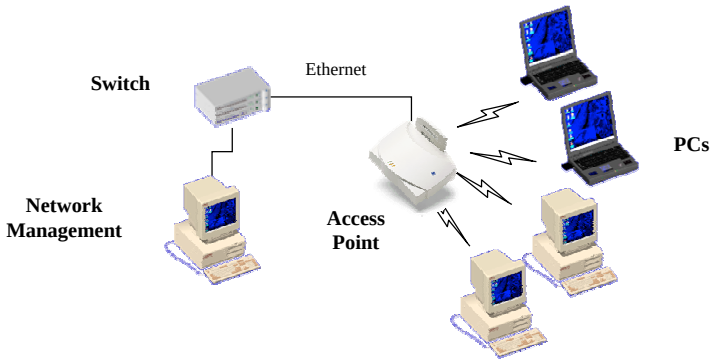
Wireless Technologies

PAN "Personal Area Network"	LAN "Local Area Network"	MAN "Metropolitan Area Network"	WAN "Wide Area Network"
Bluetooth	802.11b 802.11a HiperLAN2	802.11 MMDS LMDS	GSM GPRS CDMA 2.5-3 G
Low Data Rates	Higher Data Rates	Higher Data Rates	Lower Data Rates
Short Distances	Medium Distances	Med-longer Distances	Longer Distances
Notebook/PC to Devices/ Printer/Keyboard/Phone	Computer-Computer and to Internet	Fixed, last mile access	PDA Devices and Handhelds to Internet
< 1 Mbps	2 to 54+ Mbps	22+ Mbps	10 to 384 Kbps

802.11b

WiFi

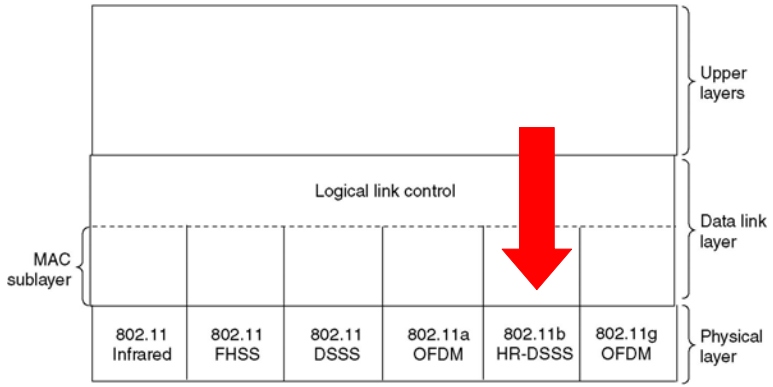


Wireless LANs

- The 802.11 Protocol Stack
- The 802.11 Physical Layer
- The 802.11 MAC Sublayer Protocol
- The 802.11 Frame Structure

The 802.11 Protocol Stack

Part of the 802.11 protocol stack.

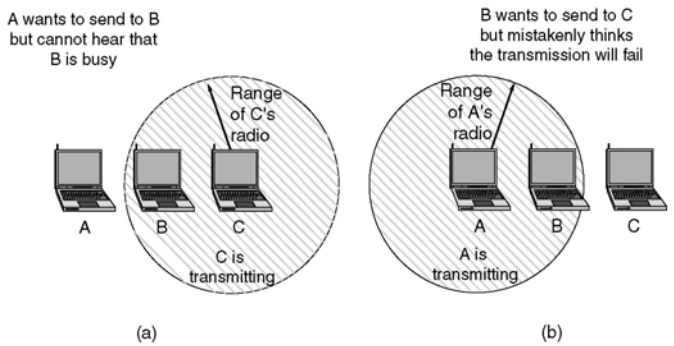


802.11 HR-DSS

- High Rate - Direct Sequence Spread Spectrum (HR-DSSS)
- Speeds
  - 1, 2, 5.5, 11 Mbps
- Dynamic speed adaptation
- Same bandwidth as cordless phones, Bluetooth and microwave ovens
- ISM Band

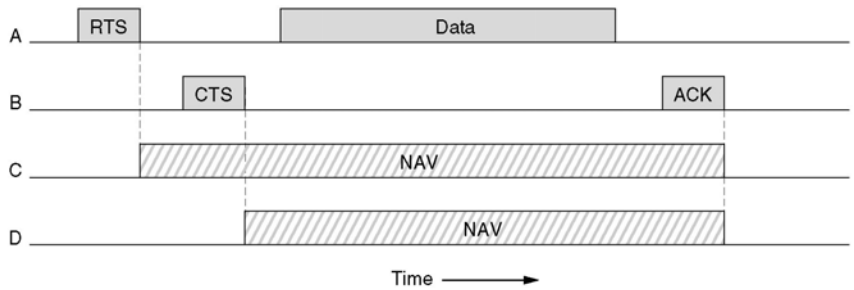
802.11 MAC

(a) The hidden station problem.
(b) The exposed station problem.

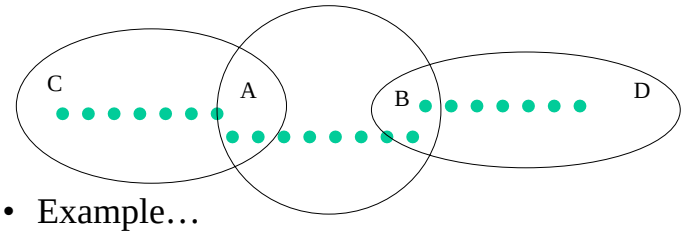


The 802.11 MAC Protocol

- CSMA/CA - Collision Avoidance

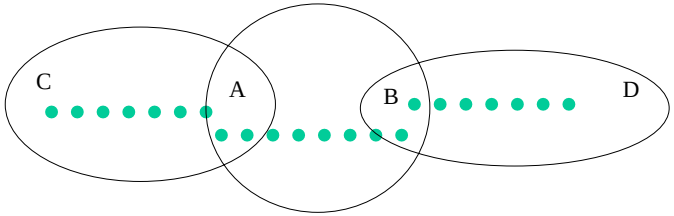


CSMA/CA



- Example…
  - A wants to send to B, sends RTS
  - B says Ok with a CTS frame
  - A sends its frame & starts ACK timer.
  - B gets frame Ok and sends ACK frame.
  - If A's ACK timer expires, start again

- Considering other stations…
  - C within range of A… may receive RTS, if so Hush. This is Network Allocation Vector **NAV**
  - D doesn't hear RTS but hears CTS… assert NAV
  - All fine & dandy!

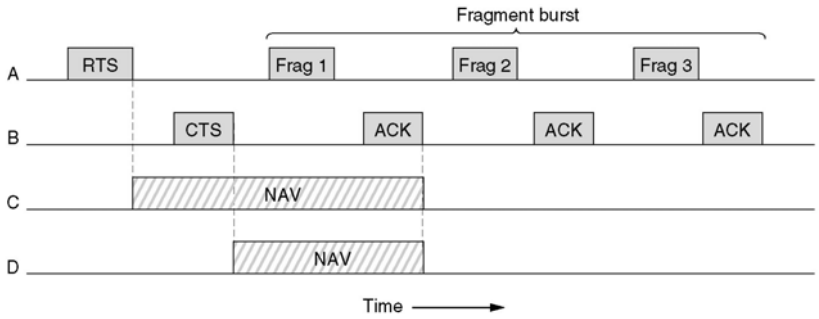


But ISM is Noisy!

- Probability of 1 bit error is *p*
- Probability of n bit frame arriving uncorrupted is $(1-p)^n$
- So, for P = 10^{-4}, 12144 bit frame has <30% probability of arriving correct.
- If 10^{-5}, roughly 1:9 will be damaged.
- If 10^{-6}, roughly >1:100 will be damaged.
- Bigger frames more susceptible to damage!

802.11 MAC & Noisy Channel

A fragment burst.



802.11 MAC & Noisy Channel

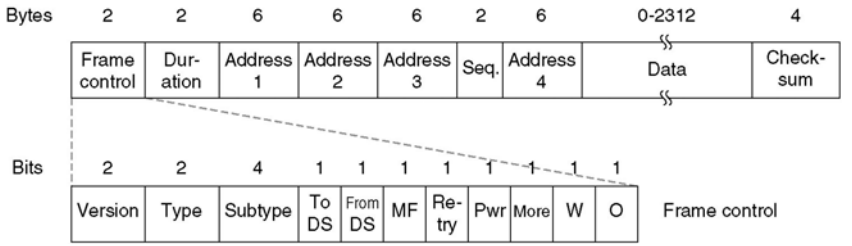
- Fragment frames, use checksums & number
- Acknowledge using Stop & Wait
- Once channel is acquired (RTS & CTS), send fragment burst, ACK each fragment.
- This is what is called Distributed Coordination Function (DCF) Mode

802.11 Point Coordination Function - PCF

- Base station polls... central control.
- Beacon frame transmitted periodically.
- There cannot be any collisions.
- Beacon frame contains system parameters.
- PCF and DCF may coexist, check Tanenbaum.

The 802.11 Frame Structure

The 802.11 data frame.



802.11 Frame Structure

- Data, Control & Management frames
- Control has 11 fields
  - protocol version [PCF | DCF]
  - Type - [Data | Control | Management]
  - Subtype [RTS | CTS]
  - To DS and From DS indicate to\from intercell distribution system (e.g. Ethernet)
  - MF More Fragments
  - Retry - this is a retransmission
  - Pwr - power management [go asleep | wake up]
  - W - encrypted with WEP
  - O - process this frame sequence in order

- Duration field says how long frame & acknowledgement will occupy channel.
- 4 addresses - Source & Dest, also Source & Dest. Base stations for intercell traffic.
- Sequence is for fragment numbering, 12 bits for frame, 4 for fragment
- Data contains payload, up to 2312 bytes
- Checksum is CRC
- Mgmt frames operate within single cell
- Control frames are RTS, CTS and ACK

802.11 Distribution Services

- Association
- Disassociation
- Reassociation (roaming)
- Distribution (wired or wireless)
- Integration (protocol translation)

802.11g High Speed Wireless LAN

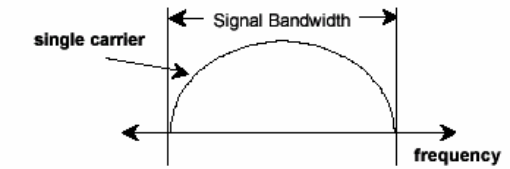
- 2.4GHz is still the frequency band with 54Mbps
- Compulsory…
  - Orthogonal Frequency Division Multiplexing (OFDM) used for rates > 20Mbps.
  - Complementary Code Keying (CCK) required for backward compatability.
- Optional
  - CCK\OFDM Hybrid Header\Payload
  - PBCC Hybrid Header\Payload (Texas Instruments)

802.11g Packet Preambles & Payloads

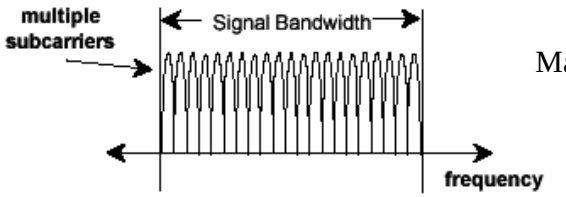
Preamble/Header	Payload

- Preamble warns of forthcoming packet
- Header contains length of packet.
- Payloads vary from 64Byte to 1500Byte.
- Generally CCK used to transmit header and payload, usually!

CCK & OFDM



Max. 11Mbps



Max. 54Mbps

WiFi Interoperability

- CSMA\CA will be used again.
- RTS\CTS will be used
- Headers may be transmitter using CCK and payloads may use OFDM

CCK	CCK
CCK	OFDM
OFDM	OFDM

802.11g Security

- Wired Equivalent Privacy (WEP)
  - Garbage
- Service Set Identifier (SSID)
  - Disable broadcasts
- WiFi Protected Access (WPA)
  - Stronger than WEP
- MAC Address Authentication
- 802.1x Network Authentication
  - EAP

Comparing Wireless Technologies

	Infrared	Bluetooth	802.11b
Frequency	10^{13} - 10^{14} Hz	2.4 GHz	2.4 GHz
Transmission Method	Line-of-sight	Frequency Hopping	Direct Sequence Spread-Spectrum
Speed	4 Mbps	1 Mbps	11 Mbps
Range	1 meters	30 meters	100 meters
Network	PAN	PAN/LAN/WAN	LAN
Signal	Data or Voice	Data & Voice	Data
Security	None	Authentication, Encryption	Authentication, Encryption