IEEE 802.16 WiMAX

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- Worldwide Interoperability for Microwave Access (WiMAX) – common name associated to the IEEE 802.16a/REVd/e standards.

- Standards are issued by the IEEE 802.16 subgroup that originally covered the Wireless Local Loop technologies with radio spectrum from 10 to 66 GHz.

  - One PHY: Single Carrier
  - Connection-oriented, TDM/TDMA MAC, QoS, Privacy
IEEE 802.16 WiMAX standards

- IEEE 802.16a (2003)
  - Amendment to 802.16, MAC Modifications and Additional PHY Specifications for 2 – 11 GHz (NLoS)
  - Three PHYs: OFDM, OFDMA, Single Carrier
  - Additional MAC functions: OFDM and OFDMA PHY support, Mesh topology support, ARQ
- IEEE 802.16d (2004) – combines 802.16 & 802.16a
- IEEE 802.16e (2005)
  - MAC Modifications for limited mobility
  - Scaling of the Fast Fourier transform (FFT) to channel bandwidth, Adaptive Antenna Systems + MIMO, QoS for VOIP, Turbo codes, Antenna diversity schemes, hybrid ARQ, …
WiMAX parameters

- Range up to 50 km, speeds up to 70Mbps (shared). Mobile speeds up to ~37 Mbps (maximal vehicle speed for working WiMAX – 150 km/h).

- Frequency bands:
  - licensed: 2.3 GHz, 2.5 GHz & 3.5 GHz (2/3 of licensed users worldwide, 20 channels) × unlicensed: 2.4 GHz, 5.4 GHz, 5.8 Ghz

- Bandwidth: 3.5/7/14/20 MHz

- ODFM: 256/512/1024 carriers

- FEC: 1/2, 2/3, 3/4

- Modulation – based on C/N ratio: BPSK, QPSK, 8PSK, QAM-16, QAM-64
WiMAX uses

The bandwidth and range of WiMAX make it suitable for the following potential applications:

- Portable mobile broadband connectivity across cities and countries through a variety of devices.
- Wireless alternative to cable and DSL "last mile" broadband access.
- Data, telecommunications (VoIP) and IPTV services (triple play).
- Source of Internet connectivity independent on business location
Duplex Scheme Support

- The duplex scheme is Usually specified by regulatory bodies, e.g., FCC

- Time-Division Duplex (TDD)
  - Downlink & Uplink time share the same RF channel
  - Dynamic asymmetry
  - Does not transmit & receive simultaneously (low cost)

- Frequency-Division Duplex (FDD)
  - Downlink & Uplink on separate RF channels
  - Full Duplexing (FDX): can Tx and Rx simultaneously;
  - Half-duplexing (HDX) SSs supported (low cost)
MAC addressing, IDs & use

- Subscriber station (SS) has 48-bit IEEE MAC address
- (Fixed) WiMAX Base station (BS) has a 48-bit base station ID – it is not a MAC address (BSID contains 24-bit operator indicator)
- 16-bit connection ID (CID)
- 32-bit service flow ID (SFID)
- 16-bit security association ID (SAID)
- Connection-oriented service
  - Point-to-Point
  - Point-to-Multipoint
QoS Classes in WiMAX

- UGS (Unsolicited Granted Services) – allocated capacity, e.g. for VoIP
- RTPS (Real-Time Polling Services) – BS asks periodically SS, e.g. multimedia, audio, …
- NRTPS (Non-Real-Time Polling Services) – longer delay OK – FTP downloads
- BE (Best Effort) – e.g. HTTP
- ERT-VR (Extended Real-Time Variable Rate Services) – latency guaranteed, not speed. Defined in IEEE 802.16e
Security in WiMAX

- Authentication
  - x.509 SS to BS (not the other way)

- Encryption
  - DES for encryption
  - 168bit 3DES for key exchange
  - Data frames only