

# G 364: Mobile and Wireless Networking

CLASS 3, Mon. Jan 12 2004

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M-W, 11:40am-1:20pm, 109 Rob

# MAC for Specific Architectures

## ◆ Centralized MAC Protocols

- Cellular telephony: Predominant form of wireless systems
- Wireless ATM: Broadband multimedia services

## ◆ Ad Hoc MAC Protocols

- Wireless MAC protocols specifically designed for ad hoc networks

# Ad Hoc MAC Protocols

◆ Three categories = three different channel access strategies

1. Contention protocols

- ◆ Use direct competition for access right
- ◆ Collisions are resolved by retransmissions
- ◆ Mostly asynchronous

2. Allocation protocols

- ◆ Synchronous
- ◆ Mapping of the nodes to the slots (scheduling)

3. Hybrid protocols: Combination of 1. and 2.

# Contention Protocols

- ◆ Direct competition for accessing the wireless channel
- ◆ Retransmissions when collision occur
- ◆ Examples: Aloha, CSMA
- ◆ Asynchronous model (except slotted Aloha)
- ◆ Good at low network loads
- ◆ Classification based on **collision avoidance**
  - Aloha: No collision avoidance

# Busy-Tone MA (BTMA)

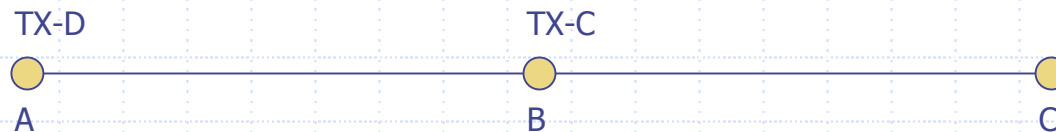
- ◆ Bandwidth is divided into two separate channels
  - Data channel
    - ◆ Bigger, for data packet TX
  - Control channel
    - ◆ TX a **busy-tone signal** = presence of activity in the data channel

# BTMA: Operations, 1

- ◆ Source node checks the control channel for a busy-tone
  - Idle → TX
  - Busy → reschedule TX for later
- ◆ *Any* node that detects activity on the data channel transmits a busy-tone on the control channel

# BTMA: Operations, 2

- ◆ Hidden node problem is lowered



- ◆ Node C is prevented to access the channel
- ◆ Exposed nodes are many (underutilization of the channel)

# Receiver-Initiated BTMA

- ◆ Decrease the problem of exposed nodes
- ◆ Only the destination nodes transmit the busy-tone in the control channel
- ◆ A node have to know if it is the destination → must monitor the data TX
- ◆ Takes time and collision may occur

# Wireless Collision Detect (WCD)

- ◆ Combines BTMA and RI-BTMA: Two distinct busy-tone signal on the control channel
- ◆ Any node that detects activity on the data channel transmits a busy-tone on the control channel
- ◆ Only the destination keeps doing it

# Busy-Tone Solutions

- ◆ Simple concept
- ◆ Extra hardware: TX and RX on the data and control channel at the same time
- ◆ No hardware switching time
- ◆ Performance: WCD > RI-BTMA > BTMA

# MA with Collision Avoidance (MACA), 1

- ◆ Handshaking dialogue = RTS + CTS
  - Lower hidden nodes interferences
  - Minimize exposed nodes
- ◆ Request-To-Send
  - From source to Destination
- ◆ Clear-To-Send
  - From destination to source

# MACA, 2



- ◆ Problem: Collision of control packets (RTS, CTS)
- ◆ Solution ...

# MACAW = MACA + CS

- ◆ Carrier Sensing for collision of RTS/CTS
- ◆ Positive ACK for recovering lost packets
- ◆ ACKs can suffer collisions
  - Source that expect ACK transmits a Data Sending (DS) packet to alert exposed nodes

# MACA + Piggyback Reservation (MACA/PR), 1

- ◆ MACA plus channel reservation  
(QoS applications)
- ◆ Channel reservation table (RT)
- ◆ RT contains reservation made by  
neighbors
- ◆ Overhead: Nodes exchange RTs

# MACA/PR, 2

1. Source → RTS/CTS for reservation
2. Source sends a Real Time packet with a time interval in the header
3. Destination sends an ACK carrying the time interval
4. Neighbors of the destination → Note the time interval in their RTs

# MACA By Invitation: MACA-BI

- ◆ Reverse the RTS/CTS process
- ◆ Destination sends a “Request-to-Receive” (RTR) to receive from a specific source
- ◆ Source transmits the packet
- ◆ Problems:
  - Predict which source wants to transmit
  - Overhead to maintain neighbor list and their traffic patterns

# Big Question ...

- ◆ What is the best protocol?
- ◆ Research is based on
  - Scenarios
  - Tradeoffs
  - Demonstration of protocols via simulations
  - (Analysis ...)

# Allocation Protocols

## ◆ Computation of SLOT schedule

### 1. Static allocation protocols

- ◆ Centralized algorithm
- ◆ Schedule is computed and given to nodes prior to node operations

### 2. Dynamic allocation protocols

- ◆ TX schedules are computed on-demand

# Static Allocation Protocols

- ◆ Global parameters as input
  - Number of nodes  $n$
  - Maximum nodal degree  $\Delta$
- ◆ "Classic" TDMA
  - Frame with  $n$  slots
  - One node  $\leftrightarrow$  one slot (always the same)
  - No collision ever (unicast, multicast)
  - Delay is bounded by the frame length
  - Poorly scalable

# Time-Spread MA

- ◆ One node has multiple slots in a frame
- ◆ Collision can occur, BUT
- ◆ One slot is collision-free
- ◆ Which one we do not know: Success is spread in time (hence TSMA)
- ◆ Frame length  $L$  scales logarithmically with  $n$ 
  - $L \in O(\Delta^2 \log^2 n / \log^2 \Delta)$

# Assignments

- ◆ Wireless MAC handout, to page xix
- ◆ Updated information on the class web page:

[www.ece.neu.edu/courses/eceg364/2004sp](http://www.ece.neu.edu/courses/eceg364/2004sp)