R&S®TSMx-API FOR R&S®TSMx MOBILE NETWORK SCANNERS

One application programming interface for all use cases

GraphQL

Product Brochure
Version 02.00

ROHDE&SCHWARZ
Make ideas real

AT A GLANCE

The R&S®TSMx mobile network scanners collect RF data to test mobile networks or analyze networks for government purposes. The new application programming interface (API) for R&S®TSMx mobile network scanners – here referred to as R&S®ViComWeb – allows the scanners to be quickly integrated into any third-party software irrespective of the operating system in use. Installations for walk and drive tests and for remote control of the scanners are supported.

A mobile network scanner is a calibrated measurement receiver used to perform measurements in mobile networks. It performs a non-intrusive measurement of the air interface and decodes every accessible parameter from multiple networks simultaneously with very high speed, accuracy, sensitivity and dynamic range. Measurements can be performed without a SIM card on all common cellular technologies such as GSM, CDMA/EV-DO, WCDMA, LTE, NB-IoT, LTE-M, 5G NR, C-V2X, WiMAX™, TETRA and P25.

The result is a comprehensive picture of the RF environment, such as the spectrum allocation and the cell-specific RF and broadcast information. With this diverse range of measurement parameters, network scanners cover many different use cases.

In mobile network testing, network operators and service companies use network scanners to verify the mobile network and its RF environment during all phases of the network lifecycle – from early lab and field testing to acceptance to troubleshooting, monitoring and benchmarking in an operational network.

Data from the scanner is also used by governments to perform cellular network analysis. Typical user groups are law enforcement agencies, intelligence services, armed forces and regulatory authorities. In their daily work, they rely on precise data about the network environment in a specific area to gather and present evidence, to protect sensitive areas and to search for and rescue missing persons.

KEY FACTS

- Easy-to-use web based interface
- Self-explanatory data structure
- All operating systems supported
- All mobile network testing use cases supported
- All cellular network analysis use cases for governments supported

USE CASES

Mobile network testing use cases

- Pre-rollout: spectrum clearance, network planning and engineering
- Ensuring correct infrastructure deployment: verification and acceptance
- Optimizing and troubleshooting the network during operation
- Network audits
- Benchmarking
- Monitoring intermittent interference

Cellular network analysis use cases

- Knowing the network environment
- Protecting sensitive areas
- Gathering and presenting evidence
- Locating a mobile phone based on its network trace

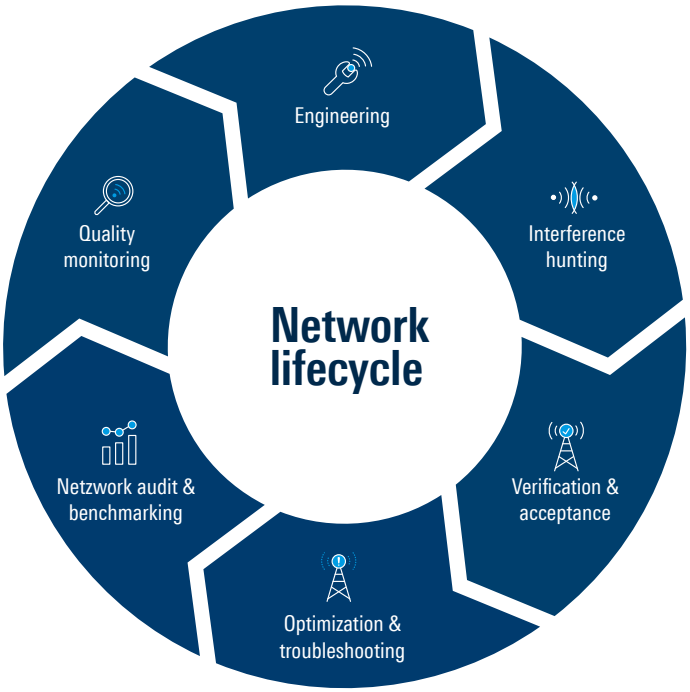
R&S®TSMx MOBILE NETWORK SCANNER FAMILY

- R&S®TSME6 ultracompact drive test scanner
- R&S®TSMA6B autonomous mobile network scanner
- R&S®TSMxxxDC ultracompact downconverters to enable 5G NR FR2 measurements

MOBILE NETWORK TESTING USE CASES

In mobile network testing, network operators and service companies use network scanners to verify mobile networks and their RF environment during all phases of the network lifecycle – from early lab and field testing to troubleshooting and monitoring in an operational network. As the number of users increases in networks, benchmarking campaigns are initiated to rank the networks by their quality, with power, interference and quality levels from network scanners playing an important role.

Mobile network testing



Pre-rollout: spectrum clearance, network planning and engineering

Spectrum clearance with interference hunting

For the deployment of new mobile technologies, it is becoming increasingly important to obtain a clean spectrum in order to achieve the expected data rates. However, as the quantity of transmitting devices increases, the number of RF interference sources also grows.

Spectrum clearance is the process of characterizing the RF spectrum and removing unwanted transmitters. Spectrum clearance takes place before deploying a network in a new or refarmed frequency band to ensure a clean operating environment.

The scanner is used to collect spectrum data quickly and easily over a wide area in walk and drive test campaigns. The collected data is analyzed in the office using a postprocessing solution to identify spots of interference. At these spots, interference hunting is required to locate the interferers and have them switched off.

Planning: propagation model tuning

Over the last few decades, new technologies and frequency bands have been defined and rolled out to increase capacity in mobile networks and serve the constantly growing user demand for voice and data services. As new technologies and frequency bands are introduced, network operators have to understand

how the technology and frequency bands behave in the field in order to develop a business plan for their network rollout. As a prerequisite for a propagation simulation based on software tools, the model used in the software has to be tuned in line with real field measurement results. For this purpose, a test transmitter is used in combination with the R&S®TSMx mobile network scanner's continuous wave (CW) measurement capability, which provides accurate power measurements from the field. These power measurements are fed into the network planning tool to tune the propagation model and achieve maximum accuracy. The propagation model is the baseline for the planning of the network in line with targets for performance and coverage key performance indicators (KPI).

Engineering: feature testing

Technological innovation is a constant driver in the evolution of cellular networks and there are high expectations for improving network efficiency and the user experience and for enabling new use cases. This is highly apparent as new technology generations such as 5G are introduced, but also in the incremental introduction of features from one 3GPP release to the next. Since best practices do not yet exist, investing in a completely new technology can be a cause for concern if there is doubt about exactly how it will perform or how a new feature will affect network performance. Engineering test activities are the starting point to ensure that products and services deliver the expected results.

Using the scanner, any technology or feature that affects RF interface can be tested and validated in early lab or field trials to establish the required best practices before a commercial rollout. Examples are new network components such as MIMO antennas and 5G beamforming, coverage of new spectra including new bands such as mmWave, new network synchronization capabilities, TDD UL/DL configuration, layer 3 (L3) broadcast messages as well as new air interfaces such as NB-IoT, LTE-M and C-V2X.

Another best practice is testing new RAN software releases thoroughly in the lab and in a test cluster in the field before rolling them out in the commercial network.

Ensuring correct infrastructure deployment: verification and acceptance

After the planning phase, the network enters the rollout stage. The quality of the installation and maintenance of mobile network infrastructures has a huge impact on network performance. This process involves several steps, and performing measurements after each step is the only way to ensure that both the expected network quality and increase in capacity are achieved.

Site installation verification

When installing and maintaining base stations, users need a quick overview of the site configuration to verify that the site was installed correctly: deployed technology, band, channel, physical cell identity (PCI) and beam as well as L3 information, which can be obtained with the scanner.

This data can also be used to identify physical installation issues such as loose antenna cables or crossed feeder cables.

Network synchronization verification
The validation of network synchronization is particularly important in 5G networks. If sites are not synchronized, network capacity and performance will decrease due to interference between uplink (UL) and downlink (DL) transmissions. Relative network synchronization within the same network is needed to avoid interference, but absolute time synchronization to UTC is also mandated for 5G TDD networks in certain countries.

Relative network synchronization can be assessed by a drive test using a scanner to measure the time of arrival offset between the pulse per second (PPS) signal and the received 5G NR or LTE synchronization signals. Relative arrival time measurements can be conducted during drive testing to identify general problems.

Absolute time synchronization to UTC can be measured using a scanner in a stationary site inspection, e.g. during site verification or troubleshooting. The entire signal chain, including the baseband, grandmaster clocks, signal processing, cables and antenna elements with phase shifters and filters can add significant time delays until the signal is broadcasted over the air. The receiver can provide absolute time values and calibrated time of arrival values in the nanosecond range, allowing these delays to be detected and optimized in the network. In addition, any timebase deviation in a network will lead to a frequency drift. The precise SSB center frequency is therefore measured to detect drifting cells in the frequency domain.

Network and spectrum occupancy verification
Proper RF conditions are the baseline for a high-performance network. Network operators are refarming the spectrum due to the increasing demand for network capacity and new services. Legacy radio access technologies are partly replaced by the latest ones, such as 5G, to increase the network efficiency, which leads to complex spectrum occupancy with the coexistence of many different radio access technologies. Carriers are closely spaced to use the spectrum as efficiently as possible. In this process, network operators must avoid accidentally deploying two different technologies in the same part of the spectrum at the same location.

An R&S®TSMx mobile network scanner helps to provide a clear view of all carriers across the spectrum, including their RF power levels. With its automatic channel detection (ACD) feature, the scanner can automatically search the spectrum for carriers and bandwidth parts in 5G NR and identify them by decoding the L3 messages. Additionally, the user gains deep network insights by accessing all the system information messages that are broadcast by the networks. This allows the network configuration to be verified with regards to neighbor relations, relations between different radio access technologies (e.g. for proper handovers and TDD configurations in LTE and 5G NR).

Regulators make frequent use of this functionality to verify that the spectrum is correctly used by the licensee.

Electromagnetic field strength (EMF) measurements
EMF measurements can be used to prove that electromagnetic radiation from mobile networks is below regulator-defined thresholds. The use of new frequency bands and technical features such as 5G NR beamforming make EMF measurements even more important. With an R&S®TSMx mobile network scanner decoding all available cells and providing accurate power

levels, EMF values can be computed for a subsequent extrapolation based on the network configuration.

Cluster acceptance

In the network planning process, the quality targets for data capacity or throughput are translated into RF coverage and quality objectives, eventually leading to a concrete network design with a certain number of sites and sectors as well as physical site properties such as antenna type, azimuth, tilt, PCIs, beams and output power.

During cluster acceptance, it is crucial to validate the RF properties of the deployment. This RF baseline lays the foundation for the overall network performance. Proper underlying radio conditions are essential for an efficient high-performance cellular network.

The R&S®TSMx mobile network scanners are therefore the ideal tool to complement active testing of mobility, signaling procedures and application performance. The scanners efficiently collect all the required data for all bands, channels and technologies deployed in the network. The R&S®TSMx scanners perform power (RSRP), quality (SINR, RSRQ) and MIMO measurements and obtain network configuration data such as PCIs, beam indices and L3 MIB/SIB information.

Based on the measurements taken, the network vendor can check if the network fulfills the required radio conditions and, in combination with active testing, can generate cluster acceptance reports. Or, if the required performance is not achieved, the scanner helps identify the causes of underperformance and helps trigger corrective actions.

To give an example: the signal to interference and noise ratio (SINR) directly affects the data throughput and the performance of mobile networks. The SINR is therefore one of the key parameters when planning and optimizing the network. The best SINR is achieved when there is one dominant server at a certain location. With more servers on air, e.g. in dense urban areas with densified networks, network optimization becomes a crucial task to provide the best possible quality of service.

Optimizing and troubleshooting the network during operation

After the network has entered commercial service, network operators need to manage the quality of the network continuously. On the RF side, there are constant changes coming from increased load in the network, changes in the environment such as new buildings, new sources of interference and aging equipment such as antenna cables. Such changes may lead to decreased performance, which can be seen by end customers or – ideally – spotted by mobile network operators with their network management tools before they affect end users' quality. Although network management tools are effective in spotting decreased performance, they are unable to identify the root cause of such problems when complex radio conditions are involved. Troubleshooting then begins and the R&S®TSMx mobile network scanner plays a critical role in the investigation. In practice, this means that tests performed during the rollout phase are repeated. In addition, this section covers additional tests performed in the operational network.

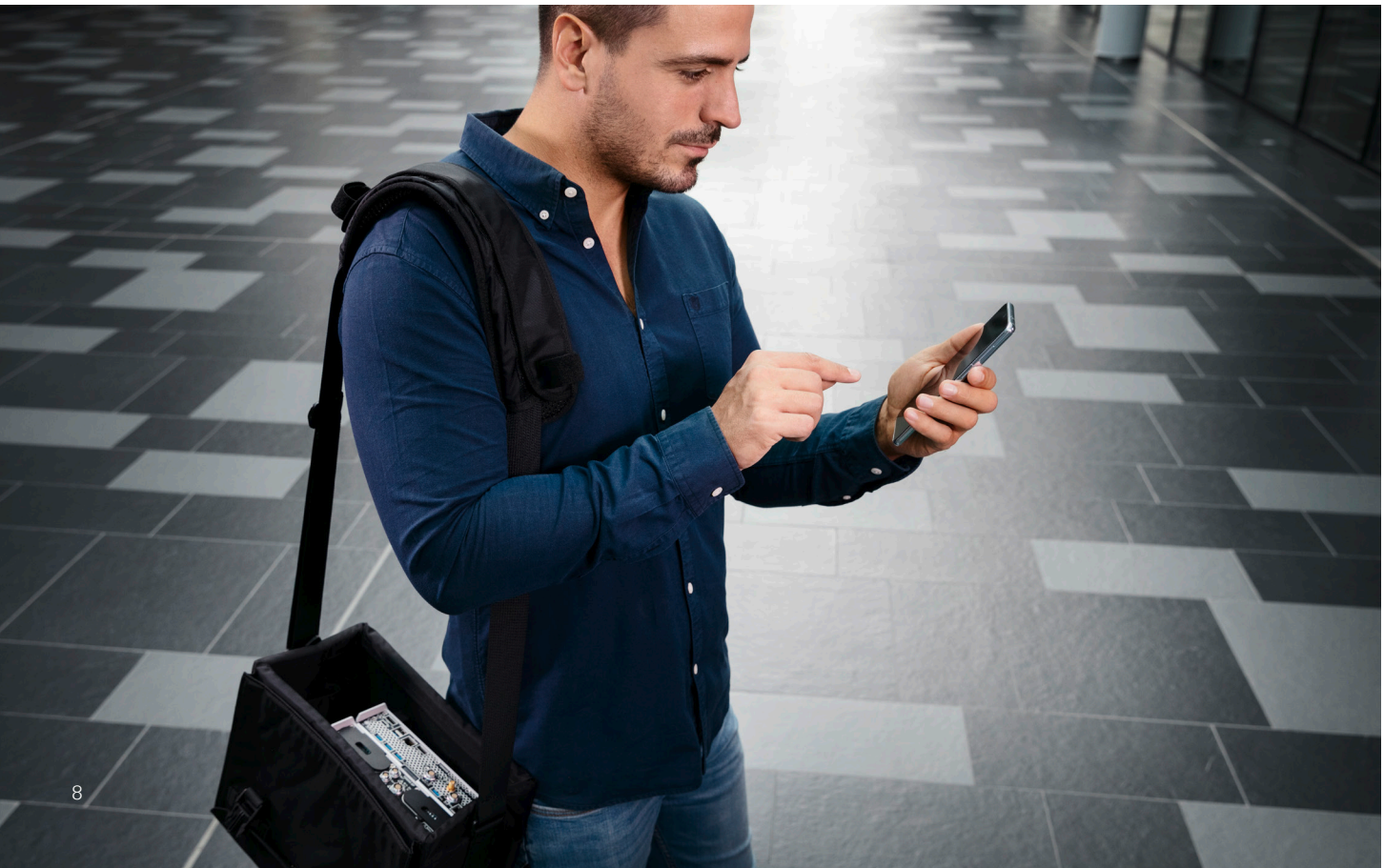
Interference detection in operational 5G networks

As described in the rollout section, interference is a threat to network performance, and therefore is constantly monitored by network operators. In practice, the uplink is the weak path and if affected, it can completely prevent connections between the network and the consumer device. Network operators can use operating subsystem (OSS) data to tell which cells are experiencing interference, so they can focus on finding and removing the source.

In 5G TDD, it is particularly difficult to identify interference with a spectrum analyzer, since the same frequency is used in both uplink and downlink. Here, the scanner provides a smart solution: the R&S®TSMx scanner can measure the uplink and downlink spectrum as well as the spectrum during the guard period separately by applying a time gate. The time gate is automatically configured based on the scanner measurements. The result is a real-time spectrum that can locate interference sources quickly.

International spectrum usage validation and interference evaluation

While the spectrum allocation within a single country can be strictly regulated and controlled, radio waves do not stop at national borders. Regulatory or operator-driven international agreements provide network operators with technical parameters in order to efficiently operate networks in border regions. In 5G networks, for example, the synchronization of networks must be ensured even across national borders. And if these networks are not using the same TDD pattern, downlink symbol blanking (DSB) must be applied to prevent interference.



Regulatory authorities and network operators can use the R&S®TSMx mobile network scanner's automatic channel detection feature to check which base stations are transmitting in which band at which frequency. The network operator can also be identified by checking the mobile country code (MCC) and the mobile network code (MNC). The next step is to measure the network synchronization and verify the TDD pattern and symbol blanking. Additionally, the scanner can localize the site of the transmitter using the base station position estimation feature.

This data gives users transparency about the RF situation at the border and allows them to monitor the implementation of an agreed spectrum utilization plan.

Network audits

Verification of coverage requirements

Typically, the allocation of spectrum to mobile network operators is linked to the fulfillment of certain coverage targets by the operators after a certain time. Regulatory authorities therefore need to verify whether these targets have been achieved by the network operators. This data can be quickly obtained with an R&S®TSMx mobile network scanner, since no SIM cards or mobile phones are needed, and the scanner automatically detects all transmitters within the licensed spectrum. Since the scanner is a calibrated device, the measurement results can reliably be used for such a legal assessment of the license conditions.

Benchmarking

Technology rollout insights

Mobile network operators compete with each other by rolling out new technologies to offer better services to their subscribers. It is therefore helpful to gain competitive insights, such as: to what extent and where has a competing network operator deployed new technology such as 5G? This can drive a company's marketing activities and investments. The drive test scanner can detect new network features easily, such as 5G, dynamic spectrum sharing and standalone mode.

Network density and technology usage insights

Understanding the competitors' networks can be invaluable for a company's targeted marketing activities and investments.

For example, it can help for a company to compare its coverage or network investment in a certain geographic area to that of its competitors. An advantage can be exploited by targeted marketing in this area and the company can gain ground through network upgrades. Additionally, the network capacity of competitors can provide information about the carried traffic in a certain area and the resulting potential for growth can drive investments in marketing or the network itself.

The R&S®TSMx mobile network scanners reliably provide information about how many sites with how many carriers have been deployed with which cellular technology for a certain geographic area, proving useful insights into competitors' network coverage and capacity. This applies to both dedicated infrastructure and shared infrastructure, as in the case of RAN sharing. Additionally, the scanners detect the antenna configuration and investments such as MIMO deployment can be analyzed. In combination with data collected using UEs during a benchmarking campaign, deployed MIMO usage can be compared with actual usage.

Base transceiver station (BTS) position estimation

The location of competitors' base stations can be of interest to network operators, for example to study competitors' network architecture and to identify potential locations for their own or shared sites.

Since site location information is not publicly available in all countries, drive test measurements with a mobile network scanner can estimate such positions, including highly accurate sector orientation.

Monitoring intermittent interference

As described in previous sections, interference is a threat to network performance and must be constantly monitored by network operators. However, interferers may not be active all the time and only occur during certain hours of the day or on certain days of the week based on the behavior of the equipment that is emitting the interference. In such cases, it is helpful to deploy an autonomous scanner such as the R&S®TSMA6B to monitor the spectrum over a longer period of time in order to identify the correct day and time when the interferer is active and then to shut it down.

CELLULAR NETWORK ANALYSIS USE CASES

While the content delivered by the mobile network scanner for cellular network analysis is identical to mobile network testing (RF parameters, SIB messages, etc.), cellular network analysis customers have different requirements.

Law enforcement agencies, intelligence services and armed forces typically require this data for a comprehensive overview of the network topology (e.g. before deploying personnel in a potentially hostile environment), to detect irregular base stations that could compromise the security and safety of people and/or governments, to support forensics investigations and to support search and rescue activities. Depending on the procedures, regulatory authorities can be either directly involved in, or provide support for, such analysis activities on top of their mobile network testing activities.

Knowing the network environment

Since cellular network operators constantly change the network configuration (through optimization, troubleshooting, refarming, etc.), getting a clear picture of the actual network environment is difficult and therefore complicates cellular network analysis activities.

An R&S®TSMx mobile network scanner is a fast and reliable solution to provide a clear view of all carriers, frequencies and technologies across the spectrum, including their RF power levels. With its automatic channel detection (ACD) feature, the scanner can automatically search the spectrum for carriers and identify them by decoding the L3 messages.

In addition to this, the device uses advanced signal separation algorithms to deliver all the required details in order to determine the geographic positions and sector azimuths of all measured cells in all frequency bands and technologies in both ground and airborne measurement campaigns.

The scanner provides RF coverage data as well as access to all system information messages that are broadcast by the network, thereby offering deep network insights that open the door to multiple types of applications.

Protecting sensitive areas

The increasing deployment of irregular base stations, which are cheaper and easier than ever to build, is a threat to mobile network integrity and poses a security risk to sensitive areas. These can range from critical infrastructures to official buildings, e.g. embassies and ministry offices, but also includes the private sector due to industrial espionage, e.g. headquarters and research centers. It is therefore critical to detect and localize such transmissions as efficiently and quickly as possible.

Since these irregularities can occur in any mobile operator network, in any technology, in any frequency range and at any time, the mobile network scanner is the perfect solution for such activities. The instrument is fully passive, network independent, provides high scanning rates, sensitivity and dynamic range, and can easily be set up for the task at hand. The RF and L3 MIB/SIB information delivered by the scanner provides all the details required for successful analysis of all cells on air and enables the identification of suspicious cells in real time.

Depending on the physical environment to be protected and monitored, the setup can be mobile or stationary, and include one or multiple networked scanners (e.g. city districts, airports) as part of 24/7/365 activities or at temporary locations (e.g. official visits, security conferences).

Gathering and presenting evidence

Forensic analysis of cellular network measurements is a reliable solution to support law enforcement by providing hard, tangible facts at different stages of their investigations – all the way from crime scene investigation to alibi verification.

Crime scene investigation of cellular networks requires the generation of a comprehensive list of cells of interest for further investigation that can be used to contact mobile network operators and collect subscriber information in order to determine possible suspects. Since tens, or even hundreds, of base stations can be measured in a particular environment, data delivered by the mobile network scanner can be used to fine tune the analysis and focus on base stations serving the specific area of interest.

By comparing scanner measurements with data obtained from mobile network operators, alibi verification provides technical evidence about the coverage at a certain location. This can determine whether or not the individual's mobile phone was at this specific location at a specific time, quickly and efficiently helping prove or disprove a suspect's alibi.

Locating a mobile phone based on its network trace

Time is of the essence during search and rescue activities, which are vital to help people in distress (e.g. lost, injured, or in danger) in difficult terrain such as forests and mountains and when determining the location of a suspect on the loose.

Matching the retrieved communications logs of a target mobile phone from the cellular network operator with base station positions and network coverage data obtained from the mobile network scanner (from previously measured data or a live measurement), greatly improves efficiency when determining the area of interest, i.e. where the search should start.

Scanner data can also be used to define optimal parameters for cells that will be added to a mobile network environment. The new cell to be deployed – as an emergency network for search and rescue activities or as an additional cell in an already crowded environment – allows the user to make calls or send messages to the target who can then provide updates on their situation and the environment or force the mobile phone to transmit in order to precisely locate the target device.

R&S®ViComWeb INTERFACE

Easy-to-use API for GraphQL™

R&S®ViComWeb offers an easy-to-use API to unlock the full potential of the R&S®TSMx mobile network scanners. The API supports all technologies and scanner features and allows the use cases described in this product brochure to be easily created. The interface is web based for easy integration into any application using the R&S®TSMx mobile network scanners.

R&S®ViComWeb uses the commonly available query language GraphQL. This allows various clients to request scanner data from the R&S®ViComWeb server. The data is structured in a schema and type system. Various data can be retrieved based on the query from the client. The query language is self-documenting, widely supported and optimized for performance. Some sample queries based on the open source GraphQL development tool Banana Cake Pop are shown below. These queries can be easily implemented with different programming languages and various platforms.

Quick start with sample queries

The API comes with full documentation and sample queries that enable quick integration of the host software.

Flexible deployment options

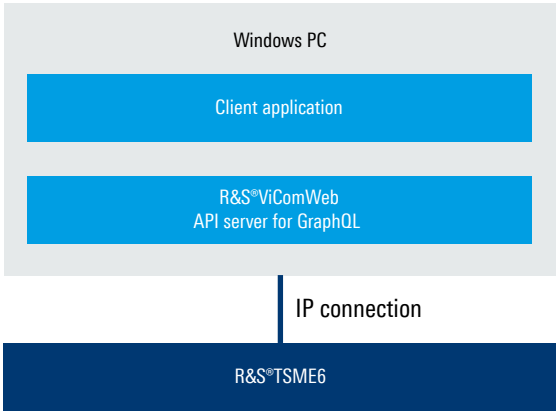
Depending on the mobile network scanner type, different deployment options are possible and shown on the next page.

Sample query for LTE

This query returns a list of all RF measurements of detected LTE channels and cells.

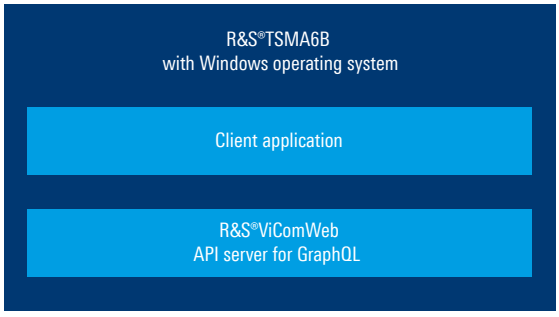
```
# give me all RF measurements of all detected LTE cells query
subscription
{
  lteChannelMeasurements {
    cellMeasurements {
      cell {
        identifiers {
          frequency
          pci
          globalCellId
        }
      }
      referenceSignals {
        txPort
        rsrp
        rsrq
        sinr
      }
    }
  }
}
```

R&S®TSME6 with Windows PC



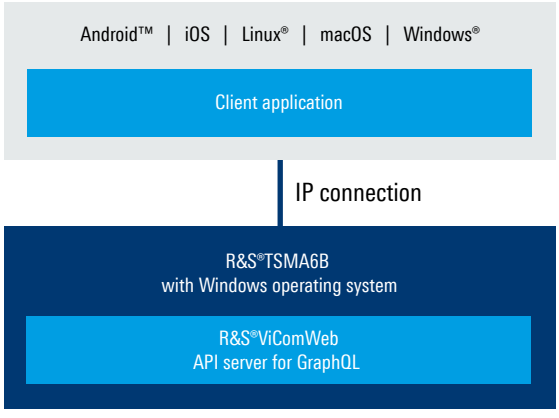
The R&S®ViComWeb API server runs on a Windows PC connected via LAN to the R&S®TSME6. The client application can run on the same Windows PC or on any other machine with IP connectivity to it.

R&S®TSMA6B with client application on the R&S®TSMA6B



The R&S®ViComWeb API server runs on the R&S®TSMA6B and the client application also runs on the Windows based R&S®TSMA6B.

R&S®TSMA6B with external client application



The R&S®ViComWeb API server runs on the R&S®TSMA6B and the client application can run on any other computer and operating system using an IP connection to the R&S®TSMA6B such as LAN, Wi-Fi® and Bluetooth®.

R&S®TSMx MOBILE NETWORK SCANNER FAMILY

R&S®TSMx mobile network scanners integrate into any measurement setup such as walk and drive tests and air-borne measurements with local or remote control.

There are two mobile network scanners available:

- **R&S®TSME6 ultracompact drive test scanner**
  This scanner is a compact measurement receiver controlled from a Windows PC running the measurement software.
- **R&S®TSMA6B autonomous mobile network scanner**
  This includes a measurement receiver and a Windows PC. The measurement software can be installed on the R&S®TSMA6B itself or on a remote device connected via Bluetooth®, Wi-Fi® or Ethernet to the R&S®TSMA6B. An optional battery pack in combination with a carrying bag enables portable measurements. This setup can also be used as an autonomous device for monitoring purposes.

The native frequency range of both scanners from 350 MHz to 6 GHz can be extended by using an R&S®TSMS53DC downconverter from 17 GHz to 53 GHz.

Scanning functionality for a particular network technology on the receivers is enabled by a license keycode, allowing easy upgrades in the field. Since the scanning algorithms are implemented in software, new functionalities such as compatibility with new 3GPP releases are continuously added and provided as updates, making the receiver a future-proof, long-term investment.

The receivers are complemented with antennas for all frequency ranges. Mounting and power options are available for all use cases.

See the following documents for details:

- R&S®TSME6 product brochure (PD 3607.6873.12)
- R&S®TSMA6B product brochure (PD 3609.5622.12)
- R&S®TSME44DC, R&S®TSMS53DC product brochure (PD 3607.9608.12)
- Receive antennas flyer (PD 3684.0176.32)

R&S®TSME6 ultracompact drive test scanner controlled from a Windows PC

R&S®TSMA6B autonomous mobile network scanner with battery pack controlled by a tablet

R&S®TSME6 with R&S®TSMS53DC ultracompact downconverter for an extended frequency range from 17 GHz to 53 GHz

SPECIFICATIONS IN BRIEF

Specifications in brief		
System requirements	for PC installation	Windows 10 or Windows 11 (64 bit), physical quad-core CPU, at least 8 Gbyte RAM and AVX2 support, NIC with 9 kbyte jumbo frame support
Supported technologies		ACD, GSM, UMTS, LTE, 5G NR
Supported mobile network scanners		R&S®TSMA6, R&S®TSMA6B, R&S®TSME6
Supported downconverters		R&S®TSME30DC, R&S®TSME44DC, R&S®TSMS53DC
Supported hardware configurations	R&S®TSMA6/R&S®TSMA6B	R&S®TSMA6 or R&S®TSMA6B plus up to three R&S®TSME6 scanners, plus one downconverter
	R&S®TSME6 with Windows PC	up to four R&S®TSME6 scanners, plus one downconverter

ORDERING INFORMATION

Designation	Type	Order No.
Application programming interface for R&S®TSMx mobile network scanners	R&S®TSMx-API	Contact your local Rohde&Schwarz sales office.