Rohde & Schwarz offers a complete test solution for WiMAX applications by combining its Signal Generator R&S® SMU200A and Signal Analyzer R&S® FSQ plus the appropriate options. This application note provides an overview of the differences between OFDM and OFDMA and demonstrates how convenient it is to generate and analyze WiMAX OFDMA signals according to standard IEEE 802.16e-2005 [1].
Differences OFDM / OFDMA

Contents

1 Differences OFDM / OFDMA .................................................................. 3
2 R&S WiMAX Test Equipment ................................................................. 3
   Signal Generators .............................................................................. 3
   Signal Analyzers, Spectrum Analyzers .............................................. 4
   Transfer Settings................................................................................ 4
   Automatic Demodulation................................................................. 4
   Comfortable Frame Editor.................................................................. 5
   Summary............................................................................................ 5
3 Demo of Generating and Analyzing WiMAX OFDMA Signals ............ 5
4 References.............................................................................................. 6
5 Additional Information ............................................................................. 6
6 Ordering information ............................................................................... 6
1 Differences OFDM / OFDMA

WiMAX covers a wide range of fixed and mobile applications. The IEEE 802.16-2004 standard, optimized for fixed access, mainly uses Orthogonal Frequency Division Multiplexing (OFDM) as transmission method in real world applications. The IEEE 802.16e-2005 standard (mobile WiMAX) uses Orthogonal Frequency Division Multiple Access (OFDMA).

The key difference between both transmission methods is that OFDM allows only one user on the channel at any given time whereas OFDMA allows multiple access on the same channel.

To enable multiple access subchannelization is used. A subchannel is a group of subcarriers that can be allocated dynamically to different subscribers. Depending on the channel conditions and data requirements modulation and coding is set individually for each subscriber. Transmit power can be adapted separately as well, which optimizes the use of network resources. Because of subchannelization OFDMA signals are more complex than OFDM signals and offer better performance and scalability.

2 R&S WiMAX Test Equipment

Signal Generators

In order to test a WiMAX amplifier or passive components or to perform WiMAX receiver tests, WiMAX signals of excellent modulation quality are needed. Such signals according to standard IEEE 802.16 [2] can be generated very conveniently by means of the vector signal generator R&S®SMU [3,4], R&S®SMJ, R&S®SMATE and baseband signal generator R&S®AMU200A with the software option R&S®SMx-K49.

For generating OFDMA signals in conformance with 802.16e-2005 the WiMAX software option offers a well arranged GUI and a comfortable editor for the frame configuration. Additionally it provides several predefined frames with different burst profiles. Thus you can easily setup an OFDMA downlink or uplink test signal.
Signal Analyzers, Spectrum Analyzers

Depending on your test setup you need to analyze the modulation quality of a WiMAX signal. This requires a high-end signal analyzer, which is capable of demodulating the broadband WiMAX signal. The signal analyzer R&S®FSQ [5,6] and the spectrum analyzers R&S®FSL and R&S®FSP can analyze these signals using WiMAX application firmware R&S®FSx-K93. Besides RF analysis WiMAX signals can be analyzed directly in the baseband with the R&S®FMU or the R&S®FSQ with the R&S®FSQ-B71 option installed.

Figure 2: The FSQ Signal Analyzer combines an RF spectrum analyzer with a signal analyzer and baseband analyzer in one box. With the WiMAX Application Firmware FSQ-K93 it is possible to analyze WiMAX standard signals (IEEE 802.16) to maximum accuracy. All important parameters (EVM, constellation diagram, frequency and phase errors, bit stream, etc) are available in graphical or numerical and list form.

Transfer Settings

At the beginning of a measurement not only the standard parameter [7] such as frequency, recording length, guard interval, etc have to be set, but also the setup for zones and bursts has to be performed. If you use a generator and an analyzer (e.g. for testing RF modules) it will be necessary to specify the parameter on both instruments. This involves setting a lot of different numbers and parameters. Therefore R&S®FSx-K93 is able to read stored setups from the R&S Signal Generator. This can be done by using a file or connecting the R&S Signal Generator via LAN interface with the R&S Analyzer and reading the setups directly from the instruments. The transfer of the settings via LAN is shown in the attached video RuS_WiMAX_OFDMA_engl_Part2.exe.

Automatic Demodulation

For base station testing or in order to measure transmit signals you can use the R&S Signal Analyzer. A feature that facilitates the analysis of OFDMA signals is the automatic demodulation based on the DL-map. In OFDMA e.g. the downlink consists of a preamble followed by an FCH field (Frame Control Header), DL-MAP and the bursts for the different users (figure 3). Both, FCH and DL-map, are generated automatically within the R&S®SMx-K49 option and are part of standard conform DL signal.

The FCH is transmitted after the preamble and contains information regarding the current frame. It specifies the burst profile and the length of the DL-MAP and data. The DL-map indicates the current frame structure and the starting point of the burst.
The WiMAX application firmware R&S ®FSx-K93 decodes the FCH and DL-map to get information about the burst allocation for the zone/burst list and demodulates the OFDMA signal according to this information. Due to this feature it is now possible to measure DL signals without setting all of the parameters or even without knowing the DL map. The automatic demodulation is demonstrated in the video RuS_WiMAX_OFDMA_engl_Part1.exe.

**Comfortable Frame Editor**

If the automatic demodulation cannot be used, e.g. no DL-map defined, special burst, low S/N or UL-signal, it will be necessary to perform the setup for zones and bursts on the analyzer. Therefore R&S analyzers offer a comfortable editor as well.

**Summary**

Thanks to the features mentioned above generating a WiMAX OFDMA signal and analyzing it with R&S equipment is as easy as in OFDM mode and requires only minimum operating effort. For more detailed information about WiMAX look at the corresponding application notes.

### 3 Demo of Generating and Analyzing WiMAX OFDMA Signals

The videos RuS_WiMAX_OFDMA_engl_Part1.exe and RuS_WiMAX_OFDMA_engl_Part2.exe show a simple and powerful way to generate and analyze WiMAX OFDMA signals using R&S ®SMU and R&S ®FSQ. They give a starting point for every measurement setup. They are Flash animations and therefore Macromedia Player has to be installed (http://www.macromedia.com). Both videos are also available in Chinese.

In the first video a WiMAX OFDMA **downlink** signal is generated and analyzed using built-in predefined configurations in the generator and automatic demodulation in the analyzer. The second video shows the generation of a WiMAX **uplink** frame with 1 databurst. The uplink signal does not have a map associated with it. Therefore the settings and the frame configuration defined at R&S SMU are loaded into R&S FSQ directly by LAN connection.
4 References


5 Additional Information

Another video about WiMAX RuS_WiMAX_OFDM.exe is available on request. This video shows how to generate and analyze a WiMAX OFDM signal with R&S®SMU and R&S®FSQ.

This application note and the associated video are updated from time to time. Please visit the website 1EF58 in order to download new versions.

Please contact TM-Applications@rsd.rohde-schwarz.com for comments and further suggestions.

6 Ordering Information

Vector Signal Generator SMU200A

<table>
<thead>
<tr>
<th>R&amp;S SMU200A</th>
<th>Basic Instrument</th>
<th>1141.2005.02</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF Options</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&amp;S SMU-B103</td>
<td>100 kHz ... 3 GHz for 1st path</td>
<td>1141.8603.02</td>
</tr>
<tr>
<td>R&amp;S SMU-B106</td>
<td>100 kHz ... 6 GHz for 1st path</td>
<td>1141.8803.02</td>
</tr>
<tr>
<td>R&amp;S SMU-B203</td>
<td>100 kHz ... 3 GHz for 2nd path</td>
<td>1141.9500.02</td>
</tr>
</tbody>
</table>
## Ordering Information

### Baseband Options
- **R&S SMU-B13** Baseband Main Module 1141.8003.02
- **R&S SMU-B10** Max. 64 Msamples I and Q, Dig. Modulation 1141.7007.02
- **R&S SMU-B11** Max. 16 Msamples I and Q, Dig. Modulation 1159.8411.02
- **R&S SMU-K49** Digital Standard IEEE 802.16 1161.0366.02
- **R&S SMU-K62** Additive White Gaussian Noise (AWGN) 1159.8511.02

### Fading Option
- **R&S SMU-B14** Fading Simulator 1160.1800.02
- **R&S SMU-B15** Fading Simulator Extension 1160.2288.02
- **R&S SMU-K71** Enhanced resolution and dynamic fading 1160.9201.02

### Vector Signal Generator SMJ100A
- **R&S SMJ100A** Basic Instrument 1403.4507.02

### RF Options
- **R&S SMJ-B103** 100 kHz ... 3 GHz 1403.8502.02
- **R&S SMJ-B106** 100 kHz ... 6 GHz 1403.8702.02

### Baseband Options
- **R&S SMJ-B13** Baseband Main Module 1403.9109.02
- **R&S SMJ-B10** Max. 64 Msamples I and Q, Dig. Modulation 1403.8902.02
- **R&S SMJ-B11** Max. 16 Msamples I and Q, Dig. Modulation 1403.9009.02
- **R&S SMJ-K49** Digital Standard IEEE 802.16 1404.1101.02
- **R&S SMJ-K62** Additive White Gaussian Noise (AWGN) 1404.0805.02

### Vector Signal Generator SMATE200A
- **R&S SMATE200A** Basic Instrument 1400.7005.02

### RF Options
- **R&S SMATE-B103** 100 kHz ... 3 GHz for 1st path 1401.1000.02
- **R&S SMATE-B106** 100 kHz ... 6 GHz for 1st path 1401.1200.02
- **R&S SMATE-B203** 100 kHz ... 3 GHz for 2nd path 1401.1400.02
- **R&S SMATE-B206** 100 kHz ... 6 GHz for 2nd path 1401.1600.02

### Baseband Options
- **R&S SMATE-B13** Baseband Main Module 1401.2907.02
- **R&S SMATE-B10** Max. 64 Msamples I and Q, Dig. Modulation 1401.2707.02
- **R&S SMATE-B11** Max. 16 Msamples I and Q, Dig. Modulation 1401.2807.02
- **R&S SMATE-K49** Digital Standard IEEE 802.16 1404.6803.02
- **R&S SMATE-K62** Additive White Gaussian Noise (AWGN) 1404.5807.02

### Baseband Signal Generator AMU200A
- **R&S AMU200A** Basic Instrument 1402.4090.02

### Baseband Options
- **R&S AMU-B13** Baseband Main Module 1402.5500.02
- **R&S AMU-B10** Max. 64 Msamples I and Q, Dig. Modulation 1402.5300.02
- **R&S AMU-B11** Max. 16 Msamples I and Q, Dig. Modulation 1402.5400.02
- **R&S AMU-K49** Digital Standard IEEE 802.16 1402.7002.02
- **R&S AMU-K62** Additive White Gaussian Noise (AWGN) 1402.7202.02

### Fading Option
- **R&S AMU-B14** Fading Simulator 1402.5600.02
- **R&S AMU-B15** Fading Simulator Extension 1402.5700.02
- **R&S AMU-K71** Enhanced resolution and dynamic fading 1402.7302.02

### Signal Analyzer FSQ and FMU
- **R&S FSQ3** 20 Hz ... 3.6 GHz 1155.5001.03
- **R&S FSQ8** 20 Hz ... 8 GHz 1155.5001.08
- **R&S FSQ26** 20 Hz ... 26.5 GHz 1155.5001.26
- **R&S FSQ40** 20 Hz ... 40 GHz 1155.5001.40
- **R&S FMU36** DC ... 36 MHz 1303.3500.02
### Ordering Information

#### WiMAX Option for FSQ and FMU
- R&S FSQ-K92: Application Firmware IEEE 802.16-2004 1300.7410.02
- R&S FSQ-K93: Application Firmware IEEE 802.16e-2005 1300.8600.02
- R&S FSQ-K92U: Upgrade from FSQ-K92 to FSQ-K93 1300.8500.02

#### Hardware Options for FSQ
- R&S FSQ-B71: Baseband Inputs DC to 36 MHz 1157.0113.02
- R&S FSQ-B72: I/Q Bandwidth Extension to 120 MHz 1157.0336.02

#### Spectrum Analyzer FSL
- R&S FSL3: 9 kHz ... 3 GHz 1300.2502.03
- R&S FSL3: 9 kHz ... 3 GHz with Tracking Generator 1300.2502.13
- R&S FSL6: 9 kHz ... 6 GHz 1300.2502.06
- R&S FSL6: 9 kHz ... 6 GHz with Tracking Generator 1300.2502.16

#### WiMAX Option
- R&S FSL-K92: Application Firmware IEEE 802.16-2004 1302.0236.02
- R&S FSL-K93: Application Firmware IEEE 802.16e-2005 1302.0736.02
- R&S FSL-K92U: Upgrade from FSL-K92 to FSL-K93 1302.0307.02

#### Spectrum Analyzer FSP
- R&S FSP3: 9 kHz ... 3 GHz 1164.4391.03
- R&S FSP7: 9 kHz ... 7 GHz 1164.4391.07
- R&S FSP13: 9 kHz ... 13.6 GHz 1164.4391.13
- R&S FSP30: 9 kHz ... 30 GHz 1164.4391.30
- R&S FSP40: 9 kHz ... 40 GHz 1164.4391.40

#### WiMAX Option
- R&S FSP-K93: Application Firmware IEEE 802.16e-2005 1308.5500.02

For additional information about Rohde & Schwarz measurement equipment, see the Rohde & Schwarz website [www.rohde-schwarz.com](http://www.rohde-schwarz.com).

---

**ROHDE & SCHWARZ**

ROHDE & SCHWARZ GmbH & Co. KG · Mühldorstraße 15 · D-81671 München · Postfach 80 14 69 · D-81614 München · Tel (089) 4129 -0 · Fax (089) 4129 - 13777 · Internet: [http://www.rohde-schwarz.com](http://www.rohde-schwarz.com)

This application note and the supplied programs may only be used subject to the conditions of use set forth in the download area of the Rohde & Schwarz website.