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 compliant 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 Throughput

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.