Wireless MAC, ...

WLAN Technologies

- Spread Spectrum
- Narrowband microwave
- Infrared

Spread Spectrum

- Distributed signals over multiple frequencies (to avoid eavesdropping or jamming)
- Frequency hopping spread spectrum
  - Sender transmits over a seemingly random series of frequencies
  - Intended receiver aware of sequence of frequencies and hops accordingly
- Direct Sequence Spread Spectrum
  - Sender transmits redundant information called “chips” between actual data bits
  - Intended receiver aware of spread removes redundant information accordingly

Narrowband Microwave

- Typically used to link two WLANs together (for example, to link WLANs in two buildings)
- Microwave dishes required at both ends of link
- Unlike spread spectrum which operates in the unlicensed ISM band, narrowband microwave requires FCC licensing
- Exclusive license typically effective within a 17.5 mile radius

Infrared

- Infrared signals used to transmit data (similar to TV remotes!)
- Higher data rates possible (than spread spectrum)
- Line of sight point-to-point configuration required (or a reflection surface that reflects signals)
- Too sensitive to obstacles, line-of-sight requirement, etc.

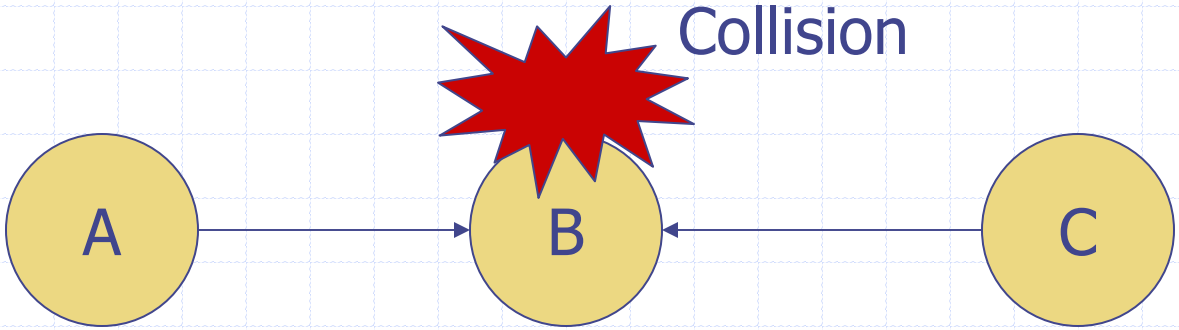
Wireline MAC Revisited

- ALOHA
- slotted-ALOHA
- CSMA
- CSMA/CD
- Collision free protocols
- Hybrid contention-based/collision-free protocols

Wireless MAC

- CSMA as wireless MAC?
- Hidden and exposed terminal problems make the use of CSMA an inefficient technique
- Several protocols proposed in related literature – MACA, MACAW, FAMA
- IEEE 802.11 standard for wireless MAC

Hidden Terminal Problem



- A talks to B
- C senses the channel
- C does not hear A's transmission (out of range)
- C talks to B
- Signals from A and B collide

Exposed Terminal Problem

- B talks to A
- C wants to talk to D
- C senses channel and finds it to be busy
- C stays quiet (when it could have ideally transmitted)

Hidden and Exposed Terminal Problems

- Hidden Terminal
  - More collisions
  - Wastage of resources
- Exposed Terminal
  - Underutilization of channel
  - Lower effective throughput

Recap

- CSMA not efficient in a distributed wireless environment because of hidden and exposed terminal problems
- Other approaches?

Basis for MACA

- In the context of hidden terminal problem, “absence of carrier does not always mean an idle medium”
- In the context of exposed terminal problem, “presence of carrier does not always mean a busy medium”
- Data carrier detect (DCD) useless!
- Get rid of CS (carrier sense) from CSMA/CA – MA/CA – MACA!!!!

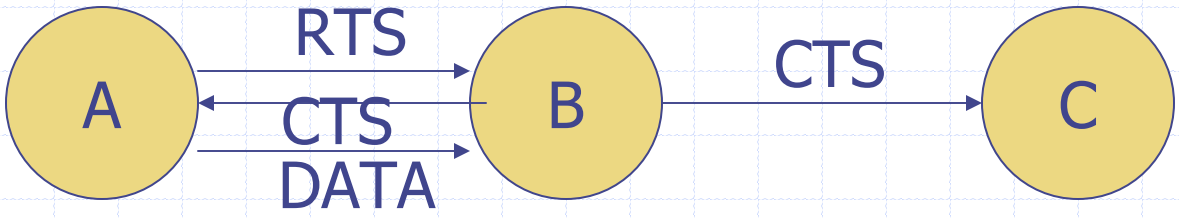
MACA

- Dialogue between sender and receiver:
  - Sender sends RTS (request to send)
  - Receiver (if free) sends CTS (clear to send)
  - Sender sends DATA
- Collision avoidance achieved through intelligent consideration of the RTS/CTS exchange

MACA (contd.)

- When station overhears an RTS addressed to another station, it inhibits its own transmitter long enough for the addressed station to respond with a CTS
- When a station overheads a CTS addressed to another station, it inhibits its own transmitter long enough for the other station to send its data

Hidden Terminal Revisited …



- A sends RTS
- B sends CTS
- C overheads CTS
- C inhibits its own transmitter
- A successfully sends DATA to B

Hidden Terminal Revisited

- How does C know how long to wait before it can attempt a transmission?
- A includes length of DATA that it wants to send in the RTS packet
- B includes this information in the CTS packet
- C, when it overhears the CTS packet, retrieves the length information and uses it to set the inhibition time

Exposed Terminal Revisited

- B sends RTS to A (overheard by C)
- A sends CTS to B
- C cannot hear A's CTS
- C assumes A is either down or out of range
- C does not inhibit its transmissions to D

Collisions

- Still possible – RTS packets can collide!
- Binary exponential backoff performed by stations that experience RTS collisions
- RTS collisions not as bad as data collisions in CSMA (since RTS packets are typically much smaller than DATA packets)

Drawbacks

- Collisions still possible if CTS packets cannot be heard but carry enough to cause significant interference
- If DATA packets are of the same size as RTS/CTS packets, significant overheads

MACAW

- Based on MACA
- Design based on 4 key observations:
  - Contention is at receiver, not the sender
  - Congestion is location dependent
  - To allocate media fairly, learning about congestion levels should be a collective enterprise
  - Media access protocol should propagate synchronization information about contention periods, so that all devices can contend effectively