Reliable small cell planning using LTE test transmitter

Application Note

Products:

- R&S®SGT100A
- R&S®TSME
- R&S®ROMES4

Reliable small cell planning is essential for important deployments like hospitals, manufacturing facilities, simply VIP (CxO) office floors or meeting rooms (the list of examples is endless). Often planning tools do not provide this high reliability and required accuracy.

Rohde & Schwarz offers a solution that helps verifying the indoor small cell planning for such critical areas during the site survey by using a test transmitter at the planned small cell position and really measuring the performance (coverage and capacity). The site survey gets more reliable and ensures that the small cell deployment will deliver the expected performance.

This application note is a simple step-by-step guide that introduces a practical method to perform reliable small cell planning.

Note:

Please find the most up-to-date document on our homepage http://www.rohde-schwarz.com/appnote/1MA297.

This document is complemented by software. The software may be updated even if the version of the document remains unchanged

Application Note
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1 Introduction

Mission- or even safety-critical small cell deployments require a highly reliable and accurate planning. Examples might be hospitals, manufacturing facilities, simply VIP (CxO) office floors or meeting rooms; the list of examples is endless. Often planning tools do not provide this high reliability since e.g. floor plans might be outdated or changes in real deployments are not maintained properly in the plans.

Rohde & Schwarz offers a solution that helps verifying the indoor small cell planning for such critical areas during the site survey by using a test transmitter at the planned small cell position and really measuring the performance (coverage and capacity). The site survey gets more reliable and ensures that the small cell deployment will deliver the expected performance.

The very compact and lightweight test transmitter R&S®SGT100A is able to generate all kinds of modulated signals. To measure the resulting performance we offer a network scanner (out of our scanner family R&S®TSME, R&S®TSMA, R&S®TSMW) that provides the radio parameters with very high accuracy. RSRP and SINR for LTE will be measured and from SINR the capacity of the new planned small cell can be derived qualitatively. The interpretation of the measurement results can be found in chapter 5.

This application note is a simple step-by-step guide that introduces a practical method to perform reliable small cell planning.

2 General Procedure

The planning process of an indoor installation needs a record of the actual situation without the planned small cell. To get this data simply do a measurement without the test transmitter (see chapters 3.4, 3.6 and 4). As a result you will typically get signals with low RSRP (Reference Signal Receive Power) and SINR (Signal to Interference and Noise Ratio) performance indicators. The RSRP value gives an indication of coverage at the measurement position, SINR value is a measure of the signal quality in relation to the interference. With bad coverage and low signal quality only a low data throughput can be expected.

Now start the test transmitter (see complete chapters 3 and 4) to emulate an LTE installation. It's important to use the correct band for the intended small cell deployment. Please be aware that you are transmitting in licensed bands (that might belong to another operator) even if the test duration is very limited, so ideally use the frequency that is owned by the operator who intends to install a small cell.

Again measure the band(s) with the scanner to get the performance indicators for the test transmitter. You will get even with low transmit power much better RSRP and SINR values.

A more in-depth interpretation of the SINR can be found in chapter 5.

3 Setup

3.1 Hardware setup

For the test setup you need the following parts:

- 2 notebooks
- 2 network cables
- 1 R&S®SGT100A incl. K255 (LTE option), K510 (ARB baseband generator 32Msamples, 60MHz RF bandwidth)
- 1 R&S®TSME incl. K29 (LTE scanning) (Alternatively TSMA or TSMW)
- 1 R&S®ROMES4 license USB stick, R&S®ROMES4ACD (Automatic Channel Detection)
- 2 antennas with SMA connector for the relevant frequency bands

The demo setup consists of two separate stations. One transmits the LTE-signal into the air. The other detects and measures the signal to give an idea of the performance of a planned small cell system.

The transmitter station should be built up this way:

The measurement station should be built up this way:

3.2 Software setup

For the transmitter station the following software has to be installed on the notebook:

- R&S®SGMA-GUI
- R&S®WinIQSIM2
- R&S®VISA
- One of the LTE waveform files, which are provided with this application note (One has 10 MHz bandwidth, the other has 20 MHz. Frequency and transmit power are set up at chapter 2.5)

The measurement station needs the following software installed on its notebook:

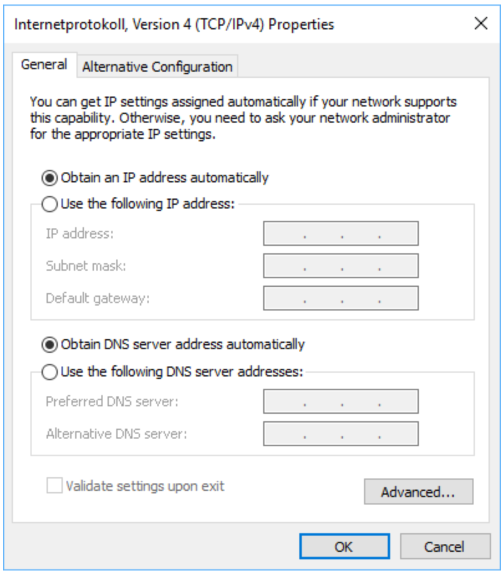
- R&S®ROMES4

3.3 Connecting the transmitter

After the demo setup is built up and the software is installed the network connections have to be configured. To avoid errors deactivate all network adapters apart from your LAN interface.

Your transmitter notebook should have dynamic network settings. To change this do the following:

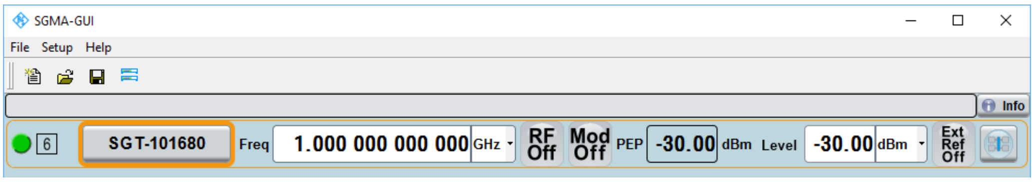
1. Open the network and sharing center.
2. Open your network adapter.
3. Open Properties.
4. Open IPv4 settings by a double click.
5. Set IP-address and DNS-server to automatically.



After the network settings of the transmitter station got configured the connection has to be established:

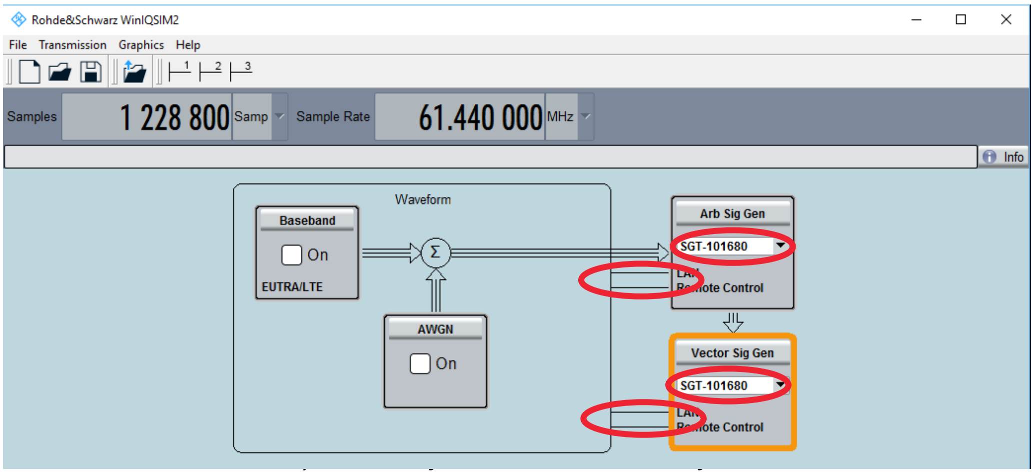
1. Press the power button of the R&S®SGT100A and wait until the green led stops blinking.
2. Press the ID button of the R&S®SGT100A.
3. Start the R&S®SGMA-GUI software.

4. Click on "Setup", then "Instruments". After that click on "Scan" in the opened window.
5. If the R&S®SGT100A is shown in the device list, close the window and check for



the green status indicator in the main window.

6. Open the R&S®WinIQSIM2 software
7. Click on "Transmission", then "Instruments". After that click on "Scan" in the opened window.
8. If the R&S®SGT100A is shown in the device list, close the window.
9. Select the R&S®SGT100A as Arb Sig Gen and Vector Sig Gen. Check if the connection indicators are shown without red crosses.



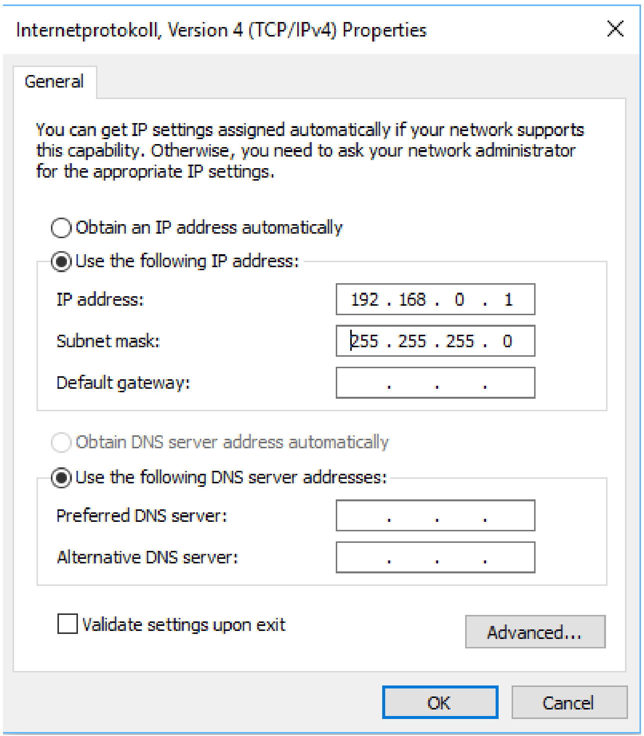
3.4 Connecting the scanner

After setting up the transmitter station, the next step is to connect the scanner to the second notebook.

The standard IP address of every TSME is 192.168.0.2.

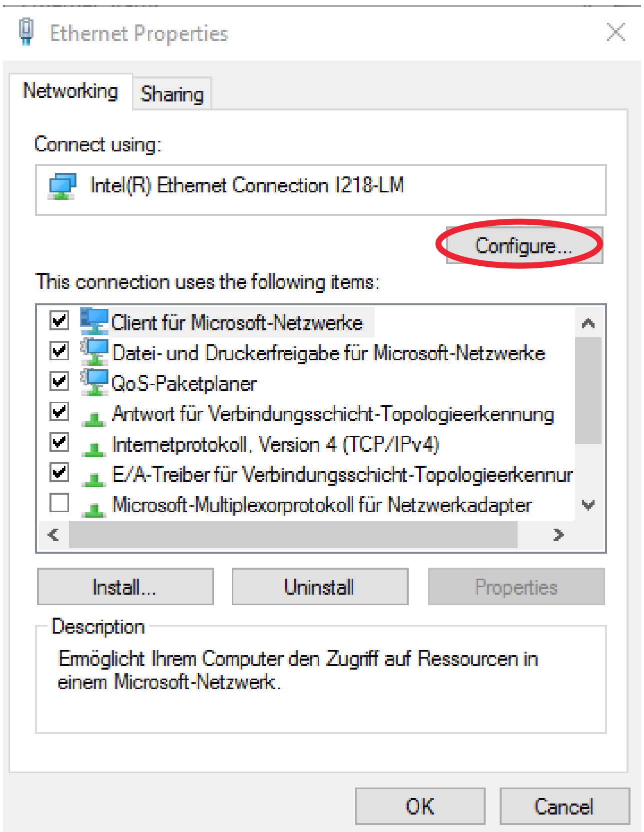
1. Open the network and sharing center.
2. Open your network adapter.
3. Open Properties.
4. Open IPv4 settings by a double click.

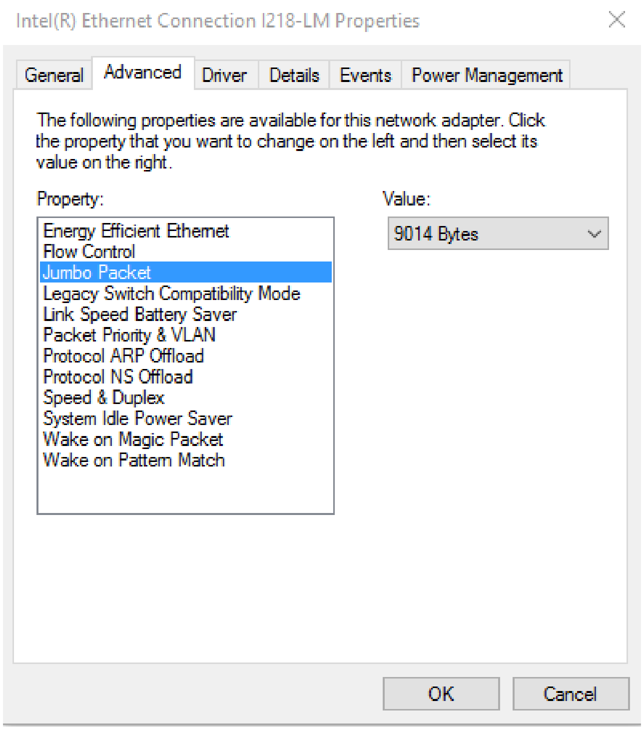
5. Set a fixed IP address of 192.168.0.1 and enter 255.255.255.0 as subnet mask.



Choose fixed DNS server, but let the DNS address box blank.

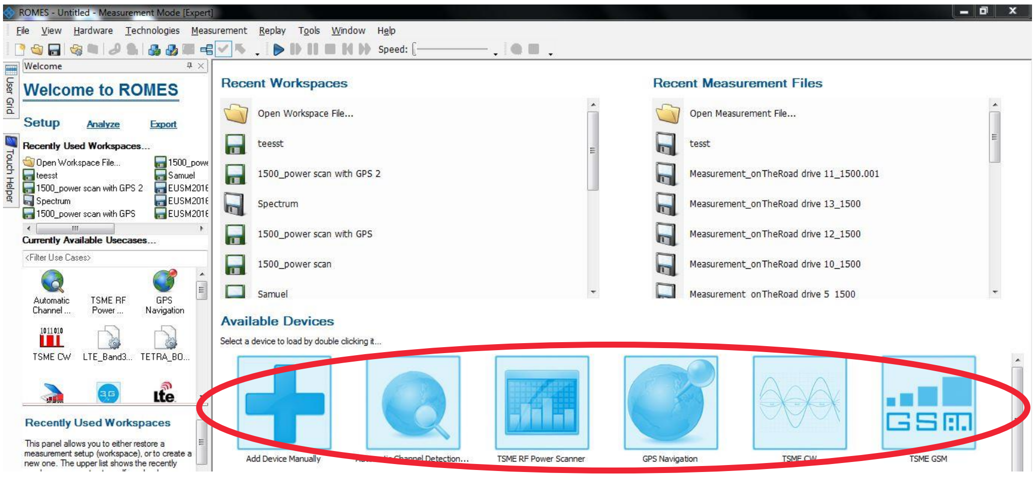
6. Go back to the properties window of your network adapter. Click on Configure.





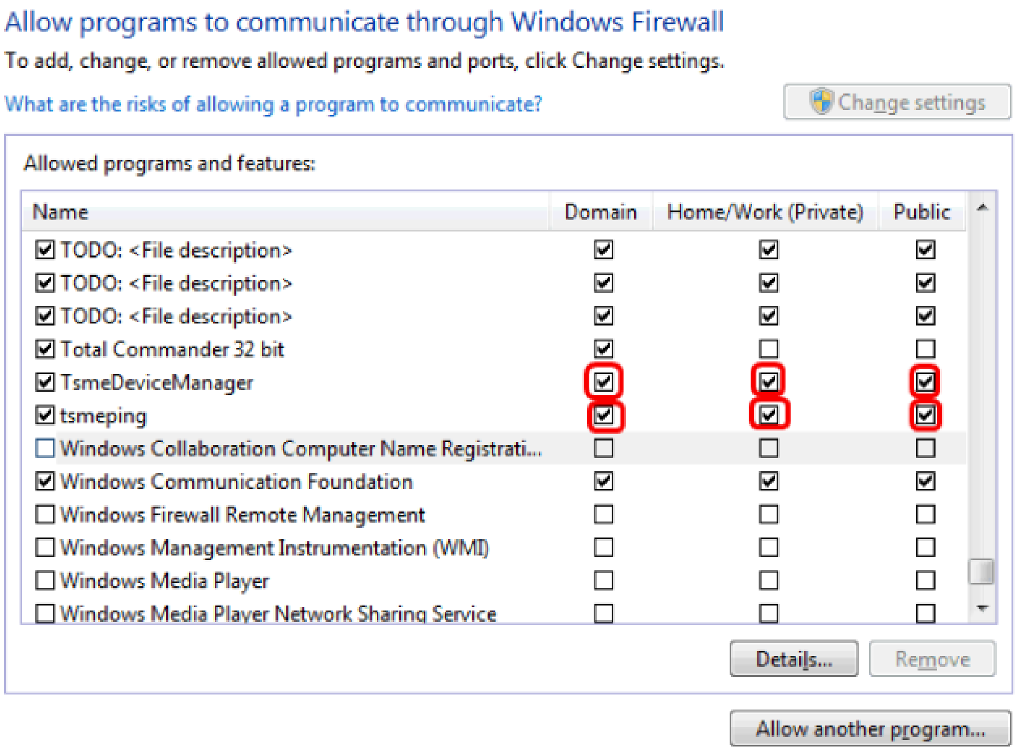
7. Go to the Advanced tab. Set the jumbo packets to "9014 Bytes".

8. Close all dialog boxes and start R&S®ROMES4. If the connections works, the software shows the functions of your TSME at the bottom of the welcome page. If the connection isn't established correctly, only "Add Device Manually" and "Indoor Navigation" are visible.



9. If the firewall settings have not been defined to include the R&S TSME applications (connection for the first time), a Windows Security Alert may appear. Change the firewall settings to permit access to the R&S TSME applications:
a) In the Windows Control Panel, select "System and Security > Windows Firewall

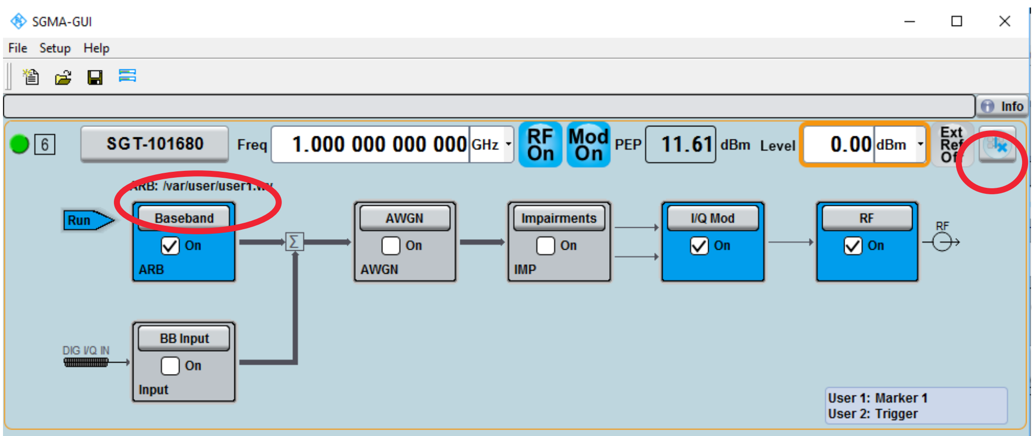
> Allow programs to communicate through Windows Firewall".



b) Allow the specified application module(s) to communicate on all three network types (domain, private, public). In particular, select:
- TSME Device Manager Application
- tsmeping

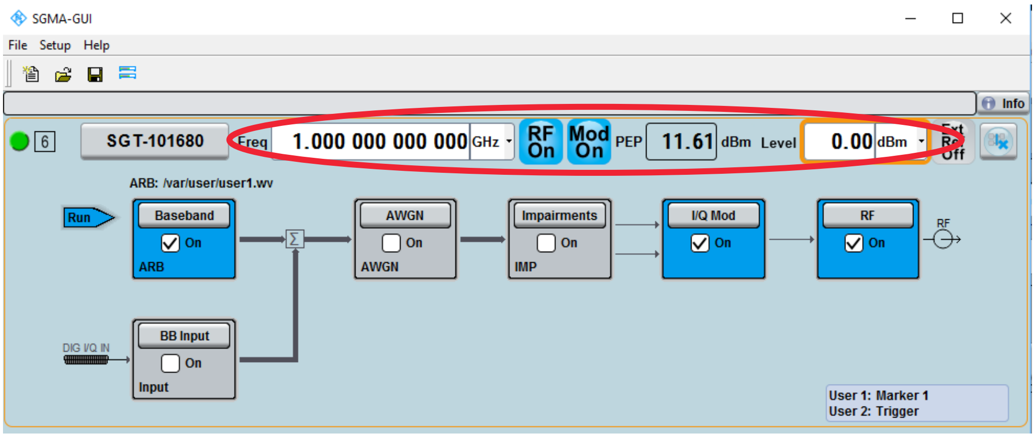
3.5 Transmitting the signal

1. Go to the R&S®WinIQSIM2 main window.
2. Click on "Transmission", then "Transmit". Select "File" as source and open the provided waveform file. Select "Instrument" as destination and insert a file name to save it on the internal memory of the R&S®SGT100A.
3. Press "Transmit Waveform".
4. Go to the R&S®SGMA-GUI main window. Expand the settings of the connected



R&S®SGT100A. Check if the at step 2 entered file name is shown.

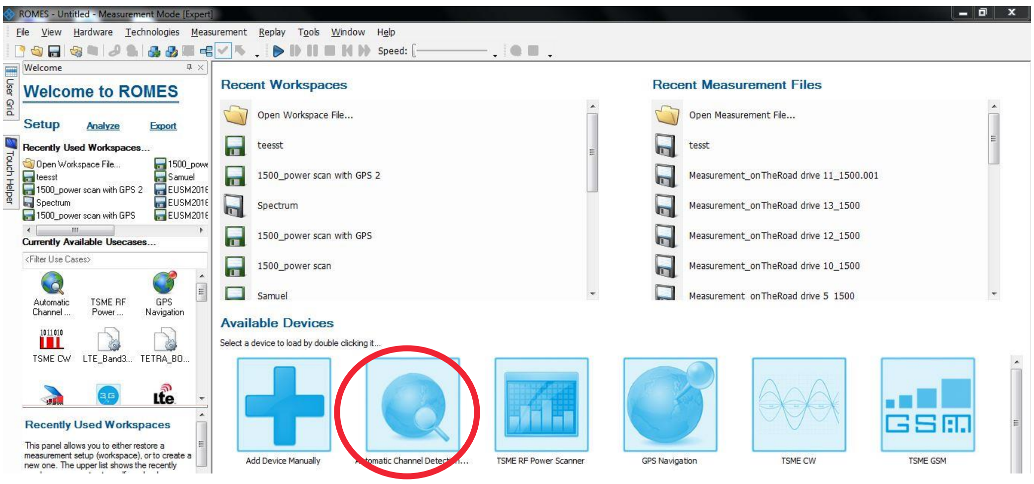
5. Enter the center frequency and the signal power. Attention: Keep your signal's power low at a maximum of 10 dBm to avoid interfering real networks outside the building. Depending on the use case the typical indoor small cell transmit power is in the range of 10 … 25 dBm. A measurement with 10 dBm transmit power gives the required reference result (SINR). The targeted SINR can be scaled up with the transmit power (a 10 dB higher transmit power should result in a 10 dB higher SINR as a feasible approximation).



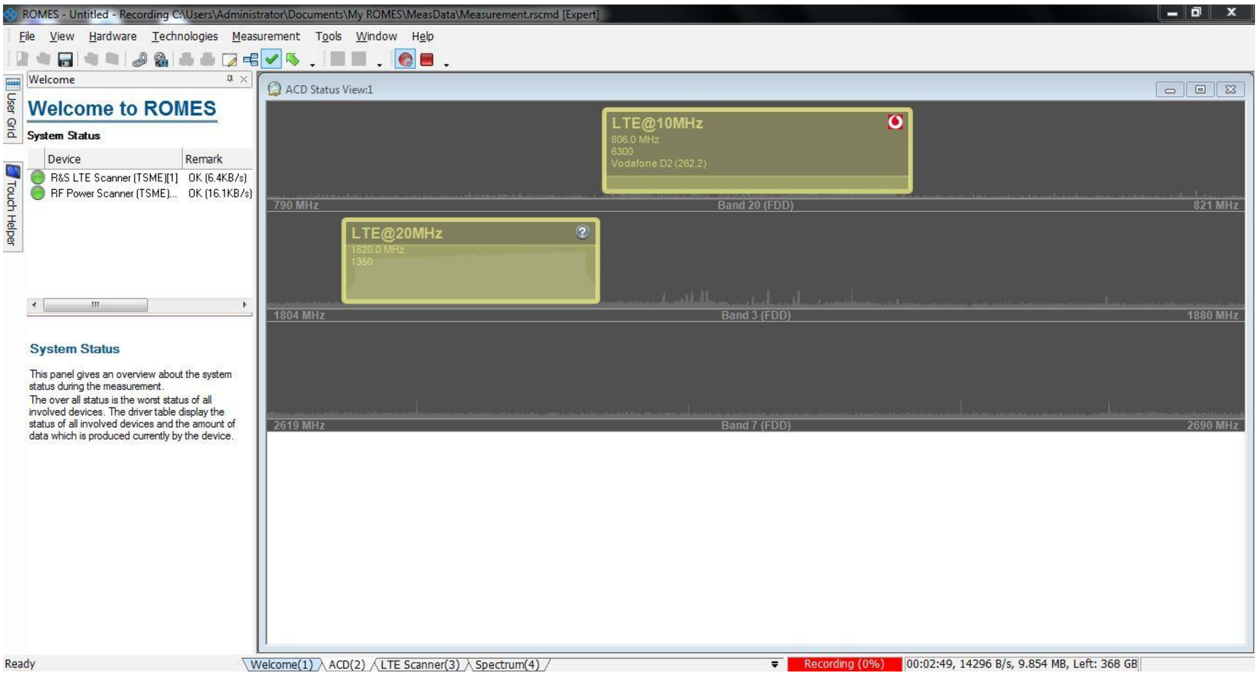
6. Switch on the modulation and the RF generator.

3.6 Starting the measurement

1. Click on "Automatic Channel Detection" at the bottom of the main window of R&S®ROMES4 and click yes, when you get asked to use a new workspace.



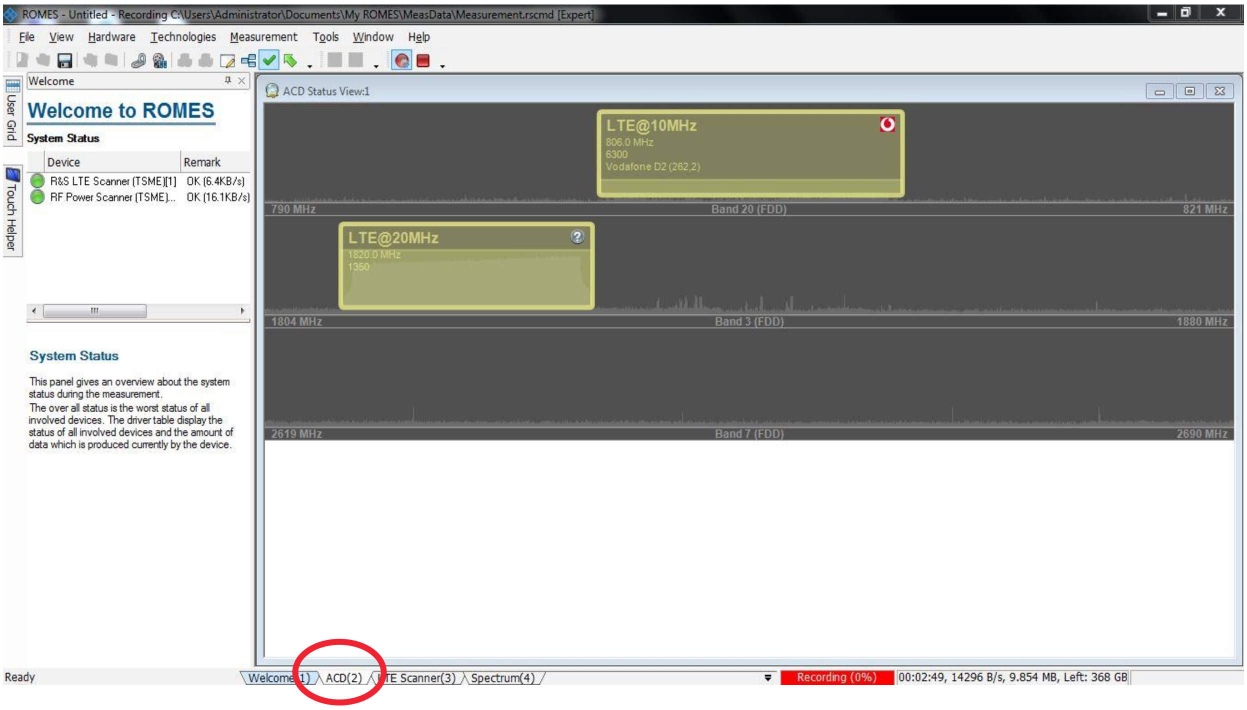
2. Select "LTE" as radio access technology and switch off GPS driver. Press "Next".
3. Select to choose your band from the 3GPP bands list. Press "Next".
4. Select the band(s) that should be used for the demo. Press "Next", then "Finish".
5. Press "Start measurement now" and specify, where the measurement should be stored.
6. The Automatic Channel Detection shows detected signals with a dashed line. After a few seconds it has decoded the signal and the line becomes solid.



4 Analysis of the measurement results

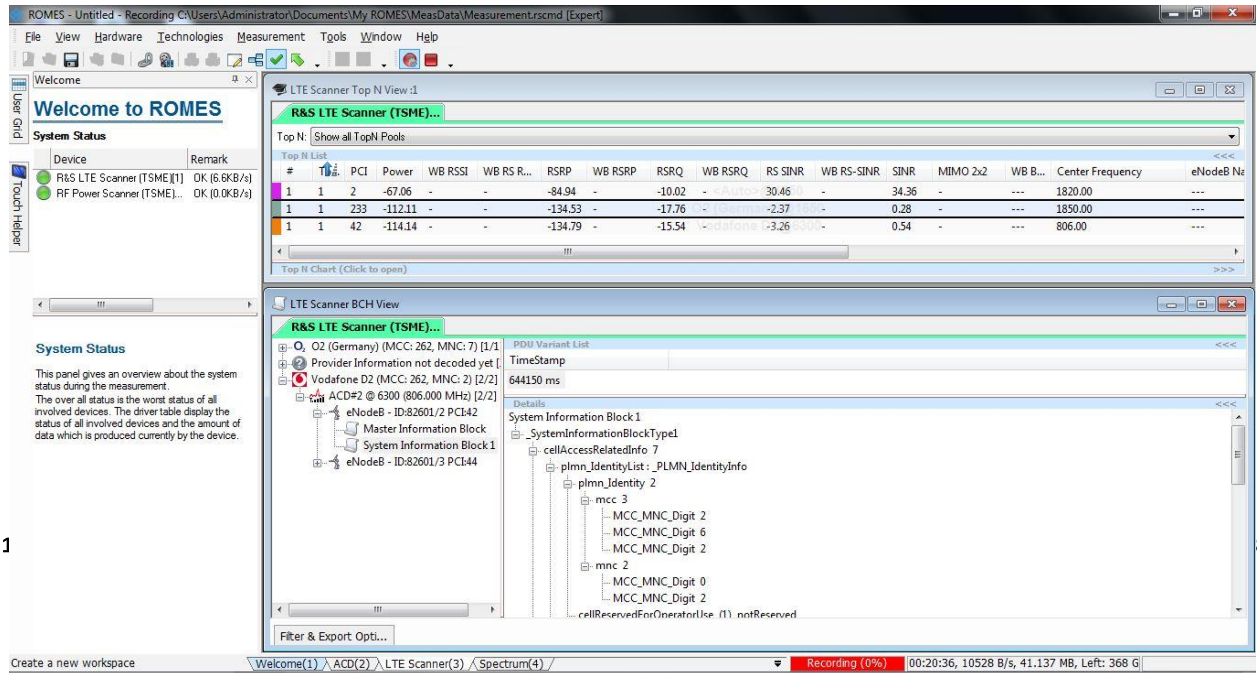
4.1 Automatic Channel Detection view

The "Automatic Channel Detection" (ACD) tab is used to get an overview of which networks are available. At the right-top corner of a signal the operator is shown. The test signal has a question mark as it is only a test signal.



4.2 LTE scanner view

The LTE scanner view consists of two windows: The "Top N View" and the "BCH



View". The windows can be rearranged to suit the personal preferences.

The "Top N View" shows the interesting performance indicators like the RSRP and SINR. To identify which signal is the test signal use the center frequency. In the example above the SINR of the test signal is 34.3 dB (1820 MHz center frequency) compared to 0.3 dB of the networks without indoor installation (adjacent center frequency 1850 MHz). The SINR improvement by the emulated small cell in this case is around 34 dB (with only 10 dBm transmit power).

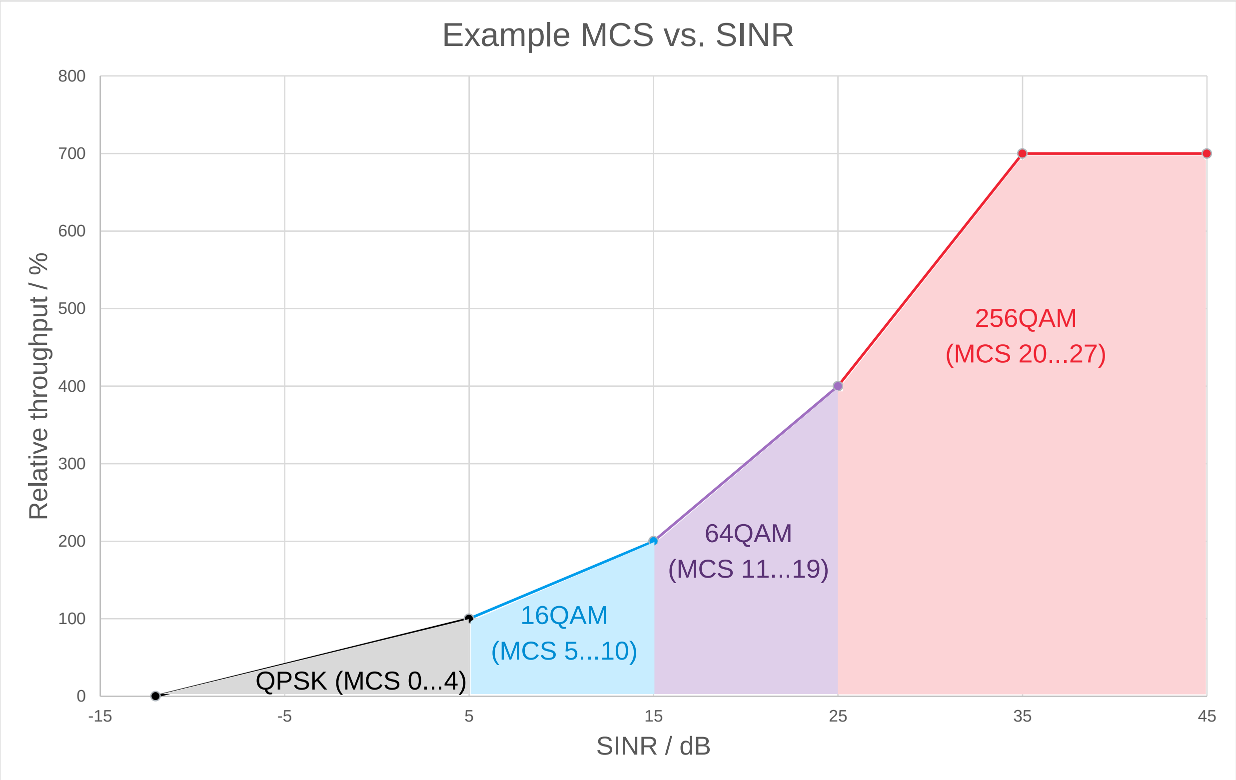
The "BCH View" gives the possibility to have a deeper look into the blocks of the signals. That's more interesting for analyzing real signals as the transmitted test signal has only a Master Information Block, but no System Information Block.

4.3 Spectrum view

The spectrum view consists of three windows. At the top you can choose which band you want to have a look. In the middle one the spectrum of the chosen band is shown. At the bottom is a waterfall diagram. This view is good for detecting interferences and non-continuous signals.

5 Interpretation of measurement results

For the achievable data throughput at a certain position (or the capacity of a cell as the sum of all data throughputs of all addressed users) the SINR (Signal to Interference and Noise Ratio) is crucial. The higher the SINR, the higher is the MCS (Modulation and Coding Scheme) and consequently the achievable data throughput. The following graph gives some example information of the MCS vs. SINR relation. This MCS-SINR relation depends on the specific Base Station vendors' algorithms performance and scheduler implementation, as well as on the channel fading profile etc.



The measurement example in chapter 4.2 shows an SINR improvement of around 34 dB by the indoor test transmitter (with only 10 dBm transmit power) compared to the adjacent outdoor signal. With an SINR at the measurement position of 34.3 dB it is clear that a very high MCS (even in the 256QAM range) could be used and a very high data throughput can be achieved. So, a small cell in such an environment (with very low interference and very high SNIR) will offer a huge capacity.

Chapter 2 describes the general procedure for a reliable small cell planning activity. First we need a record of the actual situation without the planned small cell (SINR-before). The second step is the measurement with the active test transmitter ideally on the same operator frequency. This resulting SINR-textTx can be compared with the SINR-before and the difference is the SINR gain that translates into added throughput and capacity.

6 Ordering Information

Designation	Type	Order No.
Ultracompact Drive Test Scanner	R&S®TSME	1514.6520.02
LTE Scanning	R&S®TSME-K29	1514.6859.02
RF Power Scan	R&S®TSME-K27	1514.6813.02
Simultaneous Measurement in 1 band *)	R&S®TSME-K1B	1514.7403.02
Drive Test Software	R&S®ROMES4	1117.6885.04
R&S®TSME Driver for R&S®ROMES4 Drive Test Software	R&S®ROMES4T1E	1117.6885.82
R&S®ROMES4 Driver, Automatic Channel Detection	R&S®ROMES4ACD	1506.9869.02
SGMA Vector RF Source, 3 GHz RF and baseband HW included	SGT100A	1419.4501.02
ARB baseband generator, 32 MSamples, 60MHz RF bandwidth (SL)	SGT-K510	1419.7500.02
EUTRA/LTE with R&S WinIQSIM2 (SL)	SGT-K255	1419.6804.02

*) Alternative band options:

Simultaneous Measurement in all bands	R&S®TSME-KAB	1514.7384.02
Simultaneous Measurement in 1 band	R&S®TSME-K1B	1514.7403.02
Simultaneous Measurement in 2 bands	R&S®TSME-K2B	1514.7410.02
Simultaneous Measurement in 3 bands	R&S®TSME-K3B	1514.7426.02
Simultaneous Measurement in 4 bands	R&S®TSME-K4B	1514.7432.02
Simultaneous Measurement in 5 bands	R&S®TSME-K5B	1514.7449.02

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Sustainable product design

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- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

Certified Quality Management
ISO 9001

Certified Environmental Management
ISO 14001

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