# Corso di Reti mobili

## Wi-Fi and Bluetooth

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# Overview

- Wi-Fi (802.11)
  - Accessing the network
  - Ad hoc mode and infrastructure mode
  - The MAC level
  - WMM: Wi-Fi Multimedia
- Bluetooth (802.15.1)
  - Accessing the network
  - Connection-oriented and connectionless links
  - The MAC level
  - Quality of service

# Wi-Fi

- Wi-Fi Alliance for interoperability
- The “wireless Ethernet”
- MAC address as in 802.x
- 802.11 and b, a, g amendments
- 802.11n: MIMO (2008?)

# Entering a BSS

- Scan and select
- Ad hoc mode
  - optional authentication
- Infrastructure mode
  - authentication
  - association
  - WPA authentication

# MAC addressing

- MAC address for the node
- MAC address for the AP
- The ESS
- 802.11D, r, s: roaming

# DCF

- Distributed coordination function
  - CSMA/CA method
  - optional RTS/CTS
- IFS: the interframe spacing
  - if no one transmits, go on
  - if the channel is busy, back off randomly
  - also back off if want to transmit again after a transmission

# ARQ

- Automatic Repeat Request
- After transmitting, wait for ACK
- If no ACK received, retransmit
- Give up after a maximum number of retransmissions

# WMM: QoS

- Priority with guarantees
- 8 priorities in four classes
  - voice
  - video
  - best-effort
  - background
- priority is obtained by
  - changing the IFS for each class
  - changing the backoff for each class

# Dynamic multi-rate switching

- 802.11: 1, 2 Mb/s
- 802.11b: add 5.5, 11 Mb/s
- 802.11g: add 6, 9, 12, 18, 24, 36, 48, 54 Mb/s
- switching based on
  - RSSI
  - SNR
  - frame loss ratio

# Bluetooth

- Small devices
- Short range
- WPAN: wireless personal area network
- Several power ranges
  - Class 1 1 mW – 100 mW
  - Class 2 0.25 – 2.5 mW
  - Class 3 - 1 mW

# Accessing the network

- A Piconet is made of a Master and up to seven slaves
- A Scatternet is made of several piconets
- Master and slave can exchange roles
- Any node can belong to more than one piconet

# Start as master

- Periodically send an Inquiry to discover new slaves and get their address
- Send a Page request to bring the slave into the piconet
- After paging, Authentication optionally takes place

# Start as slave

- Wait for an inquiry from the master
  - get the master's address
  - syncronise the clock
- Wait for a page request from the master
  - synchronise the hopping sequence

# Channel access

- MAC address is 48 bit
- Band is 2.4 GHz, like Wi-Fi
- FHSS (frequency hopping spread spectrum), 1 Mb/s
- 79 channels in most of the world
- 1600 hops/s: slot is 625µs long

# Hopping sequence

- Unique for each piconet
  - Depends on Master's address
- Hopping sequence virtually infinite
- Master uses even slots, slave uses odd slots
- Message lasts for 1, 3 or 5 consecutive slots
  - Sequence stops during multislot

# Synchronous links

- SCO (synchronous connection-oriented) link
  - guaranteed delay and bandwidth
  - no retransmission
  - no CRC
  - optional 1/3 or 2/3 FEC protection
  - fixed 64 kb/s bandwidth, symmetric or unidirectional
- eSCO up to 288 kb/s with ARQ

# Asynchronous links

- ACL (asynchronous connectionless) link
- Symmetric and asymmetric with different preset bandwidth up to 0.7 Mb/s
- Bluetooth 2 + EDR (extended data rate) goes up to 3 Mb/s
- 16-bit CRC, optional FEC and ARQ

# Quality of Service

- A single ACL per slave
- Parameters for request
  - type of QoS (none, best effort, guaranteed best effort), token rate, token bucket size, peak bandwidth, latency, delay variation
- Parameters on acceptance
  - poll interval, $N_{BC}$