Wireless LAN protocols

- Why wireless LAN?
  - Convenience and flexibility. No need to carry wires or retrofit buildings, (limited) mobility, no connectors (e.g. Macbook Air).
- Why not wireless LAN?
  - Not good if very high bandwidth is required
  - RF compatibility and other safety issues
  - Security (?)

IEEE 802.15.1 (Bluetooth)

- First let's consider Bluetooth, a very simple wireless LAN protocol – named for King Harald Bluetooth, a 10th century Danish king
- Bluetooth connects small devices over a very short range (~1-10m), depending on "class" – though longer ranges are possible – "personal area network" for connecting devices in your immediate vicinity

Bluetooth architecture

- Hierarchical "master-slave" system
- A collection of connected Bluetooth devices is a "piconet"
- Piconets consist of four kinds of device:
  - Master (one per piconet)
  - Slaves (up to seven per piconet, directly connected to the master, actively transmitting data)
  - Parked (known to the master but not transmitting data)
  - Standby (idle)

(Fig. 1)

- Any device can act as either master or slave; also, piconets can overlap (so it's maybe not appropriate to think of the master as a "base station")
- Active devices (master + slaves) are assigned a 3-bit active member address (AMA) (this is why there can be at most 7 slaves)
- Parked devices are assigned an 8-bit parked member address (can be upgraded to active members as needed or as a slot becomes available)
- It is possible for slaves to belong to more than one piconet; it is also possible for a master to be a slave in another piconet – however not simultaneously – the devices jump back and forth

(Fig. 2)

- it is not possible for a device to be a master in two piconets (in that case the piconets would merge into one)

Bluetooth Radio Interface

- Bluetooth operates in the 2.4GHz ISM band
- Multiple access via frequency hopping spread spectrum (FHSS)
    - 79 "hop carriers" each with 1 MHz of bandwidth
    - 1600 hops/s (625 μs per "slot")

    - so every 625 μs, the system occupies a different, pseudo-randomly selected 1 MHz frequency range

(Fig. 3)

- Why do this?
    - Devices in the ISM band must tolerate interference from other devices in the same band
    - By randomly jumping from frequency to frequency, it is unlikely (but not impossible!) that interference will be encountered
- When a piconet is formed, the master sets the hopping pattern
- All devices have a unique 48-bit device ID, which establishes the hopping pattern (when master)
- Time-division duplexing: transmissions proceed as master, slave 1, master, slave 2, master, etc.
- It is possible for transmissions to occupy 3 or 5 slots, as needed – in this case no hopping is performed during the block, and intermediate hops are skipped

(Fig. 4)

- data payload is up to 343 bits for single-slot packets
- What is the data rate? – given 1 slave, 2 slaves ... – for the master

IEEE 802.11 (WiFi)

- The world's most widely used wireless LAN standard
  - 802.11 (1997): 1-2 Mbps
  - 802.11a (1999): 27-54 Mbps (however, limited range – only 802.11 outside of 2.4 GHz)
  - 802.11b (1999): 11 Mbps
  - 802.11g (2003): 22-54 Mbps
  - 802.11n (2010?): 108-600 Mbps
- Compare with Ethernet – note – Cat 5 wire is most commonly used with 100 Mbps and is temperamental at higher data rates (e.g., 1 Gbps Ethernet) – with 802.11n, all you need to do is upgrade the terminals