Wireless Standards

Developed by: Alberto Escudero Pascual, IT +46

Based on the original work of: Bruno Rogers

Goals

- Understand the meaning of a standard
- Be aware of how IEEE works
- Understand the structure of IEEE Standards
- Understand the technical differences between amendments in the IEEE 802.11 family
- Understand the main difference between WiMAX and WiFi

Table of Contents

- Standards – Open vs Close/Propietary
- IEEE and its working groups
- IEEE 802.11 Legacy (WiFi)
- IEEE 802.11 Amendments (b, a, g, n)
- IEEE 802.16 (WiMAX)

What is a standard?

"*A prescribed set of rules, conditions, or requirements concerning definitions of terms; classification of components; specification of materials, performance, or operations; delineation of procedures; or measurement of quantity and quality in describing materials, products, systems, services, or practices*."

National Standards Policy Advisory Committee (US, 1978)

Why Standards?

- Vendors
  - Thrust
  - Access to global market
- Consumers
  - Interoperability with other products
  - Safety, quality, and consistency

IEEE (eye-triple-e)

- Institute of Electrical and Electronics Engineers
- International non-profit organization developer of standards
  - Telecommunications
  - Information technology
  - Power generation
- 900 active standards, 400 standards under development
- Includes well known standards such as Ethernet (IEEE 802.3) and Wireless Networking (IEEE 802.11)

IEEE 802 LAN/WAN

- A family of standards that refers to LAN and MAN
- Restricted to networks that transport variable-sized packets
- Relates to the two lowest layers of the OSI model
  - Physical Layer and Data Link Layer
- Includes IEEE 802.11 (Wireless LAN) and IEEE 802.16 (Broadband Wireless Access-Wimax)

IEEE 802.11 Legacy

- The standard for “wireless Ethernet”
- By definition:
  - Using CSMA/CA as access method
  - 2 data rates (1 and 2 Mbps)
  - Frequency ranges: Infrared (IR) or 2.4GHZ.
- Not used in its original form in products anymore

Naming of IEEE 802.11

- Wi-Fi

- A brand licensed by the Wi-Fi Alliance for products interoperability

- Currently used for 802.11 like Ethernet is used for 802.3

- Wireless LAN

- Generally used for any wireless local area network

- Also the alternative name of the IEEE 802.11 standard used by IEEE

Naming of IEEE 802.11

- IEEE 802.11x
  - Used to refer to the whole group of standards within IEEE 802.11
  - Used to refer to a group of evolving standards within the IEEE 802.11 family that are under development
  - Mistaken with the IEEE 802.1x standards for port-based network access control
- No working group with that name exists in IEEE
- Avoid using IEEE 802.11x

IEEE 802.11 Technical Aspects

- Physical layer (L1)
  - Modulation Techniques
  - Frequency range
- Data-link layer (L2)
  - Media access method

Modulation Techniques

- The bandwidth (bit rate) is set by the modulation technique
- The more efficient the data is encoded, the higher bitrate can be achieved
- An efficient modulation technique requires sophisticated hardware to handle the modulation and de-modulation of data
- Advanced modulation techniques are more resistant to interference than simpler ones

Modulation Techniques

- FHSS
  - Modifying the carrying frequency by sequence jumps
- DSSS
  - Replace bits with pseudo-random noise and its complement
- OFDM
  - Multiple signals sent at same time but on different frequencies

Frequency Range

- 2.4 Ghz ISM (Industrial, Scientific, Medical) frequency band defined by the ITU
  - Used by 802.11b/g
- 5 Ghz UNII (Unlicensed-National Information Infrastructure)
  - Used by 802.11a

Frequency Range

- 2.4 Ghz is very noise due to the high penetration
  - WLAN
  - Cordless phones
  - Bluetooth devices
- 5Gz band implies less interference BUT
  - High absorption rate (rain, buildings, humans)
  - Line of sight is important
  - Smaller cells.

Media Access Method

- 802.11b uses a CSMA/CA
  - Collision Avoidance instead of Collision Detection (Ethernet)
  - Large overhead
- CSMA/CA avoids collisions by using a polling method
  - RTS and CTS messages
  - Interframe spaces (IFS)
  - CRC and ACK

IEEE 802.11 Amendments

- Most widely accepted are 802.11b/a/g
- Other amendments are 802.11f/h/i/k/n
  - Enhancements, extensions or corrections

IEEE 802.11b

- Frequency: 2.4 GHz
- Modulation Technique: DSSS+CCK
- Maximum raw data rate: 11 Mbps
- Adaptive Rate Selection: 11, 5.5, 2, 1 Mbps
- Includes enhancements of the original 802.11 standard to support higher data rates
  - 5.5 and 11 Mbit/s

IEEE 802.11a

- Frequency: 5 GHz
- Modulation technique: OFDM
- Maximum raw data rate: 54 Mbit/s
- Adaptive rate selection (54, 48, 36, 24, 18, 12, 9 , 6 Mbit/s)
- 12 non-overlapping channels
  - 8 dedicated for indoor use and 4 for point to point

IEEE 802.11a

- Not complient with IEEE 802.11b products
- Never reached the hype that 802.11b did.
  - Poor initial product implementations
  - Regulations regarding the 5 Ghz band

IEEE 802.11g

- Frequency: 2.4 Ghz
- Modulation technique: OFDM+CCK + DSSS
- Maximum raw data rate: 54Mbps
- Hardware is interoperable with 802.11b hardware

IEEE 802.11n

- Maximum raw data rate: 540 Mbit/s
- MIMO (multiple-input multiple-output)
  - multiple transmitter and receivers
  - increases the data throughput and the transmitting range
- Expected to be finalized in mid 2006

IEEE 802.11n

- Spatial diversity
  - Taking advantage of multipath propagation
  - Increases the throughput
  - Reduces the bit error rate
  - Using echoes and fragments of multipath propagation to improve the main signal.

IEEE 802.11n

- Spatial division multiplexing (SDM)
  - Many transmitters for the same data stream
  - Sets of independent data streams are sent out within a single channel of bandwidth
  - Increases the throughput as the number of data streams are increased

WiMAX vs WiFi

- The future broadband wireless standard?
- PtMP outdoor solutions

WiMAX vs WiFi: Coverage and Range

IEEE 802.11 (WiFi)

- Indoor PtP solution
- Small cells (<100m)
- Hidden-node problem (CSMA/CA)
- Simple modulation technique (64 bits) in a/g

IEEE 802.16 (WiMAX)

- Outdoor PtMP solution
- Large cells (7-10 kms)
- Long distance links (50 kms)
- No hidden node problem (DAMA-TDMA)
- Complex modulation technique, 256 bits

WiMAX vs WiFi: Scalability and Thoughput

IEEE 802.11 (WiFi)

- Fixed channel bandwidth (20 Mhz)
- Few non-overlapping channels (3- 5)
- Maximum raw data rate of 54 Mbps.

IEEE 802.16 (WiMAX)

- Flexible channel bandwidth (1.5-20 Mhz)
- Many non-overlapping channels (depends on the bandwidth of each channel)
- Maximum raw data rate of 70 Mbps in a 20 Mhz channel.

WiMAX vs WiFi: Quality of Service

IEEE 802.11 (WiFi)

- QoS is ONLY supported in 802.11e
- Limited prioritization on a single connection
- One QoS policy for all connections to a single AP

IEEE 802.16 (WiMAX)

- Achieved by “polling” on a “per-flow” basis
- Four types of scheduling services:
  - Unsolicited Grant Service (UGS)
  - Real-Time Polling Service (rtPS)
  - Non-Real-Time Polling Service (nrtPS)
  - Best Effort (BE) Service

Conclusions

- A standard ensures interoperability
- IEEE is the main standardization body for ICTs
- IEEE 802.11 (Wireless LAN) is a family of standards for “wireless Ethernet”
- The IEEE 802.11 amendments (b/a/g etc.) differ in modulation techniques, frequency range and media access methods
- WiMAX (802.16) is designed to be an outdoor metropolitan standard while WiFi (802.11) was intended to be an indoor office solution.