G 364: Mobile and Wireless Networking

CLASS 3, Mon. Jan 12 2004

Stefano Basagni

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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)

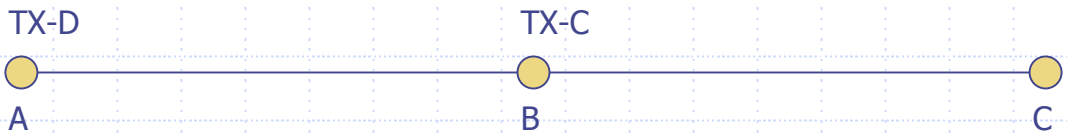
- Bandwidth is divided into two separate channels
  - Data channel
    - Bigger, for data packet TX
  - Control channel
    - TX a busy-tone signal = presence of activity in the data channel

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 Δ
- "Classic" TDMA
  - Frame with n slots
  - One node ←→ 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 no 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