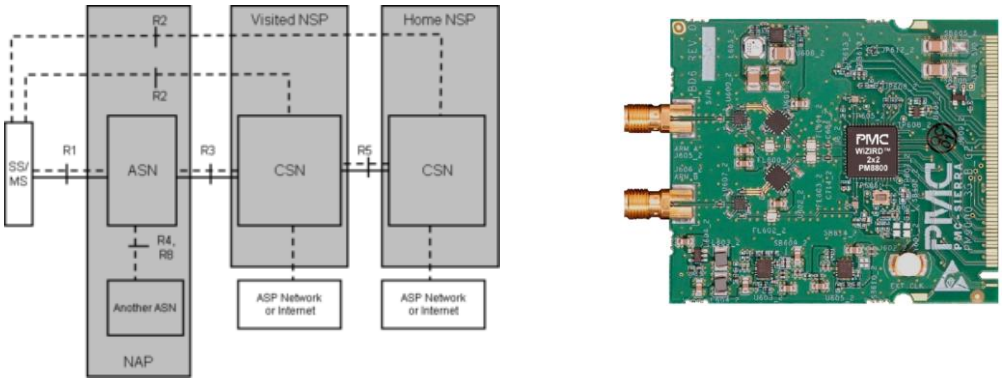
Technical Training on WiMAX IEEE 802.16e

Learning through workshop/case study (4day)

IEEE 802.16 is a series of Wireless Broadband standards authored by the IEEE. The current version is IEEE 802.16-2009 amended by IEEE 802.16j-2009. IEEE 802.16 is written by a working group established by IEEE Standards Board in 1999 to develop standards for the global deployment of broadband Wireless Metropolitan Area Networks. The Workgroup is a unit of the IEEE 802 LAN/MAN Standards Committee.

Although the 802.16 family of standards is officially called WirelessMAN in IEEE, it has been commercialized under the name “WiMAX” (from "Worldwide Interoperability for Microwave Access") by the industry alliance called the WiMAX Forum. The mission of the Forum is to promote and certify compatibility and interoperability of broadband wireless products based on the IEEE 802.16 standards.



The WiMAX Architecture & WiMAX MIMO board

The most popular implementation of the IEEE 802.16 standard is the Mobile WirelessMAN originally defined by the 802.16e-2005 amendment that is now in process of being deployed around the world in more than 140 countries by more than 475 operators.

This workshop on WiMAX is very comprehensive and first in this country covering the fundamentals of Wireless Technology and taking the researchers/engineers through the layers of the WiMAX PHY, MAC layers also cover Security Aspects of the WiMAX. This course also covers the hand over techniques, and Multiple Antenna and related implementation aspects. Though taken on lecture basis several examples and explanation will make the engineers understand the techniques.

Day 1: Wireless Technology Fundamentals

Types of wireless systems and evolutions
Fundamentals of cellular wireless

- Frequency reuse
- Multiple access
- Duplexing
- Sectorization
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Basic TX.operations in a wireless system

- Source coding
- Scrambling
- Error control coding

- Interleaving
- Pulse shaping
- RF modules

Basic RX. Operations

- RF modules
- Synchronization; time and frequency
- Channel compensation
- Decoding
- Deinterleaving and descrambling

Wireless Channels

- Multipath channel effects
- Fading and its consequences
- ISI, flat vs. frequency-selective fading

Day 2: Introduction to WiMAX PHY Layer

Overview of WiMax

- IEEE 802.16 – set of standards
  - The history and the evolution of the various 802.16x standards and their features will be covered.

- Frequency bands of operation
  - Various licensed and unlicensed frequency bands are planned to be used in WiMAX. Some countries like Korea have made it clear. We shall discuss these points.

- Applications & Services
  -Backbone and access are the main applications envisaged. We shall look at the various services planned with WiMAX networks and the competing systems.

- Types of networks & evolution
  - The various scenarios that could emerge with WiMAX will be covered. Interaction with WiFi and other wireless networks will be discussed.

Physical Layer Concepts

- Key challenges
- Channel conditions
- OFDM concepts
- Typical physical layer parameters in WiMAX
  - This section will be an overview of the key concepts in the WiMAX radio layer. The use of OFDM will be highlighted. The key parameters and their impact on the radio signal and services will be discussed. Some of the key technologies which are likely to play an important role in the WiMAX deployment will be covered.

OFDMA in WiMAX

- OFDMA Vs. OFDM-TDMA
- OFDMA parameters in WiMAX
  - OFDMA is the key technology which will be used in mobile WiMAX. It combines the radio features of OFDM and its multiple access capabilities. The key features which have made

OFDMA suitable for WiMAX will be highlighted. Comparisons with CDMA and other related technologies will be highlighted.

- PUSC and FUSC in WIMAX
- Concept of Sub-channels, tiles & slots
- Concept of Zones
  - Multicellular deployment is an important issue in WiMAX. The use of OFDMA with respect to this will be discussed. Key allocation schemes will be addressed along with typical frame structures used.

- PUSC and FUSC Examples
  - Clear examples of the key allocation techniques will be given.

- Band AMC and its implementation in WiMAX

- Leveraging interference & frequency diversity in WiMAX
  - The use of key concepts in the allocation will be discussed.

Day 3: Introduction to WiMAX MAC Layer

MAC Layer in WiMAX

- Goals and objectives of MAC layer
  - The high level objectives of the MAC layer in WiMAX will be highlighted.
- End-to-End connectivity and convergence with higher layers
  - How different higher layers can live with WiMAX will be presented.
- Typical TDD frame structure in WiMAX
  - A typical TDD frame will reveal the important messages in WiMAX. It will set the stage for a more detailed discussion on the importance of these message exchanges.
- Concept of connections and types of connections
  - Unlike WiFi, WiMAX has these concepts of connections and an ID associated with each connection. Different types of connections are used for transferring different types of messages. These will be highlighted and discussed in detail.
- Network Entry Process
  - Details of how a new station enters a WiMAX network will be explained.
- Role of DLMAP and ULMAP
- Role of DCD and UCD
  - These are key messages as they inform about the allocation and also give details of the allocation.
- Concept of service flows , states, and Dynamic Service Addition
  - This is a key concept involving the transfer of user data.
- Role and types of polling
  - Polling is used in the resource allocation process. Various types of polling are used for different services.
- MAC headers
  - Different MAC frames come with different headers which aid in carrying information about the MAC frame. Bandwidth request and user data headers are the popular MAC headers.
- Types of Service
  - The various service classes that are supported in WiMAX and the typical applications that fall into the various service classes will be explained.
- Bandwidth Request
  -Various types of bandwidth request are allowed in WiMAX. There are incremental and startup bandwidth requests for example. These will be dealt with in detail.

Security in WiMAX

- Introduction to Encryption and Security concepts
- WiMAX Security schemes

- Authorization and authentication
- Media security

Handover in WiMAX

- Types of Handover in WiMAX
- Hard handover – Detailed steps

Sleep and Idle Mode operations

- Periodic Ranging steps
- Sleep mode – Motivation
- Sleep mode – details
- Idle mode – motivation
- Idle mode - details

Retransmission

- Motivation
- ARQ – steps
- HARQ – Motivation and types
- HARQ operational details

Day 4: Multiple Antenna Technologies and their use in WiMAX

Multiple antenna technologies – Concepts

- Motivation
- Types of multiple antenna technologies
- Diversity and spatial multiplexing and their tradeoffs
- Impacts of multiple antenna systems on performance

Multiple Antennas in WiMAX

- Multiple antenna options in WiMAX
- Notation used; Matrix A, B, and C
- Implementation aspects; Signaling related to MIMO
- Impact on performance
- Certification and product related
- Beamforming and its impacts in WiMAX

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