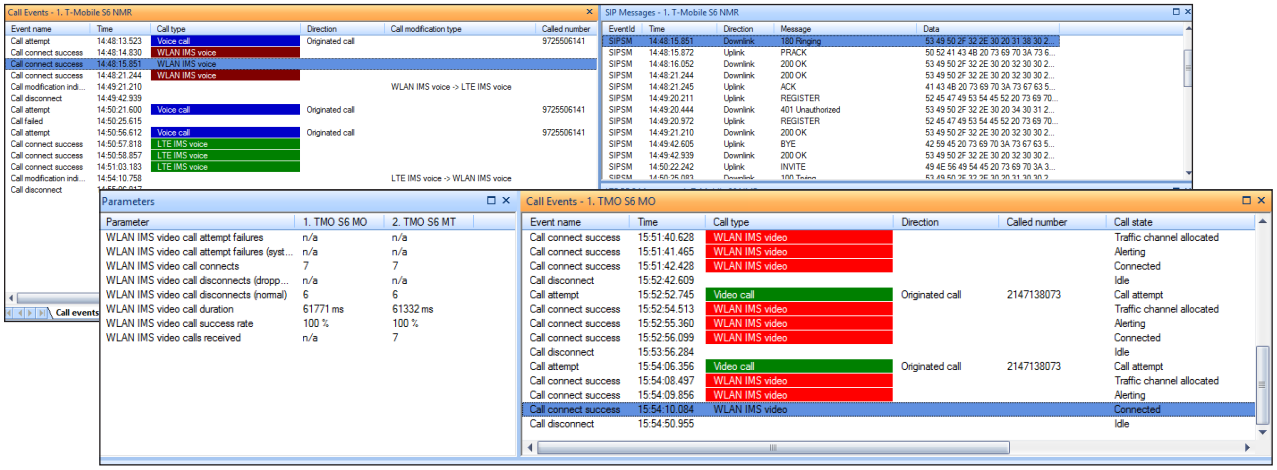


Figure 4. VoWiFi and ViWiFi call events, SIP and RRC messages

VoLTE/ViLTE and SMS over LTE testing

IMS Profile for Conversational Video Service (IR.94) and IMS Profile for SMS (IR.92) detail how video and SMS are sent in 4G/LTE. Nemo Outdoor collects all of the key metrics of VoLTE video calls, including accessibility, retainability, SIP signalling, and RTP packets for video. Also SRVCC information, including information about the call modification type and result, is logged. VoLTE SMS testing provides the SMS message events for send/receive and also SIP messages. MSG events include the new IMS SMS message type. Video and SMS over IMS is supported with Qualcomm IMS and Samsung IMS clients.

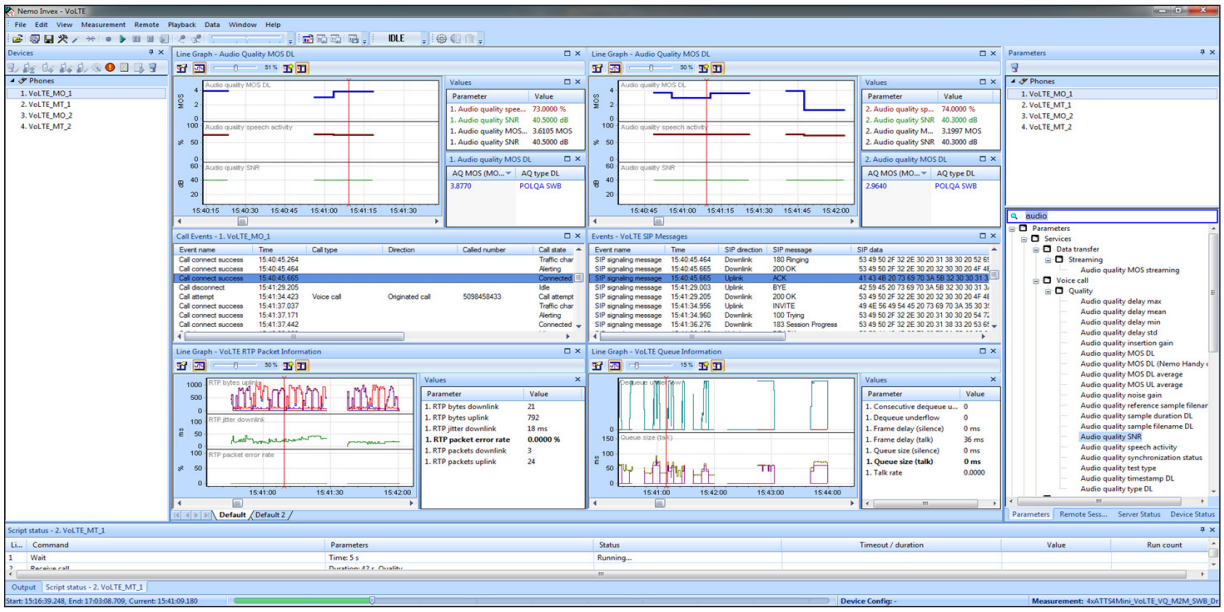


Figure 5. 4 x VoLTE/POLQA measurements

Call Events - 1. TMO S6 MO

Event name	Time	Call type	Direction	Called number	Call state
Call attempt	16:50:45.738	Video call	Originated call	2147138073	Call attempt
Call connect success	16:50:47.535	LTE IMS video			Traffic channel allocated
Call connect success	16:50:48.765	LTE IMS video			Alerting
Call connect success	16:50:50.026	LTE IMS video			Connected
Call disconnect	16:51:07.876				Idle
Call attempt	16:51:38.970	Video call	Originated call	2147138073	Call attempt
Call connect success	16:51:41.484	LTE IMS video			Traffic channel allocated
Call connect success	16:51:42.638	LTE IMS video			Alerting
Call connect success	16:51:43.378	LTE IMS video			Connected
Call disconnect	16:52:22.465				Idle
Call attempt	16:53:59.826	Voice call	Originated call	9725506141	Call attempt
Call connect success	16:54:00.810	LTE IMS voice			Traffic channel allocated
Call connect success	16:54:01.779	LTE IMS voice			Alerting
Call disconnect	16:54:02.269				Idle
Call attempt	16:54:05.714	Video call	Originated call	2147138073	Call attempt
Call connect success	16:54:08.733	LTE IMS video			Traffic channel allocated
Call connect success	16:54:09.534	LTE IMS video			Alerting
Call connect success	16:54:10.752	LTE IMS video			Connected

Figure 6. VoLTE and ViLTE call events

IoT Measurement Solution

Cellular IoT (CIoT) is defined as a set of technologies under 3GPP to enable IoT connectivity using the licensed frequencies, co-existing with the legacy cellular broadband technologies, such as LTE, UMTS and GSM. The main CIoT technologies being rolled out globally are NB-IoT and LTE Cat-M1.

Cellular IoT performance is heavily dependent on IoT devices, network equipment implementation, interoperability between the equipment, and network design. Field measurements are important for operators and industrial IoT customers to verify and benchmark the performance of IoT solutions.

Nemo Outdoor provides an impressive set of IoT KPIs with easy-to-use advanced analytics capabilities and it has been used by operators in multiple pilots and coverage measurements in IoT networks around the world. With Nemo Outdoor, you can verify, for example, connected mode mobility (CMM) that enables VoLTE calls to continue when an LTE-M device is moving from a cell to another cell. Nemo Outdoor supports NB-IoT and LTE-M testing with devices based on the Neul and Qualcomm chipsets and with scanning receivers from PCTel and Rohde & Schwarz.

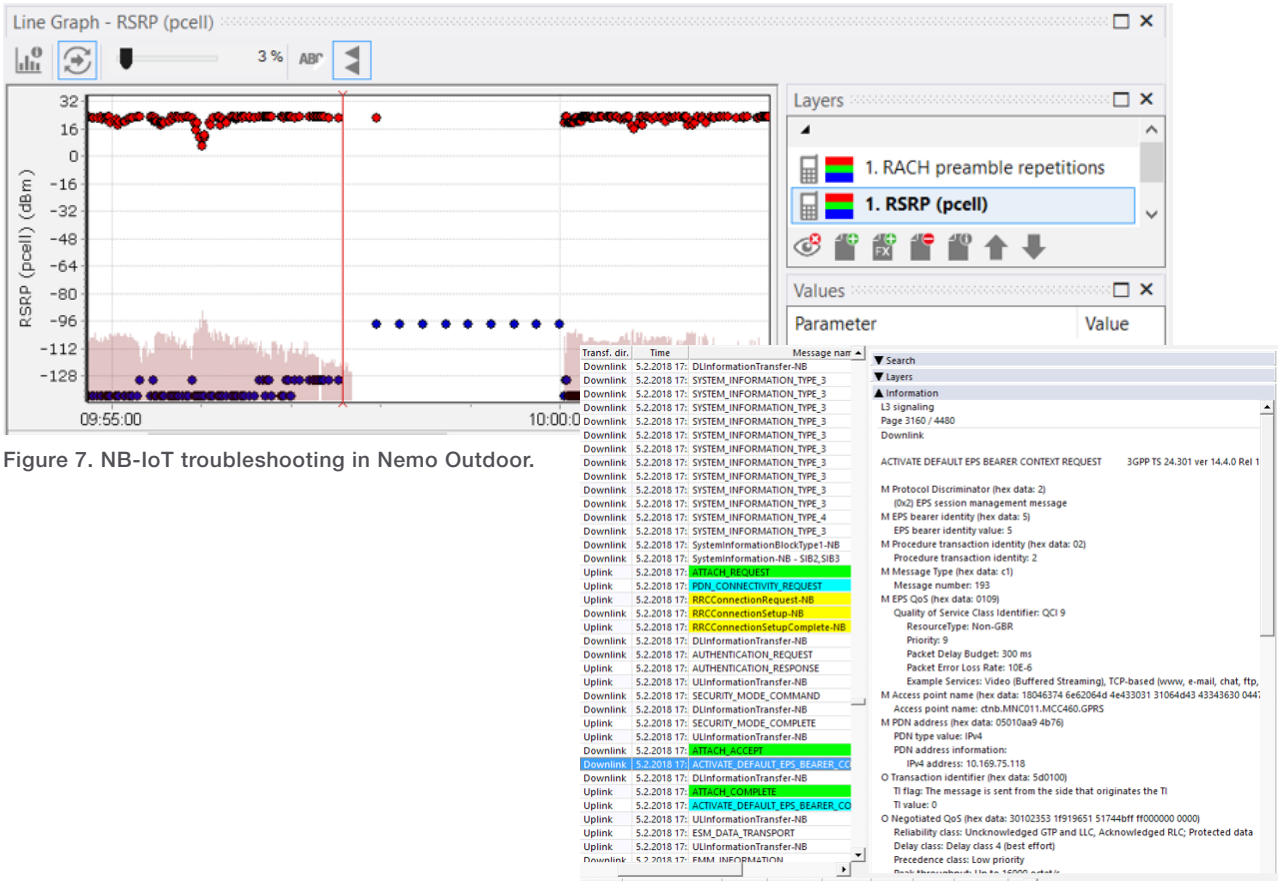


Figure 7. NB-IoT troubleshooting in Nemo Outdoor.

Key features

- Support for Neul and Qualcomm chipsets
- Support for PCTel and Rohde & Schwarz NB-IoT and LTE-M scanners
- Simultaneous LTE/NB-IoT measurements, RSRP, RSRQ, CINR, PSS/SSS CINR with PCTel IBflex scanners
- Support for connected mode mobility (CMM) testing

Supported IoT KPIs

Nemo Outdoor provides an impressive set of IoT KPIs. For example, the following metrics are supported:

- PDSCH/PUSCH throughput
- Ping statistics
- NB-IoT L3 payload UL/DL
- RSRP serving cell avg
- RS SNR serving cell avg
- PRB utilization UL/DL
- TX power PUSCH max/min/avg
- NB-IoT PUSCH subcarriers
- NB-IoT PUSCH/PDSCH repetitions max/min/avg
- RACH access delay
- RACH preamble repetitions
- RACH statistics
- RACH preamble count
- RACH PUSCH power
- RACH pathloss

LTE Test Features

Carrier aggregation testing

Staying ahead in a fast-changing competitive environment means being the first to deliver new functionalities and impeccable quality. To better serve our network testing customers, Nemo Outdoor offers support for LTE-A 7CC carrier aggregation testing, with the same data protocols and services used by subscribers. Carrier aggregation forcing (enable/disable) is available with Samsung Shannon 355 chipset-based devices.

With Nemo Outdoor operators can monitor the performance and quality of their LTE-A networks. The measurements provide detailed information about the primary and secondary component carriers (SCell1 and SCell2), including cell type, PCI, CFI, band, bandwidth, link adaptation and radio resource allocation.

The examples below show how LTE data is presented in the Nemo Outdoor user interface.

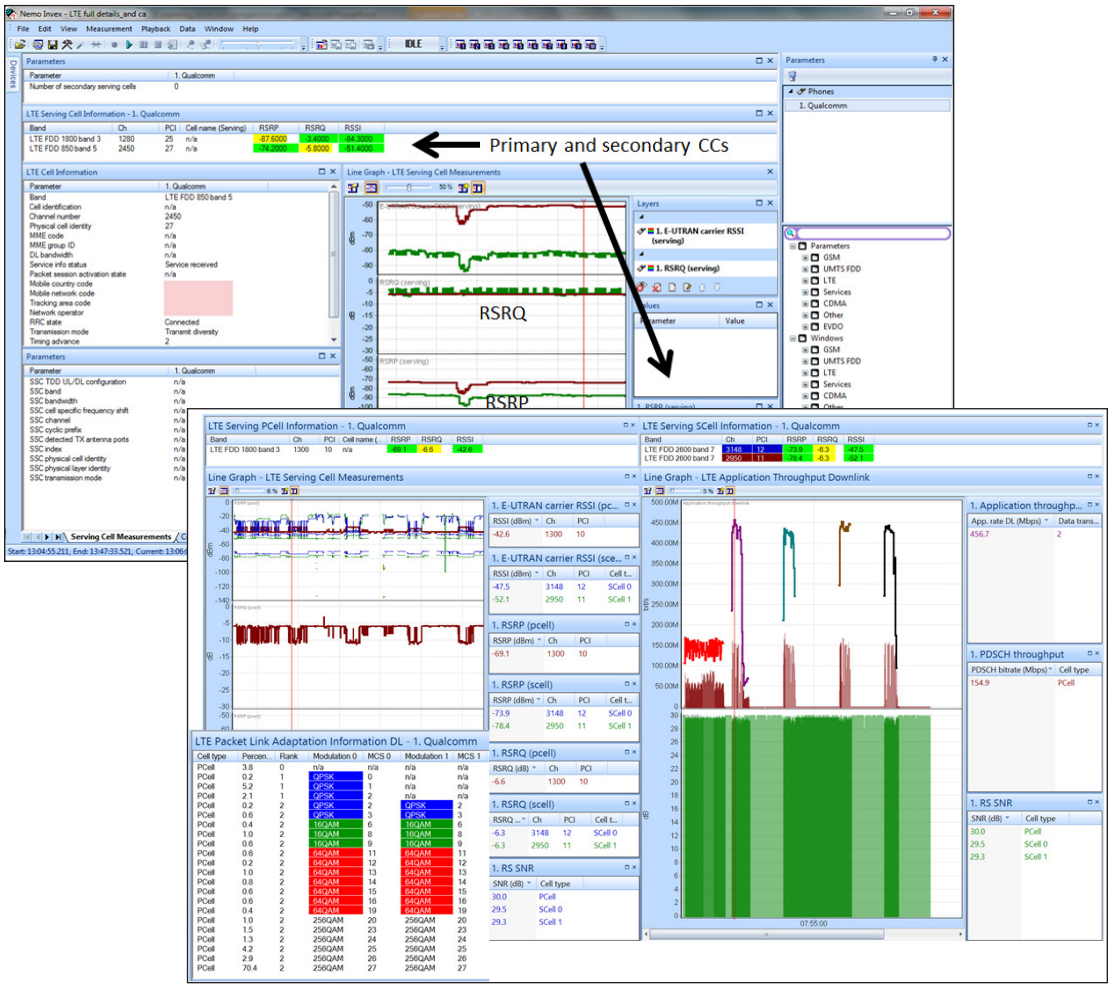


Figure 9. Two LTE carrier components

Multimedia Broadcast Multicast Service (eMBMS)

Video streaming services have become very popular and take up a major share of internet traffic worldwide. LTE broadcast is a single-frequency network (SFN) technology that enables multiple users to receive the same multimedia content, such as live sports, simultaneously using point-to-multipoint (PMP) distribution. LTE broadcast is part of the series of 3GPP LTE standards known as evolved Multimedia Broadcast Multicast Service (eMBMS).

With Nemo Outdoor, operators can capture and decode eMBMS information using Qualcomm chipset-based devices, and with the PCTEL MX, SeeGull MXflex, SeeGull IBflex, and Rohde & Schwarz TSMW and TSME scanners. Measurement data contains LTE eMBMS active bearer info, signaling messages, and main KPIs, including eMBMS data throughput for different layers (PMCH, RLC and MAC), eMBMS configuration and PMCH information for LTE broadcast services. MBMS related information is logged to MBMS information (MBMSI) and Physical channel throughput broadcast (PHRATEB), and to MAC layer throughput broadcast (MACRATEB) events.

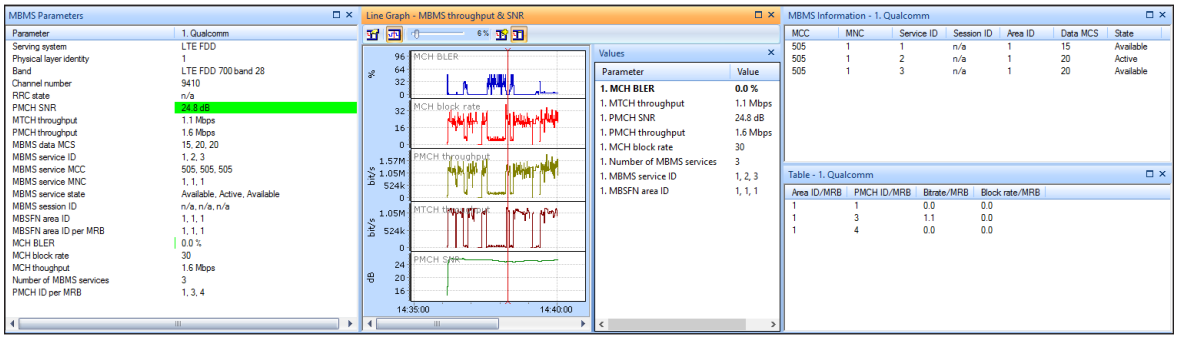


Figure 10. eMBMS information in Nemo Outdoor

Benchmarking

You can rely on Keysight's impressive benchmarking solutions Nemo Invex II, Nemo Intelligent Device Interface, Nemo Backpack, and Nemo Carrying Case. Benchmarking measurements can be performed on any combination of networks and system technologies ranging from GSM, WCDMA, 1XEVDO, and TD-SCDMA to HSPA+, WiMAX, LTE, and 5G NR. Nemo Invex II allows 24 simultaneous voice measurements and up to 24 concurrent data measurements to be performed simultaneously. In addition, it is possible perform up to 24 concurrent voice quality measurements. Nemo Intelligent Device Interface supports up to nine devices with Nemo Outdoor and up to 24 devices with Nemo Invex II. Nemo Backpack II allows 12 simultaneous voice measurements and up to 12 concurrent data measurements to be performed simultaneously. In addition, it is possible to perform up to six concurrent voice quality measurements with Nemo Carrying Case option in Nemo Outdoor. The network, system technology and measurement mode options also present endless possibilities for combination.

As many as 12 test devices can be connected with Nemo Outdoor at once, including Samsung and Qualcomm-based terminals, as well as scanning receivers from Keysight, PCTEL, and Rohde & Schwarz. In addition, they are all conveniently connected to the same Nemo Outdoor platform running on a single laptop. Furthermore, combined with Nemo Server, you can carry out long-term network performance measurements.

Please refer to the Nemo Invex II, Nemo Intelligent Device Interface, Nemo Backpack, and Nemo Carrying Case product materials for more detailed information.

Nemo Invex II

Nemo Intelligent Device Interface

Nemo Backpack

Scripts and Measurement Lists

In Nemo Outdoor measurement automation is enhanced through scripting. By creating and editing script files with Nemo Outdoor's built-in script editor, Nemo Outdoor makes voice and video calls, data uploads/downloads, HTML browsing, SMS/MMS messages, emails, and ping measurements according to your needs and purposes.

Nemo Outdoor's script group functionality enables you to synchronize script files and/or certain lines in the script file for specific devices. Both synchronization methods can be used together or separately depending on your needs.

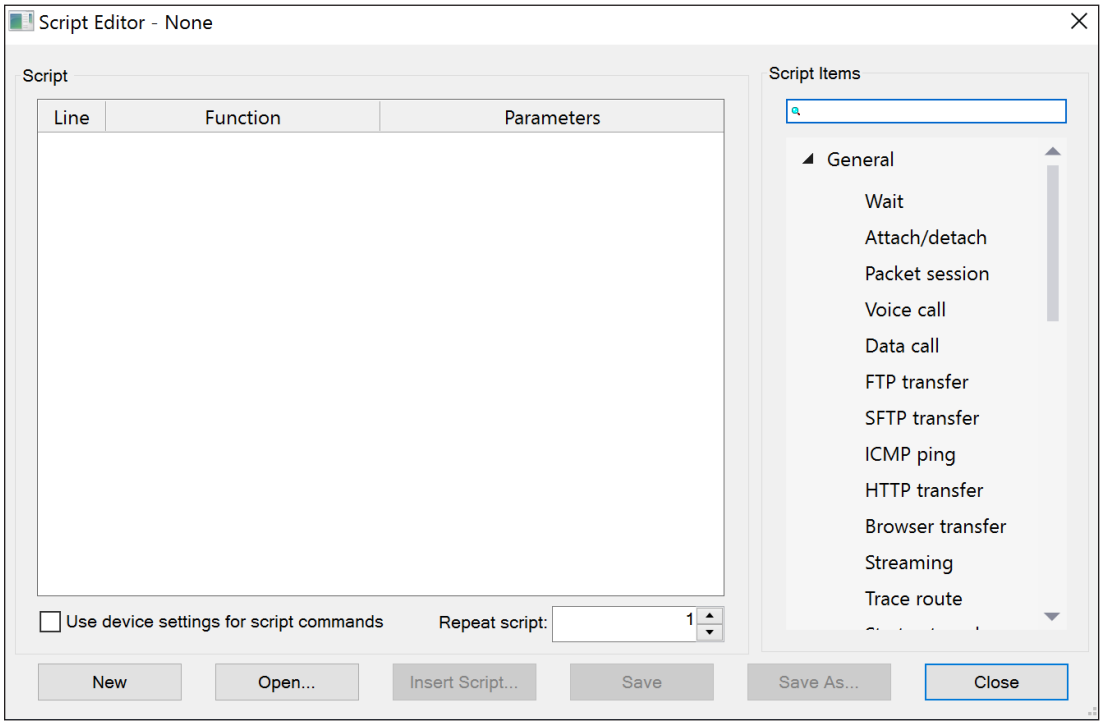


Figure 11. Nemo Outdoor Script Editor

Measurement lists are more complex than individual scripts, enabling even larger-scale measurement campaigns and increased measurement automatization. Measurement lists, which can be loaded and saved, enable you to run automated measurements with several devices combining multiple scripts. What is more, you can use measurement lists with just one device to run several scripts sequentially, one after another. However, each measurement is individually recorded in a separate file. You are also able to use measurement lists without scripts.

Nemo Outdoor Device Setup

Nemo Outdoor has a flexible and user-friendly user interface which allows users with different levels of experience to have an easy and smooth access to the system. The automatic device detection functionality automatically detects devices connected to the PC and assigns them the appropriate COM port and data connection settings. You can determine the order of added devices and can set the devices to start automatically upon setup. You don't need to spend time on manually going through the procedure; let the easy and intuitive Nemo Outdoor user interface automatically handle device connections for you.

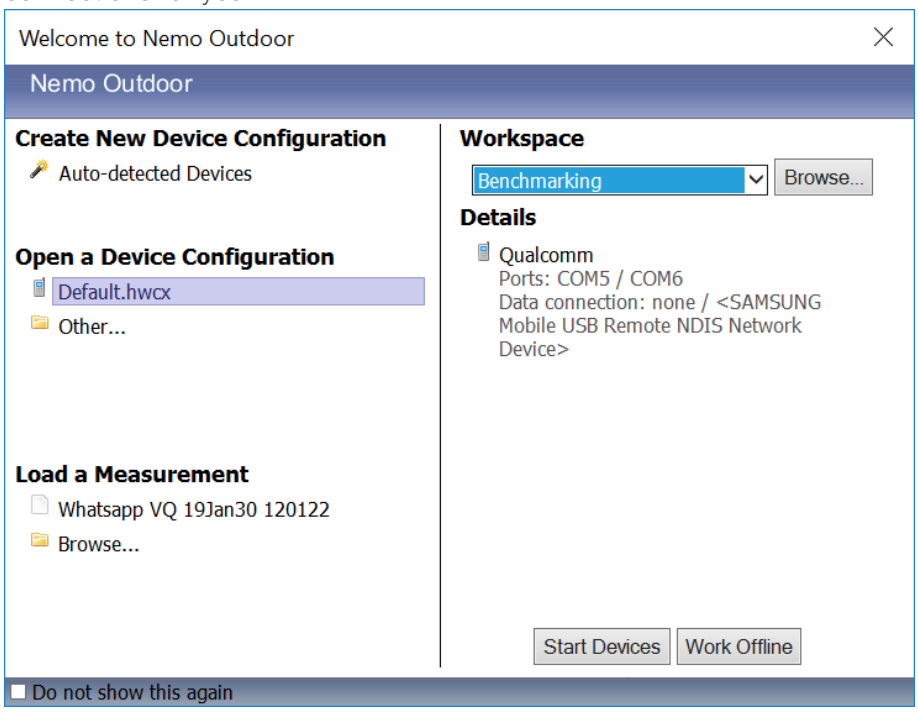


Figure 12. The automatic device detection functionality makes Nemo Outdoor easy to set up and use

RF validation

In order to prevent measurements errors caused by a faulty antenna or loose RF cables, you can perform RF cross-checking with the test devices connected to Nemo Outdoor. This can be done using the RF offset parameter, RF test feature, level check, or scanner configuration check.

With the RF test feature, you can validate all test devices before starting measurements. The RF test gives detailed information about the RF performance of the connected test devices, UEs and scanners. During the RF test, the average and max average field strength values are calculated for all serving cells measured and then the results reported by all devices are compared.

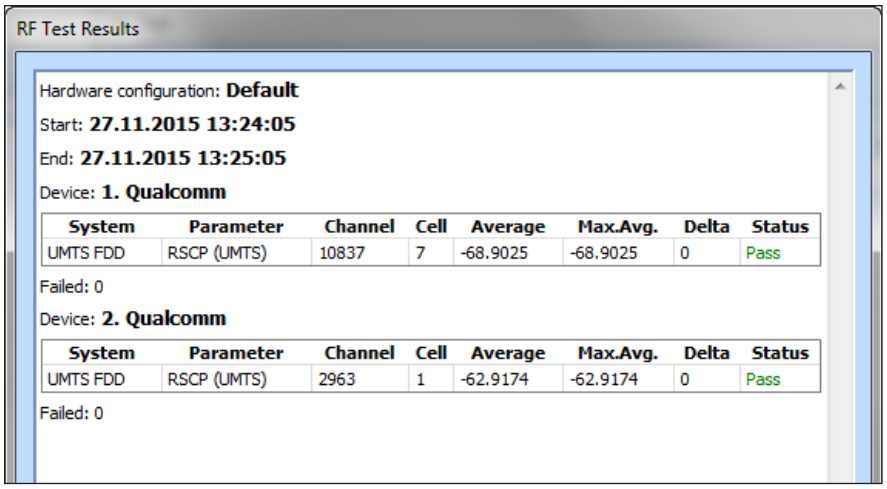


Figure 13. RF test results in Nemo Outdoor

With the level check you can compare field strength values measured by a scanner and test UEs. The data is displayed in a table grid. This helps you detect possible antenna and cable defects real-time during measurements and also during playback.

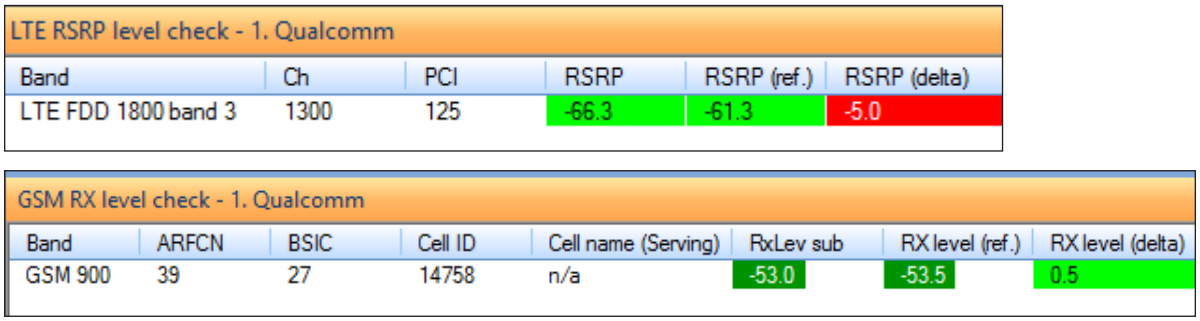


Figure 14. Level check compares field strength values measured by a scanner and test UEs

Another way to prevent measurements errors caused by missing/incorrect RF antenna connections is to use the RF offset check when the measurement is started. The RXL/RSSI value of each measured channel/carrier is read from each connected phone and scanner. The value from each channel is compared to the highest value from all devices. If the measured value is less than X dB (= user-definable RF offset value) below the highest value, a warning message is displayed with the channel number and the device name(s). In Remote mode, the offset value X can be set by Nemo Cloud. If a warning message is triggered by the field unit, it is shown in Nemo Cloud.

With the scanner configuration check you are notified during a measurement if a scanner is not configured to scan all serving cell channels measured by the UEs configured in the system.

Centrally Controlled Testing with Nemo Cloud

Nemo Cloud is a one-stop-shop platform for centrally controlled network testing from measurement session creation to final measurement reports. It allows network operators to remotely operate Nemo Outdoor, Nemo Invex II, and Nemo Handy/Nemo Handy Autonomous test units and check their status. The location and status of field units, including the driver's contact details, are tracked in Nemo Cloud. Configuration settings can be shared to and between all measurement units within the same project quickly and easily. Nemo Cloud supports all devices and test protocols currently supported with Nemo tools.

A single user is able to remotely monitor and manage numerous Nemo measurement kits in the field thus eliminating the need for two technicians in a test vehicle. Measurement sessions are created and scheduled in Nemo Cloud and they can be assigned for individual measurement units or to groups of units. Field unit hardware configurations and test device details can be verified remotely to avoid failed drive tests caused by malfunctioning hardware. In addition, hardware failures, incorrect scripts and other issues can be spotted and corrective measures taken immediately instead of at the end of a one-week test campaign. By reacting without delay, both time and money can be saved.

For locally controlled Nemo tools, Nemo Cloud provides file and configuration sharing between measurement units. This reduces work before the start of the measurement project in the field and eliminates human errors in local measurement unit configuration.

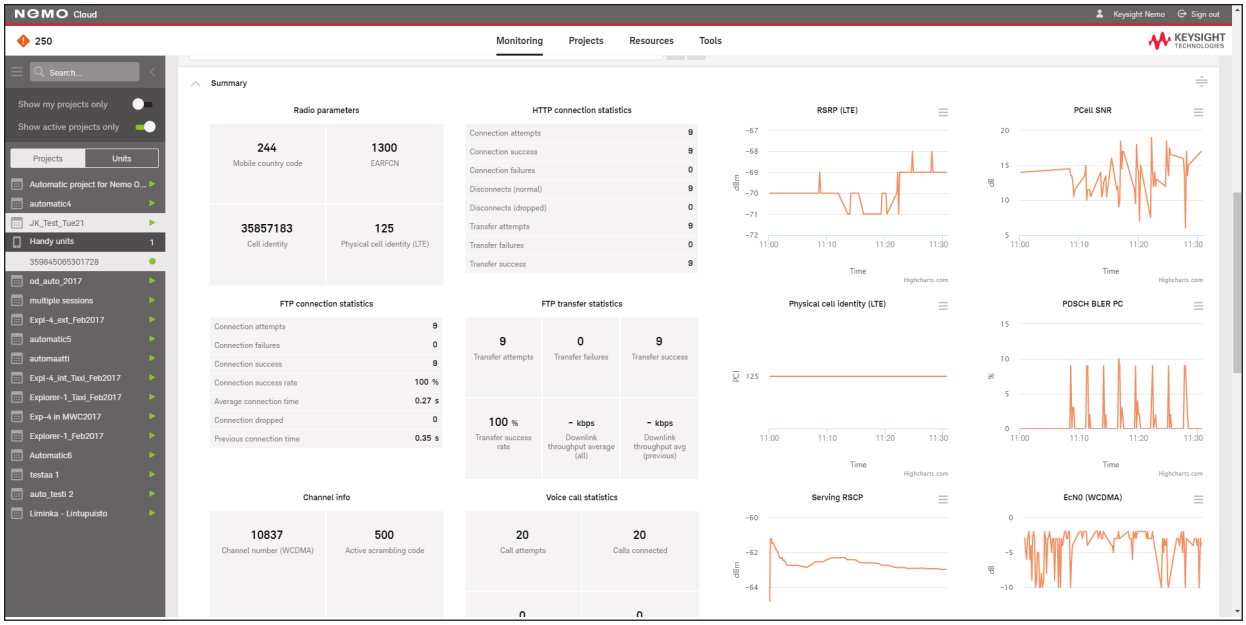


Figure 15. Nemo Cloud provides a centralized platform for viewing information about your measurement projects

Troubleshooting and Verification

Network optimization

Networks are in a constant state of evolution, and require continual optimization, troubleshooting, verification, and fine-tuning. Nemo Outdoor offers tools for various troubleshooting and verification tasks, such as DAS anomaly analysis, real-time RF ingress and missing neighbor detection, pilot pollution analysis, and GSM interference analysis.

DAS anomaly analysis

With DAS anomaly analysis you can easily check and verify in-building small cells and Distributed Antenna Systems (DAS) antennas by giving a pass, fail, or untested result for each cell. With this simple test, network engineers can quickly verify that all cells are transmitting without the need to revisit the indoor venue. DAS anomaly analysis is supported with GSM, WCDMA, LTE, and WLAN technologies.

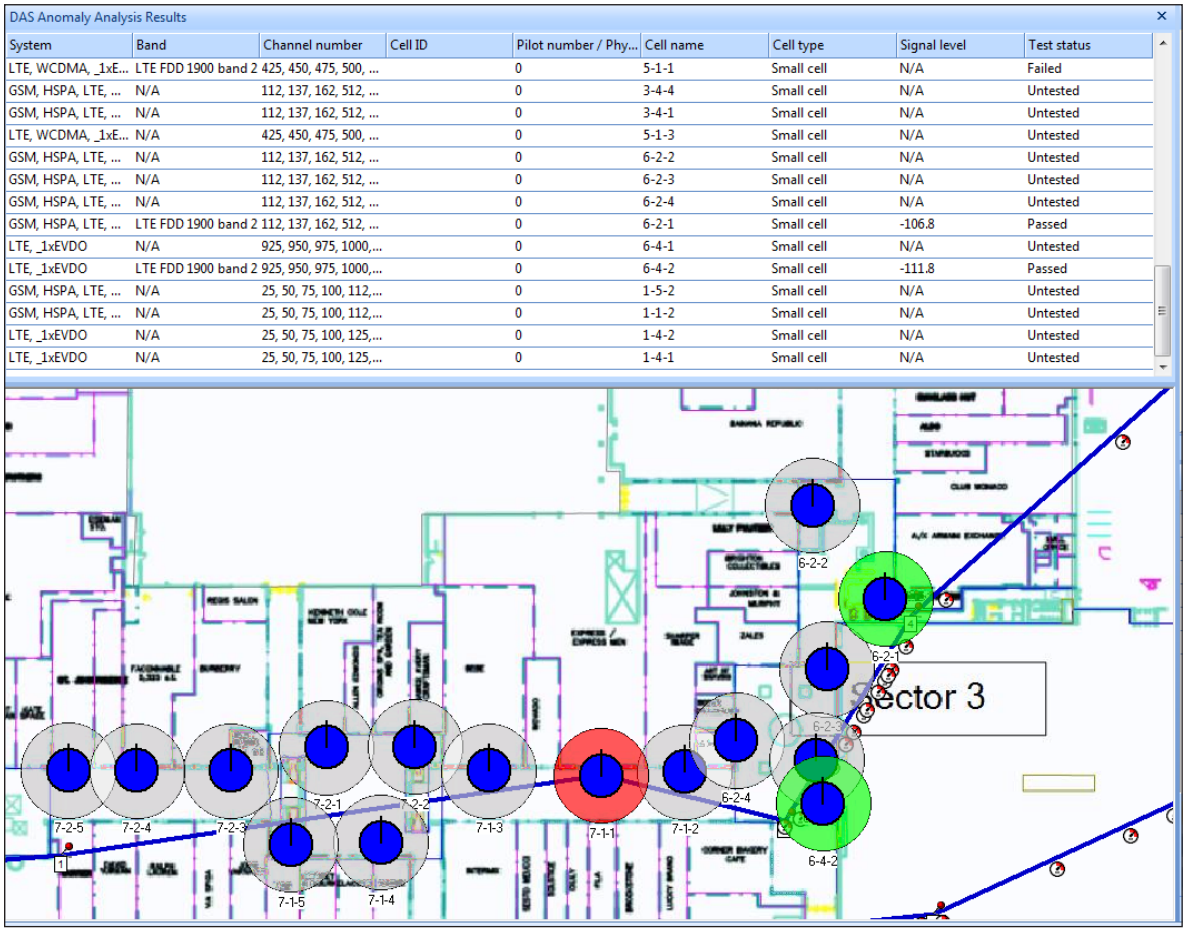


Figure 16. DAS anomaly analysis

RF ingress detection

RF ingress occurs when outdoor cells (macro cells) interfere with indoor antenna systems in which case immediate network optimization is required. Nemo tools calculate the distribution between the small cell/DAS and macro cell coverage inside a building and give real-time information whether RF ingress by a macro cell is detected or not.

GSM interference analysis

In GSM mobile communication networks, system capacity is often limited by co-channel interference. When surrounding cells use the same carrier frequency, or use a channel too close to the one used by a terminal, this creates adjacent or co-channel interference. GSM co-channel and adjacent channel analysis is done in real time during a measurement and playback with Nemo Outdoor. Interference detection is done based on GSM terminal and GSM scanner measurements and these measurements are combined together for analysis.

Pilot pollution analysis

Available for WCDMA, CDMA and EVDO networks, pilot pollution analysis measurements can be performed in real time with Nemo Outdoor by using test terminals or a scanning receiver. In a pilot pollution situation there are more active/monitored pilots than a handset can measure, or there is no clear dominance of a single pilot in the area. The pilot signal is used to distinguish cells in the network from one another. Pilot pollution analysis is done based on cell measurement events, and analysis is always active. You can define thresholds for pilot pollution analysis via the Nemo Outdoor user interface.

Pilot pollution situations detected with WCDMA scanners and terminals and GSM co-channel/ adjacent channel interference situations can be displayed on a map. A line from the current location is drawn to the interfering cell(s). A BTS file with WCDMA scanners and terminals can be used to display cell names for cells causing pilot pollution.

IP packet capturing

With IP packet capturing, network packets sent between IP addresses are stored in log files and can be post-processed with a third party application such as Ethereal. A separate log file is generated for each test terminal making data transfers. IP packet capturing is especially useful in problems related to TCP/IP communication which do not necessarily appear in the measurement logs.

Data Views and User Interface

Nemo Outdoor's flexibility is best displayed and experienced through its class-leading user interface. It is arranged into control and data windows which can further be arranged and adjusted depending on your needs.

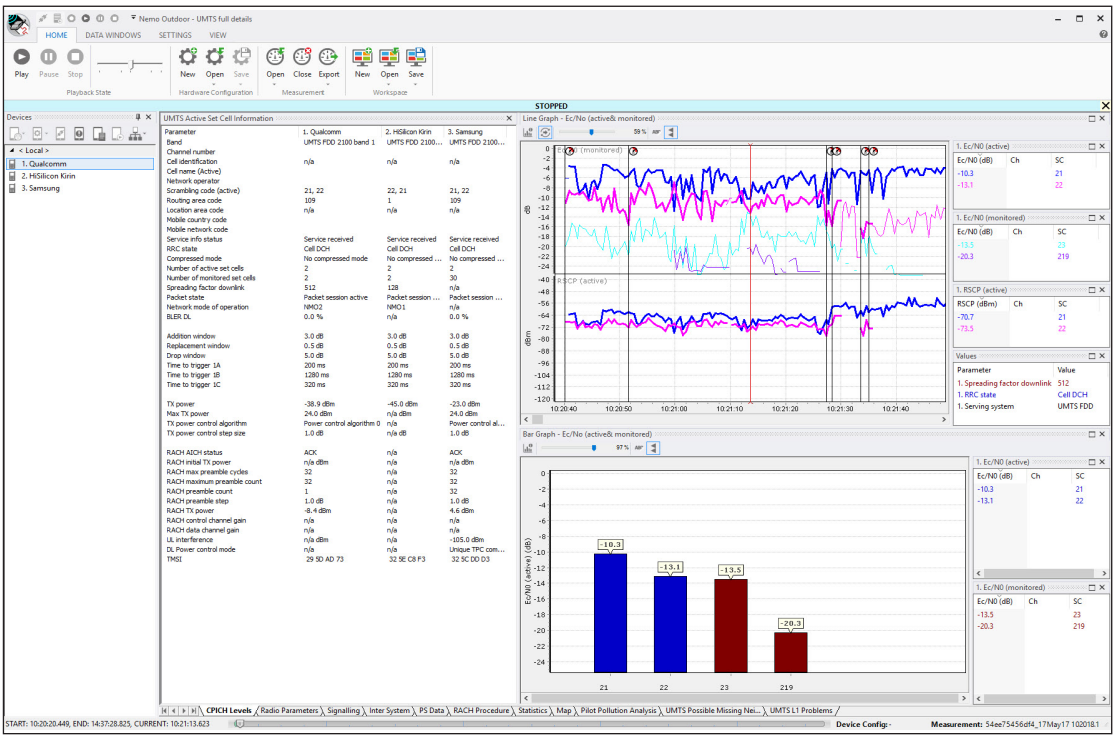


Figure 17. Nemo Outdoor user interface is extremely flexible

The Nemo Outdoor user interface is compatible with common Windows standards. During measurement, you can easily monitor the results and the progress of the measurement process. After the initial device setups and configurations, you can save all device-related settings to a hardware configuration file and load the same configuration later on. The Nemo Outdoor user interface is first and foremost flexible and customizable to suit your specific needs. View groups allow the organization of measurement windows into different tabs for easier viewing. This is especially useful when there are several graphs and maps open simultaneously in the Nemo Outdoor main window.

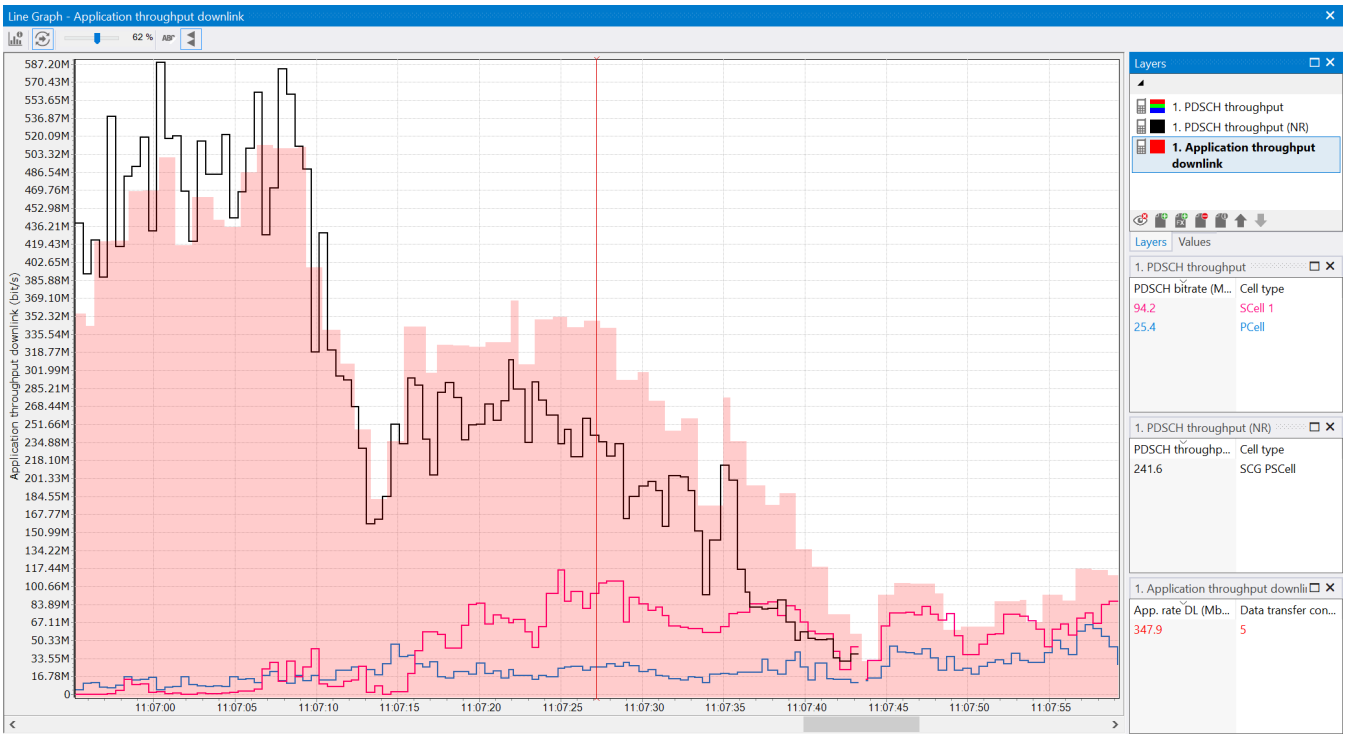


Figure 18. A 5G line graph in Nemo Outdoor.

Nemo Outdoor maps provide you with a better understanding of the measurement route and results through visualization. When Nemo Outdoor is used with a GPS receiver and positioning coordinates are collected, the measurement route is drawn on a map and you can easily correlate events to location coordinates. Most of the time drive testing is performed using regular GPS receivers that give exact coordinate information in normal situations. Once the GPS fix is lost, however, coordinates cannot be updated correctly. In areas where there are a lot of tunnels or other obstacles, the loss of GPS signal can affect the accuracy of your network measurements and negatively impact your test results. With Nemo Outdoor you can correct measurement route drawings, for example, when the route is missing because the test vehicle drove through a tunnel.

Nemo Outdoor offers parameter-based route coloring, which means that you can observe the values of certain network parameters from the route coloring on the map. You can define which color refer to which parameter value. This way it is easy to spot the problem areas on a map. To make analysis even simpler, the same route can be drawn several times on the map and different route coloring can be applied to each of them. In addition, certain events can be shown as icons on the map.

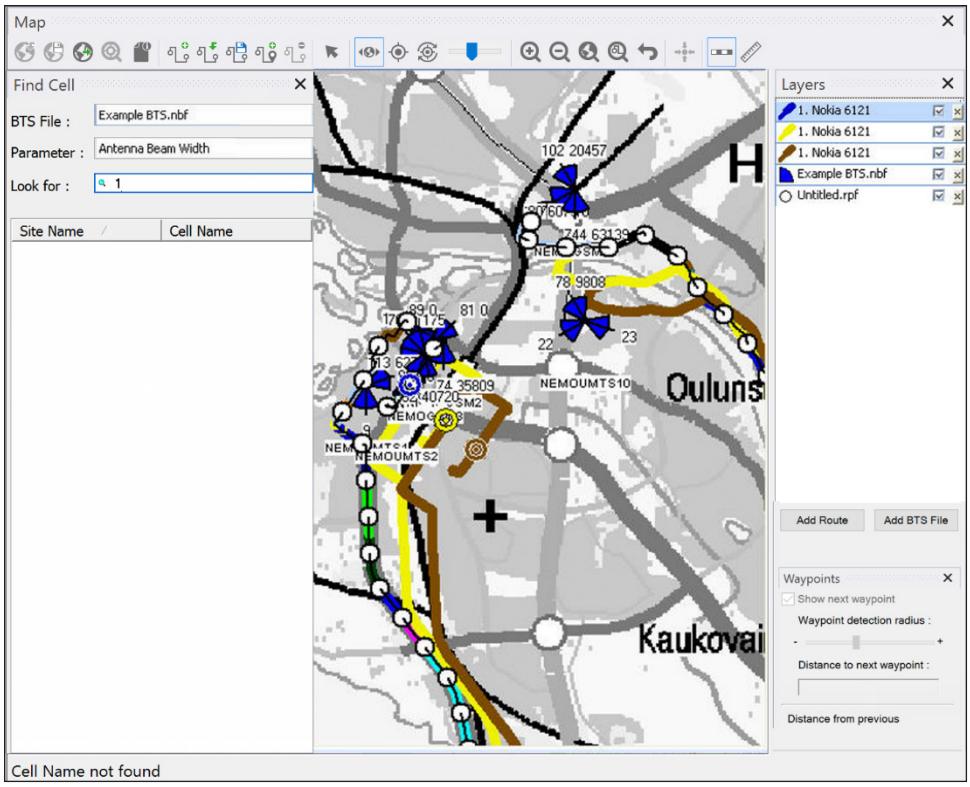


Figure 19. On a map you can view, for example, base station icons and a route plan

Nemo Outdoor maps and floor plans can also display a base station overlay. With a user-defined BTS file, the map shows the location of each base station, the defined antennas with antenna directions, and even antenna apertures and cell identifying parameters. Furthermore, all this information can be edited directly in Nemo Outdoor. During drive testing or playback, a line connecting the current location to the serving and/or neighbor cell (sector) will be drawn automatically (in CDMA systems, multiple lines can be drawn to active sectors). This provides a highly visual impression of the network operation. For example, if a call is connected to a non-optimal cell, it will appear instantly on the map. The map will also display missing neighbors for quick identification and resolution.

Nemo Outdoor supports Google Map, MapInfo, OpenStreetMap, and iBwave map formats. It also supports MapXtreme Geoset files (.gst) and GPS eXhange format (GPX). All user-defined map settings, such as, the order of the different map layers and the zoom factor are stored in the .gst file. Nemo Outdoor maps can also be exported to Google Earth maps. Furthermore, Google Earth can be used to create KMZ files, georegistered raster images of floorplans, that can be used as indoor maps in Nemo Outdoor.

Decoding

In events and messages grids, the data can be analyzed even more in-depth by decoding the individual events and messages simply by double-clicking the event in question. You can define both the background and text color in event and message grids. This color coding can be done based on a certain message, sub channel or decoded message.

Notifications

Notifications enable you to add another dimension to the measurement process. Audio prompts help you during drive testing to immediately notice when something special happens. You can configure Nemo Outdoor to play audio notifications or voice prompts whenever a certain event occurs. The voice prompts are Windows .wav files, and in Nemo Outdoor both female and male default notification sounds are available. If you prefer, you can record and use your own voice notifications instead of the default files. Custom notifications can also prove useful when creating a script file. For example, you can set a video call to start only when it is supported by a cellular technology. Nemo Outdoor's advanced exporting functionality also enables you to export individual custom-made notifications.

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