WiMAX & Broadband Trainings

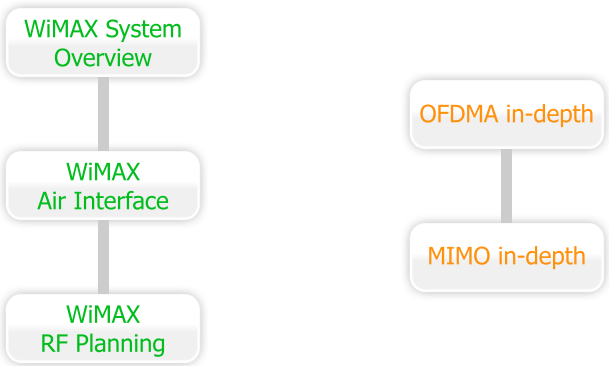
ABOUT US

IS-Wireless is an IPR provider and software developer specializing in OFDM/OFDMA-based radio interfaces. Our portfolio includes implementations of PHY layers for 3GPP LTE and mobile WiMAX. This is complemented by a set of design services targeted mainly at 4G operators and manufacturers. As experts working with OFDM/OFDMA since 1998, we truly believe in the success of these techniques and are fully committed to 3GPP LTE, aiming at solutions for LTE Advanced.

As a part of our business routine we deliver technical courses in the area of 3GPP LTE, WiMAX, OFDM, OFDMA, MIMO, radio network planning and radio interface design. By being active in system design and network planning for LTE and WiMAX, we are able to provide a rare mixture of great theoretical treatment together with a very practical approach. This truly leads to a solid return on investment for our customers. As an outcome, we continuously receive great course evaluations. Last, but not least, we are providing unrivalled post-course support.

WiMAX & Broadband Trainings

We are proud to offer a complete and comprehensive coverage of radio-related topics describing WiMAX system and the key broadband techniques.



Course feedback

Here is what course participants say about our courses:

„Instructor was very knowledgeable – no such thing as a hard question!"

„His experience in the field was a welcome bonus."

„The WiMAX instructor was very good, clear and always had an answer for all the doubts and questions."

„Very good presentations and good interaction with the audience. Presenter VERY skilled in the subject and could explain discuss about all subjects/questions arising. Highly recommendable!"

„Extremely good instructor. Very competent and professional."

„Excellent instructor! Very clear and always with answers when a doubt was raised."

„As a new designer I got a really good insight to the theoretical stuff, knowing what I'm actually doing."

Our courses are delivered globally as instructor-led trainings, either onsite or online.

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TARGET GROUP

Our courses are targeted at a vast group of WiMAX and broadband access specialists working for telecom vendors, mobile operators, system integrators, consultancies, regulators and research institutions. Depending on the course, prospective participants may be interested in the overall description of the key broadband techniques such as OFDMA or MIMO, WiMAX radio interface and radio access network, or finally in the process of planning and optimization of the WiMAX network. Hence, our courses are suitable for all implementation engineers, system architects, network planners, system testers, tool developers, product managers, technical managers working with WiMAX or with other broadband systems such as LTE.

RECOMMENDED BACKGROUND

Most of our courses require general knowledge about wireless.

CUSTOMIZATION

Should you need a customized design, modifications to the offered course or the development of some new parts, do not hesitate to let us know! We would be delighted to adapt our content to your particular needs.

WHY OUR COURSES

The are several reasons to choose our courses. Here are the most important ones:

- all our trainers are also experienced engineers — we talk about the systems that we build ourselves
- the courses are very interactive and practical, enriched by a number of hands-on exercises
- we broadly utilize tools supporting the process of analysis, planning and evaluation of the WiMAX radio interface and network, while at the same time keeping the course independent from the choice of any particular tool (we are aware that our customers utilize various tools)
- the tools include link-level simulator, system-level simulator and RNP tool (set of tools depends on the course)
- we provide unrivalled post-course support

MORE INFORMATION:

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WiMAX System Overview, 3 days

COURSE OUTLINE

WiMAX Network Architecture
- The role of IEEE and WiMAX Forum
- WiMAX waves, releases and system profiles; WiMAX Forum certification
- Network nodes: MS, BS, ASN-GW, ASN, CSN
- Network interfaces: R1, R8, R6, R4, R3, R2
- ASN Profiles

OFDM, OFDMA and MIMO
- Fundamentals of multipath propagation (selectivity in time, frequency and space)
- Serial vs. parallel transmission, multicarrier transmission
- OFDM subcarriers and subcarrier separation, cyclic prefix, IFFT/FFT processing
- OFDM transceiver processing
- Multiuser diversity and OFDMA
- Multiple access with OFDMA
- Multiple antenna concept
- Open and closed loop spatial multiplexing
- Multi-user MIMO

WiMAX Access Network and Radio Interface
- WiMAX air interface protocol stack
- Responsibilities of the PHY layer
- TDD and FDD radio frames
- Channels and signals (preambles, DL-MAP, UL-MAP, DCD, UCD, FCH, Ranging, fast feedback channel)
- FUSC, PUSC, OPUSC, AMC
- MIMO in WiMAX
- Overview of synchronization and ranging procedures
- MAC layer architecture

Quality of Service in WiMAX
- Logical connections, service flows and traffic flows
- Identifiers: SFID, CID
- MAC states and packet processing
- Mapping between PDUs, service flows, connections and service classes
- QoS classes: UGS, rtPS, nrtPS, BE
- QoS-aware scheduling

WiMAX Core Network
- User Plane and Control Plane
- Mapping of network functions to nodes
- MS state states (registered, deregistered, sleep, awake)
- Subscriber identities and their relations
- Security protocol stack
- VoIP call establishment via IMS

WiMAX Cross-system Procedures
- Network Entry and Exit
- Call setup
- Location update
- Handover
- Handover types (macro-diversity HO, hard HO, fast BS switching)

WiMAX Features Roadmap (up to WiMAX Forum Rel 2.0)
- Overview of features in the WiMAX Forum Rel. 1.0 and 1.5
- Features expected in WiMAX Rel 2.0
- Bandwidth aggregation up to 100 MHz and new bands
- The use of relays
- MIMO improvements (including up to 8 streams in the downlink, collaborative MIMO in the downlink)
- MBSFN and Self-organizing Networks (SON)
- Fractional Frequency Reuse

Overview of alternative systems and interworking considerations
- Overview of 3GPP-LTE architecture
- Summary of 3GPP-LTE radio access techniques
- Roaming: data access via home network and data access via visited network
- Inter-working with 3GPP E-UTRAN and CDMA 2000 networks

Note: the course content is subject to minor changes and adaptations to the customer needs.

COURSE OUTLINE

Introduction to WiMAX
- WiMAX network architecture
- Nodes and domains: MS, BS, ASN-GW, ASN, CSN
- Interfaces: R1, R8, R6, R4, R3, R2
- ASN Profiles
- WiMAX bandwidths and bit rates
- Summary of radio access techniques used in WiMAX air interface

Overview of OFDM and OFDMA
- Fundamentals of multipath propagation (selectivity in time, frequency and space)
- Basics of OFDM transmission, subcarriers, cyclic prefix, IFFT/FFT processing
- OFDMA as an extension of OFDM
- Multiple access with OFDMA
- Advantages and disadvantages of OFDM and OFDMA

WiMAX Air Interface Protocol Structure
- WiMAX air interface protocol stack
- Control information and user data organization
- Information mapping: bursts, sub-channels and slots

WiMAX PHY Layer
- RF channel definitions
- MS and BS transmitter power parameters
- PHY interface options: WirelessMAN-SC, WirelessMAN-SCa, WirelessMAN-OFDM, WirelessMAN-OFDMA, WirelessHUMAN
- OFDMA parameters for WirelessMAN-OFDMA
- TDD and FDD radio frame organizations
- Radio frame elements (sub-frames, sub-channels, slots, data regions, bursts, TTG, RTG)
- Channels and signals (preambles, DL-MAP, UL-MAP, DCD, UCD, FCH, Ranging, fast feedback channel)
- Subcarrier allocation schemes and pilot assignment
- Pseudo random permutations: FUSC, PUSC and Optional PUSC
- Adaptive permutation: Adaptive Modulation and Coding (AMC)
- MIMO scenarios in WiMAX for downlink and uplink
- Adaptive MIMO switch
- Space-Time Coding and Spatial Multiplexing
- Beamforming
- Uplink Collaborative MIMO
- MIMO allocations in the frame
- Downlink and uplink processing chain including channel coding, modulation, subcarrier mapping, Space-Time Coding and OFDMA signal generation

WiMAX PHY Layer Demo and Experiments (tool-based)
- OFDMA waveforms
- Chosen BS and MS signals and PHY channels shown in the time and frequency domain
- Complete downlink and uplink radio frame shown as time-frequency grid

WiMAX MAC Layer
- MAC overall architecture and functions
- MAC sub-layers: Security, Common Part, Convergence
- Logical connections, service flows and QoS
- Link adaptation mechanism, Adaptive Modulation and Coding
- MAC security processing
- Power saving
- MAC packet processing
- Hybrid ARQ
- Timing Relationship and Timing Advance

WiMAX Radio Interface Procedures
- Synchronization
- Cell selection, reselection
- System info acquisition
- Ranging procedure and allocations
- Initial and periodic ranging
- Handover ranging
- Bandwidth request
- Power control for uplink and downlink, closed loop and open loop
- Measurements and reporting
- RSSI, CINR, relative delay, round trip delay
- WiMAX reporting events

WiMAX Deployment
- Planning for coverage and capacity
- Site sharing options
- Tools used in the planning process
- Self-organizing networks (SON) concept

Note: the course content is subject to minor changes and adaptations to the customer needs.

WiMAX RF Planning, 3 days

COURSE OUTLINE

WiMAX RF Design Process
- RF Planning workflow
- Inputs to and targets for the planning; expected outputs
- Coverage and capacity requirements
- Planning constraints
- Significant differences in planning when compared to GSM and UMTS

WiMAX Architecture and Air Interface (tool-based)
- WiMAX waves, releases and system profiles; WiMAX Forum certification
- WiMAX network architecture: nodes and interfaces
- BS and MS architecture
- Radio frame for mobile WiMAX (FDD and TDD)
- OFDMA parameters for WirelessMAN-OFDMA
- Data mapping for downlink and uplink
- Preambles and pilots
- FUSC, PUSC, OPUSC, AMC
- Link-level radio interface simulations

Radio Propagation Principles (tool-based)
- Spectrum considerations and WiMAX frequency bands
- RF channel definitions
- MS and BS transmitter power parameters
- Large-scale and small-scale propagation effects; pathloss, shadowing and fading
- Propagation models: statistical, empirical and deterministic
- Configuration and tuning of the propagation model

Antenna Considerations and MIMO
- Antenna properties - size, gain, beam-width, polarization, front-to-back ratio
- WiMAX diversity techniques
- Spatial multiplexing, single-user and multi-user MIMO
- Transmission modes and MIMO feedback signaling
- Impact on WIMAX link budget and capacity

Antenna system sharing options

Coverage Planning and Link Budgets (tool-based)
- Link budgets, gains and losses
- Role of adaptive modulation and coding scheme
- Requirements for signal-to-noise-and-interference ratio (SNIR) and receiver sensitivity
- Thermal noise calculations and interference estimation
- Maximum allowed path loss
- Impact of cyclic prefix length on the link budget
- Indoor considerations
- Impact of antenna configuration
- Range determination and site-to-site distance estimation
- Signal level and best server coverage plots
- SNIR and spectrum efficiency coverage plots
- Site sharing options coverage with the use of repeaters
- WIMAX downlink and uplink link budget exercises
- Planning tool configuration and simulations

Frequency Reuse and Interference Management (tool-based)
- Interference avoidance, cancellation and coordination
- Interference management vs. FUSC, PUSC and AMC
- Interference scenarios for FDD and TDD
- Considerations for Single Frequency Network (SFN)
- Frequency-parallel schemes (OFDMA) in SFN
- Classical frequency reuse concept (integer reuse)
- Fractional frequency reuse methods including soft reuse and partial reuse
- Frequency planning performance evaluations and simulations

WiMAX Capacity Planning (tool-based)
- QoS concept and QoS classes
- Traffic types and device types
- Impact of MCS and SNIR distribution on
- Capacity planning with MIMO
- Influence of Modulation and Coding Scheme distribution on sector capacity
- Overview of backhaul network options and requirements
- Exercises in capacity calculations
- Planning tool configuration and simulations

RAN Procedures Configuration
- Preamble planning
- Configuration of FUSC, PUSC, OPUSC, AMC
- Cell reselection and handover parameters
- Uplink and downlink transmit power control

WiMAX Inter-working with Other Networks
- Roaming: data access via home network and data access via visited network
- Inter-working with 3GPP E-UTRAN and CDMA 2000 networks

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COURSE OUTLINE

Fundamentals of Digital Communications
- Requirements imposed on broadband wireless access systems
- Classical schemes for radio transmission: single carrier modulation / mapping schemes (BPSK, QPSK, QAM)
- Review of classical schemes for multiple access (TDMA, FDMA)
- Spread spectrum transmission and CDMA
- General model of a digital communications system; sources of degradation

Large-scale and Small-scale Propagation
- Multipath effect and its influence on communications over radio
- Time spread, Doppler spread and angular spread
- Time selectivity, frequency selectivity and spatial selectivity
- Pathloss and shadowing
- Rician and Rayleigh fading, K-factor

OFDM Fundamentals
- Serial vs. Parallel transmission, multicarrier transmission
- Determination of the key OFDM modem parameters
- Continuous and discrete model of OFDM system
- OFDM signal in the time and frequency domains
- OFDM subcarriers and subcarrier separation
- Cyclic Prefix (CP) role, linear and circular convolution, impact on equalization
- IDFT/DFT, IFFT/FFT
- Block structure of the OFDM transceiver
- Equivalent OFDM model of parallel AWGN channels
- High Peak-to-average Power Ratio (PAPR) problem and possible countermeasures
- Advantages and disadvantages of OFDM

OFDMA Fundamentals
- OFDMA as an extension of OFDM
- Exploitation of the multiuser diversity phenomenon
- Creation of the time-frequency resource grid; single time-frequency resource granularity
- Adaptive assignment of time-frequency resources
- Combination with Adaptive Modulation and Coding
- Water-filling concept
- Scheduling and QoS support; example scheduler resource allocation problems
- Scalable OFDMA
- SC-FDMA
- Advantages and disadvantages of OFDMA

Synchronization Problems in OFDMA
- Synchronization mismatches: carrier frequency, phase, symbol timing and sampling clock offsets
- Estimation of synchronization offsets
- Correction of synchronization offsets
- Synchronization methods working in time and frequency domain
- Pilot-based synchronization

OFDM/OFDMA Channel Estimation and Correction
- Pilot types (block, comb, mixed, grid), preambles
- Minimal requirements for pilot separation
- Architecture of OFDM channel estimator and corrector
- Zero-forcing and MMSE equalizer

Combination of MIMO with OFDM/OFDMA
- Introduction to multiple-antennas
- Transmit diversity, spatial multiplexing, single-user and multi-user MIMO, beamforming
- Open-loop and closed-loop MIMO
- Advantages of combining MIMO with OFDM/OFDMA
- 3-dimensional resource (time, frequency and space) allocation problem
- Pilots for MIMO/OFDM/OFDMA
- Combination of STBC and OFDM
- Combination of SFBC and OFDM
- Combination of Spatial Multiplexing and Beamforming with OFDM

OFDMA Under Co-channel Interference
- Overview of co-channel interference control methods
- Interference randomization, avoidance, cancellation and coordination
- Considerations of Single Frequency Network (SFN)
- Integer and fractional frequency reuse concepts
- Comparison of FDD and TDD co-channel interference scenarios

OFDM/OFDMA Applied in Standard Systems
- 3GPP LTE Rel. 8 and 9
- 3GPP LTE Rel. 10 and beyond (LTE Advanced)
- WiMAX (IEEE 802.16d and 802.16e)
- Other systems (WiFI, DAB, DVB)

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COURSE OUTLINE

Radio Propagation Overview and Antenna Fundamentals
- Propagation in dispersive multipath channels
- Basic antenna characteristics (time, frequency and angular spread)
- Vertical, horizontal and circular polarization of electromagnetic wave
- Basic antenna structures (isotropic and dipole), their characteristics and parameters
- Sector antenna pattern, influence of down-tilting
- Line-of-sight and non-line-of-sight propagation

Spatial Diversity Methods
- Three domains for providing diversity (time, frequency and space)
- Diversity combining schemes: MRC for receive diversity, Alamouti for transmit diversity and selection combining for both
- Combination of spatial diversity (RAKE receiver and cyclic delay diversity)
- Use of space time coding (STBC, STTC)

Beamforming
- Fundamentals of creating adaptive antenna patterns
- Transmit and receive beamforming (DoD and DoA)
- Physical vs. mathematical beamforming
- Switched multibeam vs. adaptive antenna array
- Optimal usage of beamforming (desired signal
- enforcement, interference suppression or cancellation)
- Combination of beamforming with spatial diversity or spatial multiplexing
- Practical examples of range increase

Spatial Multiplexing
- Basic idea of creating independent spatial channels
- General mathematical model for spatially multiplexed channels
- Encoder and decoder for Horizontal Layered Space (H-BLAST)
- Encoder and decoder for Vertical Layered Space (V-BLAST)
- Encoder and decoder for Diagonal Layered Space (D-BLAST)
- Spatial multiplexing with feedback (closed loop)
- Water-filling concept in closed loop MIMO
- Zero-forcing receiver and singular value decomposition (SVD)

MIMO in Multiple-user Scenario
- Extension of spatial multiplexing concept to multiple-user scenarios
- Classification of multiple-user scenarios for MIMO usage
- 3-dimensional scheduling in LTE system
- Coordinated MIMO transmission from more than one base station

Combination of MIMO with OFDMA and SC-FDMA
- OFDMA and SC-FDMA as the key transmission techniques for current broadband systems
- MIMO-related synchronization and channel estimation aspects
- Combination of STBC and OFDMA
- Combination of SM/BF and OFDMA
- Possible allocations of transmit diversity and spatial multiplexing
- Receive beamforming with SC-FDMA

MIMO Applied in the Major Standards
- MIMO in 3GPP Rel. 8, Rel. 9 and Rel. 10 E-UTRAN
- MIMO in IEEE 802.16e
- MIMO in eHSPA

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