# Reliable small cell planning using LTE test transmitter Application Note

#### Products:

- R&S<sup>®</sup>SGT100A
- R&S<sup>®</sup>TSME
- R&S<sup>®</sup>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 <a href="http://www.rohde-schwarz.com/appnote/1MA297">http://www.rohde-schwarz.com/appnote/1MA297</a>.

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



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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 Often planning tools do not provide this high reliability since e.g. floor plans might be outdated or changes in real deployments are not maintained properly in the plans.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<sup>®</sup>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<sup>®</sup>TSME, R&S<sup>®</sup>TSMA, R&S<sup>®</sup>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.

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# 3 Setup

### 3.1 Hardware setup

For the test setup you need the following parts:

- 1 2 notebooks
- 2 network cables
- 1 R&S<sup>®</sup>SGT100A incl. K255 (LTE option), K510 (ARB baseband generator 32Msamples, 60MHz RF bandwidth)
- 1 R&S<sup>®</sup>TSME incl. K29 (LTE scanning) (Alternatively TSMA or TSMW)
- 1 R&S<sup>®</sup>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<sup>®</sup>SGMA-GUI
- R&S<sup>®</sup>WinIQSIM2
- I R&S<sup>®</sup>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<sup>®</sup>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.

Internetprotokoll, Version 4 (TCP/IPv4) Properties										
General	Alternative Configuration									
You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.										
() Ob	Obtain an IP address automatically									
OUs	e the following IP address: —									
IP ac	dress:				]					
Subn	et mask:		1.		]					
Defa	ult gateway:		1.1		]					
() Ob	tain DNS server address autor	natically								
OUs	e the following DNS server add	resses:								
Prefe	erred DNS server:		1.		]					
Alter	native DNS server:		1.1		]					
V	alidate settings upon exit			Advar	nced					
			OK		Cancel					

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

- 4. Click on "Setup", then "Instruments". After that click on "Scan" in the opened window.
- 5. If the R&S<sup>®</sup>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<sup>®</sup>WinIQSIM2 software
- 7. Click on "Transmission", then "Instruments". After that click on "Scan" in the opened window.
- 8. If the R&S<sup>®</sup>SGT100A is shown in the device list, close the window.
- 9. Select the R&S<sup>®</sup>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.

In	ternetprotokoll, Version 4 (TCP/IPv4)	Properties X
G	General	
	You can get IP settings assigned autom this capability. Otherwise, you need to for the appropriate IP settings.	atically if your network supports ask your network administrator
	Obtain an IP address automatical	y
	• Use the following IP address:	
	IP address:	192.168.0.1
	Subnet mask:	255.255.255.0
	Default gateway:	
	Obtain DNS server address autom	atically
	• Use the following DNS server addr	esses:
	Preferred DNS server:	
	Alternative DNS server:	
	Validate settings upon exit	Advanced
		OK Cancel
hoose fixed l	DNS server, but let the DN	IS address box blank.

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

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

Ethernet Properties	$\times$							
Networking Sharing								
Connect using:								
Intel(R) Ethemet Connection I218-LM								
Configur	e							
This connection uses the following items:								
<ul> <li>Client für Microsoft-Netzwerke</li> <li>Datei- und Druckerfreigabe für Microsoft-Netzwerke</li> <li>QoS-Paketplaner</li> <li>Antwort für Verbindungsschicht-Topologieerkennung</li> <li>Internetprotokoll, Version 4 (TCP/IPv4)</li> <li>E/A-Treiber für Verbindungsschicht-Topologieerkenn</li> <li>Microsoft-Multiplexorprotokoll für Netzwerkadapter</li> </ul>	) nur >							
Install Uninstall Propertie	s							
Description Emöglicht Ihrem Computer den Zugriff auf Ressourcen in einem Microsoft-Netzwerk.								
ОК С	ancel							

Intel(R) Ethernet Connection I218-LM Properties									
General	Advanced	Driver	Details	Events	Power Mana	gement			
The foll the prop value o Property Flow C Umbo Legacy Link S Packet Protoc Protoc Speed System Wake Wake	owing propert perty that you in the right. /: r Efficient Ethiontrol / Switch Com beed Battery t Priority & VL ol ARP Offload & Duplex i Idle Power S on Magic Par on Pattern M	ies are a want to emet patibility Saver AN id Saver cket atch	Wailable fr Change o Mode	vr this net n the left	work adapter. and then select lue: 1014 Bytes	Click ct its	Y		
					ОК	Cance	ł		

- 7. Go to the Advanced tab. Set the jumbo packets to "9014 Bytes".
- Close all dialog boxes and start R&S<sup>®</sup>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.



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".

#### Allow programs to communicate through Windows Firewall

To add, change, or remove allowed programs and ports, click Change settings.

☑ TODO: <file description=""></file>			
	<b>V</b>	✓	~
✓ TODO: <file description=""></file>	✓	✓	✓
✓ TODO: <file description=""></file>	◄	$\checkmark$	~
Total Commander 32 bit	✓		
✓ TsmeDeviceManager			
✓ tsmeping			
Windows Collaboration Computer Name Registrati			
Windows Communication Foundation	✓		~
Windows Firewall Remote Management			
Windows Management Instrumentation (WMI)			
Windows Media Player			
🗆 Wiederer Madie Dierer Nieburgh Charles Castier			

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<sup>®</sup>WinIQSIM2 main window.
- 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<sup>®</sup>SGT100A.
- 3. Press "Transmit Waveform".
- 4. Go to the R&S<sup>®</sup>SGMA-GUI main window. Expand the settings of the connected



R&S<sup>®</sup>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<sup>®</sup>ROMES4 and click yes, when you get asked to use a new workspace.

ROMES - Untitled - Measurement Mode [Expert]				_ 0 ×
Ele View Hardware Technologies Measu	urement <u>R</u> eplay T <u>o</u> ols <u>W</u> indow H <u>e</u> lp			
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Welcome 🔍 🛪 🛛				
Welcome to ROMES	Recent Workspaces		Recent Measurement Files	
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Recently Used Workspaces	Teesst teesst		tesst t	E
Open Workspace File     If 1500_power     If the set of th	1500_power scan with GPS 2		Measurement_onTheRoad drive 11_1500.001	
Spectrum     Spectrum	Spectrum Spectrum		Measurement_onTheRoad drive 13_1500	
Currently Available Usecases	1500_power scan with GPS		Measurement_on TheRoad drive 12_1500	
(Filter Use Cases)	1500_power scan		Measurement_onTheRoad drive 10_1500	
Automatic TSME RF GPS	Samuel	+	Measurement on The Road drive 5 1500	+
Channel Power Navigation	Available Devices			
	Select a device to load by double clicking t			
TSME CW LTE_Band3 TETRA_BO				i I
Recently Used Workspaces				s •
This panel allows you to either restore a measurement setup (workspace), or to create a new one. The upper list shows the recently	Add Device Manually Attomatic Channel Detection	TSME RF Power Scanner GPS	S Navigation TSME CW T	SME GSM

- 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.

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Welcome <sup>a</sup> ×	ACD Status View:1		
Welcome to ROMES			
System Status		LTE@10MHz O	
Device Remark		6300 Vodafone D2 (262.2)	
R&S LTE Scanner (TSME)[1] OK (6.4KB/s)	and the second		and the standard standard standard standard standard standards
Ch I	790 MHz	Band 20 (FDD)	821 MHz
kiper	LTE@20MHz	a attraction of the	
۲ ( m, ) ۲	1804 MHz	Band 3 (FDD)	1880 MHz
System Status			
This panel gives an overview about the system status during the measurement.			
The over all status is the worst status of all involved devices. The driver table display the	and the second		l
status of all involved devices and the amount of data which is produced currently by the device.	2619 MHz	Band 7 (FDD)	2690 MHz
	P		
Ready	Welcome(1) ACD(2) (LTE Scanner(3) Spectrum(4) /		49, 14296 B/s, 9.854 MB, Left: 368 GB

# 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

٢	ROMES - Untitled - Recording C:\Users\Administ	strator\D	ocument	ts\My F	ROMESIMe	asData\M	easurement	rscmd (Ex	pert]									
-	<u>File View H</u> ardware <u>T</u> echnologies <u>M</u> ease	surement	t T <u>o</u> ol	ls <u>W</u> i	ndow H	elp												
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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 (SINRbefore). 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	Туре	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

#### **Rohde & Schwarz**

The Rohde & Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, radiomonitoring and radiolocation. Founded more than 80 years ago, this independent company has an extensive sales and service network and is present in more than 70 countries.

The electronics group is among the world market leaders in its established business fields. The company is headquartered in Munich, Germany. It also has regional headquarters in Singapore and Columbia, Maryland, USA, to manage its operations in these regions.

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#### Sustainable product design

- Environmental compatibility and eco-footprint
- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

Certified Quality Management

Certified Environmental Management ISO 14001

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