CETECOM™

Your Partner in Mobile & Wireless Communications

WiMAX™ *from A-Z*

RELOADED

Presented by INACON GmbH

v2.510

WiMAX from A-Z Reloaded

Course Duration:

- 2 days

Who Should Attend This Class?

- Engineers and technical staff who require detailed inside knowledge of the WiMAX and IEEE 802.16e standards.

Course Description:

- This course addresses the needs of engineers and technicians who need to understand WiMAX technology and system operation in detail. This includes the special requirements of design and test engineers of WiMAX equipment on both ends: network and CPE.

- The focus is on the latest revision of the standard which is IEEE 802.16e-2005 and also considers the upcoming changes of corrigendum 2 and task group 802.16m.

- The course starts with an overview of the IEEE 802.16 family of standards and WiMAX. This includes the definition of stationary, nomadic and mobile access scenarios and points out the differences among them. We will also illustrate the basic e2e-architectural aspects of ASN and CSN and we present the frequency ranges of WiMAX.

- A detailed description and discussion of the e2e-architecture of WiMAX networks. Different implementation options are presented like Greenfield architecture or integration of WiMAX networks into existing DSL- or 3G-architectures.

- Consideration of the different ASN-implementation options along the profiles A, B and C.

- Detailed description of the OFDMA physical layer of WiMAX. After a comprehensive introduction to OFDM, the focus is on aspects like OFDMA-tiles and zones (PUSC, FUSC, etc.) and their differences and on the mapping of user data to ODFMA-subchannels and slots.

- Aspects of the physical layer, namely a detailed description of MIMO and AAS in WiMAX and the presentation of the signal processing chain (randomization, FEC, modulation). This part includes an introduction to HARQ-techniques like chase combining and incremental redundancy.

- Presentation of the OFDMA-specific layer 1 frame and the means and mechanics of uplink and downlink resource allocation or ranging within this frame structure.

- Focus on the WiMAX protocol suite, covering protocols like MAC, ASN-Ctrl, PKMv2 and Mobile-IP (CMIP and PMIP). Included is a description of important scenarios like idle mode activation and deactivation, paging, and ASN-based mobility management.

- The final section is dedicated to different e2e-scenarios like initial registration of a CPE to the network under different conditions and using different credentials. This section illustrates the optimum interworking of WiMAX networks with the IMS and it covers CSN-based mobility management aspects.

Pre-Requisites:

- The student should possess detailed knowledge of wireless communications, particularly within the area of digital signal processing in wireless communications.
- This experience should stem from hands-on work in the area of design, integration, test or troubleshooting of GSM, CDMA or WCDMA-equipment.
- Comprehension of different digital modulation schemes like QAM or PSK and of different multiple access schemes like TDMA, FDMA and CDMA is required.
- Knowledge of the TCP/IP-protocol environment and particularly of the IP security issues e.g. in WLAN's is necessary.

Course Target:

- The student will obtain detailed understanding of WiMAX and the IEEE 802.16e standard and the related procedures and network operation and architectures.
- After the course the student will be enabled to design, test and operate 802.16 networks and CPE's.

Some Questions That Will Be Answered:

- How does the e2e-network architecture of WiMAX look like under different conditions (Greenfield, DSL-operator, mobile operator)?
- Which mobility management options exist in WiMAX networks and how do they differ?
- How do OFDM and OFDMA work? How can there be soft handover in OFDMA?
- What are the differences between PUSC, FUSC or AMC in OFDMA?

- What do we have to consider when setting up single frequency network operation with our WiMAX OFDMA-network?
- How does WiMAX provide for QoS? Which parameters are used?
- In which frequency bands will WiMAX actually be deployed?
- How does MIMO work in WiMAX and how does it impact the operation?
- How do procedures like sleep mode, idle mode, paging and handover operate in detail?
- How can the PKMv2-security architecture of WiMAX be integrated into our existing security architecture?

Table of Contents:

⇒ HARQ-Support (Chase Combining)
Chase Combining vs. Incremental Redundancy, Support of Chase Combining in WIMAX

⇒ Multiple Antenna Techniques
Overview and Terminology, SISO, SIMO, MISO, MIMO, Variations of MIMO in WIMAX, Matrix A (Matrix B, Matrix C), Operation of Matrix B Downlink, Operation of Matrix B Uplink (UL Collaborative MIMO)

- **Important Assets and Features of the Upper Layers**

⇒ Overview
QoS-Distinction, Security, Mobility Features, MBS, Mesh Networking

Architecture Details

- **E2E-Architecture Overview**

⇒ ASN and CSN

⇒ NAP and NSP

⇒ NAP-Id and NSP-Id
Globally unique Op-Id assigned by IEEE Registration Authority, Globally unique Op-Id assigned by ITU-T (based on E.212 MCC/MNC), Non-unique Op-Id for private Networks, NSP-Identifier Flag, Obtaining NAP-Id and NSP-Id

⇒ Possible Relationships between ASN and CSN
Assessing the Situation of CSN 1 and NSP 1, Assessing the Situation of CSN 2 and NSP 2, Assessing the Situation of CSN 3 and NSP 3, Conclusions

- **Functionalities within the ASN**

⇒ Overview
ASN-anchored Mobility Mgmt, CSN-anchored Mobility Mgmt, QoS and Traffic Flow Mgmt, AAA, DHCP-Relay Function, RRM (optional)

- **Functionalities within the CSN**

⇒ DHCP

⇒ AAA-related Functions

⇒ CSN-anchored Mobility Mgmt

⇒ IMS-Function

- **Subscriber Station / Mobile Station**

⇒ Power Classes

- **Definition of Interfaces**

- **ASN-Implementation Options**

⇒ Overview and Introduction

⇒ Details of Profile A Implementations

⇒ Details of Profile B Implementations
Implementation Example (Detailed Analysis)

⇒ Details of Profile C Implementations

⇒ ASN-Functions in case of Profile A, B and C
ASN- and CSN-anchored Mobility Management, QoS and Traffic Flow Management, AAA (Authentication, Authorization, Accounting), Radio Resource Management (RRM)

- **3GPP-Interworking Architecture**

⇒ Overview of Options

⇒ Interworking as I-WLAN Direct IP-Access

⇒ Interworking as I-WLAN 3GPP IP-Access

⇒ Interworking as GAN/UMAN

⇒ Network Architecture in case of I-WLAN Direct IP-Access

- **Overview of the Initial Network Entry Procedure**

OFDM and OFDMA in WIMAX

- **Introduction**

⇒ Impact of Orthogonality in the Frequency Domain – 3 Steps

⇒ Practical Exercise: Physical Basics of OFDM / OFDMA

⇒ Practical Exercise: Scaling of OFDM / OFDMA-Systems
Scaling of the WIMAX OFDMA PHY

- **Advanced Issues of OFDM / OFDMA**

⇒ OFDM / OFDMA and IFFT
Considering the Discrete Oscillator Array Option, Details of the IFFT Option (Why is it called F a s t Fourier Transformation?)

⇒ Using different Modulation Schemes on Different Subcarriers

⇒ Tackling Inter-Symbol Interference (ISI)
Introduction, Delay Spread, Cyclic Prefix (Variable Duration and other Assets of the Cyclic Prefix, Cyclic Prefix in WIMAX OFDMA)

⇒ Layout of the IEEE 802.16 OFDM
Remarks on the Brick Wall Image, Subchannelization , Pilot Subcarriers, Null Subcarriers

⇒ FDD- and TDD-Operation in OFDM / OFDMA-Systems
View of an FDD-Implementation, View of a TDD-Implementation

- **Multiplexing Several Users on the OFDMA Physical Resource**

⇒ Introduction to Subchannelization
Slot Definition, Data Region Definition

⇒ Permutation Rules
Overview DSCA and ASCA (PUSC and OPUSC, FUSC and OFUSC, TUSC1/TUSC2, AMC)

⇒ Details and Operation of DL-PUSC
Operation and Selection of Subcarriers, Efficiency / No of Pilot Symbols

⇒ Details and Operation of UL-PUSC
Operation and Selection of Subcarriers, Efficiency / No of Pilot Symbols

⇒ Details and Operation of FUSC (DL only)
Operation and Selection of Subcarriers, Efficiency / No of Pilot Symbols

⇒ PUSC, FUSC and Frequency Reuse Issues
Frequency Reuse Schemes (GSM: 3, 3, 9, WIMAX: 1, 1, 1, WIMAX: 1, 3, 3, WIMAX: 1, 3, 1, Clarification: Cell vs. BS / Site), PUSC and Fractional Frequency Reuse (Operation)

⇒ Number of Subchannels per FFT and Permutation Scheme

- **OFDMA-Frame Structure (TDD)**

⇒ Frame Duration and other Time Constraints

⇒ No of Subchannels

⇒ Permutation Zones and Preamble

- **Typical Layout and Resource Allocation**
Details of DL-Subframe, Details of UL-Subframe

- **Throughput Rates and Performance Values**

⇒ Downlink Direction
Constraints

⇒ Uplink Direction
Constraints

Protocol Suite

- **Protocol Stacks**

⇒ Control Plane

⇒ User Plane (IP) with CMIP-Support

- **The MAC-Layer of IEEE 802.16e**

⇒ Tasks and Functions

Convergence Sublayer (MAC-CS) (Packet Classification, Payload Header Suppression (PHS)), Common Part Sublayer (MAC-CPS) (Functions within MAC-CPS), Security Sublayer (MAC-SS)

⇒ Connection Identifiers (CID)
Introduction and Operation, CID, SFID and QoS, Value Ranges (Basic Connection CID's, Primary Management CID's, Secondary Management and User Data Transport CID's, Multicast CID's), Pre-Defined CID-Values (Selection) (Initial Ranging CID, Initial Ranging CID (AAS), Broadcast CID, Fragmentable Broadcast CID, Padding CID)

⇒ Selected MAC-PDU Types
Generic MAC-PDU (HT and EC, Type Field, ESF, CI, EKS, Length, CID, HCS, Subheaders)

⇒ Bandwidth Request MAC-PDU
HT and EC, Type Field, Number of Bytes requested, CID, HCS)

⇒ Quality of Service in WIMAX
Traffic Classes (UGS, RT-VR, NRT-VR, BE, ERT-VR), Parameter Overview

⇒ MAC-related Network Entry
Overview, Broadcast Messages, Ranging, Basic Capabilities Exchange, Authentication and Key Generation along PKMv2 and EAP, Registration (Secondary Mgmt CID), Setup of Pre-Provisioned Service Flows

⇒ Key Generation through PKMv2 and EAP
Procedural Overview (EAP-Method, Key Material (MSK, EMSK), Derivation of AK and KEK / Generation of TEK), Cryptographic Suites

⇒ Operation Modes
Overview, Behavior during Normal Operation Mode (Data to be transferred in DL-Direction, Data to be transferred in UL-Direction), Behavior during Sleep Mode (Overview and Initiation, Configuration through Sleep Window Parameters, MS Initiated Sleep Mode Termination, BS Initiated Sleep Mode Termination), Behavior during Idle Mode (Detailed Description, Entering Idle Mode, Leaving Idle Mode, Differentiation Idle Mode – Sleep Mode, Periodic Location Updating, Paging Groups, Paging Interval Calculation)

Important Scenarios

- **Initial Network Entry**
- **EAP-SIM-Procedure**

⇒ Initial Conditions

⇒ Applicability of this Procedure

⇒ Detailed Description

- **Handover Procedures**

⇒ Handover Types
Hard Handover, Soft Handover

⇒ Example of a Handover Procedure