Products: R&S®SMU, R&S®SMJ, R&S®SMATE, R&S®AMU, R&S®FSQ, R&S®FSL, R&S®FSP, R&S®FMU

WiMAX: IEEE 802.16e-2005
Introduction to OFDMA Measurements

Application Note 1EF58

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].

ROHDE&SCHWARZ

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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.

Figure 1: As top-class, the SMU200A Vector Signal Generator can combine two complete RF and baseband paths at a frequency up to 6 GHz in the first path and 3 GHz in the second path. Together with the SMU-K49 Digital Standard 802.16 option, it is the ideal instrument for generating two independent 802.16 signals to perform all necessary receiver tests - with only a single instrument.

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.

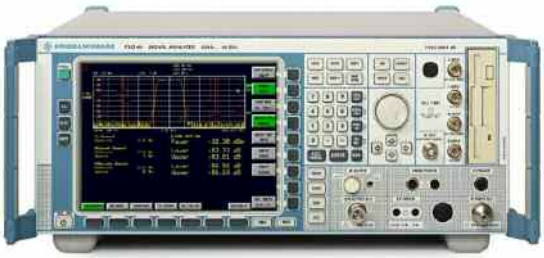

Figure 2: The FSQ Signal Analyzer combines an RF spectrum analyzer with a signal analyzer and baseband analyzer in one box. With the WiMAX Application Firmware FSQ-K93 it is possible to analyze WiMAX standard signals (IEEE 802.16) to maximum accuracy. All important parameters (EVM, constellation diagram, 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.

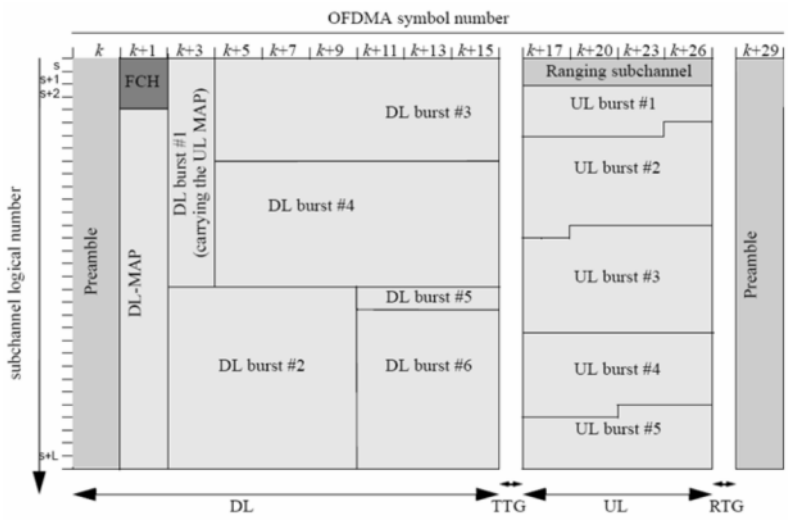

Figure 3: OFDMA frame with downlink and uplink subframe

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

[1] Institute of Electrical and Electronics Engineers Inc.,IEEE P802.16e/D12, Standard for Local and metropolitan area networks; Partt 16: Air Interface for Fixed Broadband Wireless Access Systems, Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands, IEEE. 2005

[2] Institute of Electrical and Electronics Engineers Inc., IEEE P802.16-2004/Cor12/D5 Standard for Local and metropolitan area networks; Part 16: Air Interface for Fixed Broadband Wireless Access Systems, IEEE. 2004

[3] Rohde & Schwarz, Vector Signal Generator R&S®SMU200A, Operating Manual Vol 1, R&S 2005

[4] Rohde & Schwarz, Vector Signal Generator R&S®SMU200A - Supplement Standard WLAN-WiMAX, R&S 2005

[5] Rohde & Schwarz, Signal Analyzer R&S FSQ: Operating Manual Vol 1, R&S 2005

[6] Rohde & Schwarz, Application Firmware R&S®FSQ-K93 Software Manual, R&S 2006

[7] Christoph Rauscher, Fundamentals of Spectrum Analysis, R&S 2004

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

R&S SMU200A	Basic Instrument	1141.2005.02
RF Options		
R&S SMU-B103	100 kHz ... 3 GHz for 1st path	1141.8603.02
R&S SMU-B106	100 kHz ... 6 GHz for 1st path	1141.8803.02
R&S SMU-B203	100 kHz ... 3 GHz for 2nd path	1141.9500.02

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

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.

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