G 364: Mobile and Wireless Networking

CLASS 4, Mon. Jan 14 2004

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

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 (TSMA), 1

- 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
  - $L \in O(\Delta^2 \log^2 n / \log^2 \Delta)$

TSMA, 2

- Based on mathematical properties of finite (Galois) fields
- Choose q (power of a prime p) and k such chat $q^{k+1} > N$ and $q > k\Delta+1$
- Each node is assigned a unique polynomial f in GF(q)
- f → unique schedule
  - Slot i is for TX ←→ (i mod q) = f(int(i/q))

TSMA, 3

- Schedule is such that a node is assigned at least a “free” slot in each frame
- Frame length $L \in O(\Delta^2 \log^2 n / \log^2 \Delta)$
- TX schedules are shorter of TDMA when Δ is reasonably small. Example, $n = 1000$

$\Delta =$	2	5	10	15
TDMA	1000	1000	1000	1000
TSMA	49	121	529	961

A Lower Bound for TSMA

- Mostly of theoretical interest
- Provide a measure of optimality
- For TSMA schedule: $\Omega(\log n)$
  - Independent of Δ
  - Possibly improvable (no matching upper bound)
- TSMA can be used for broadcast in ad hoc networks

Static Allocation: Drawbacks

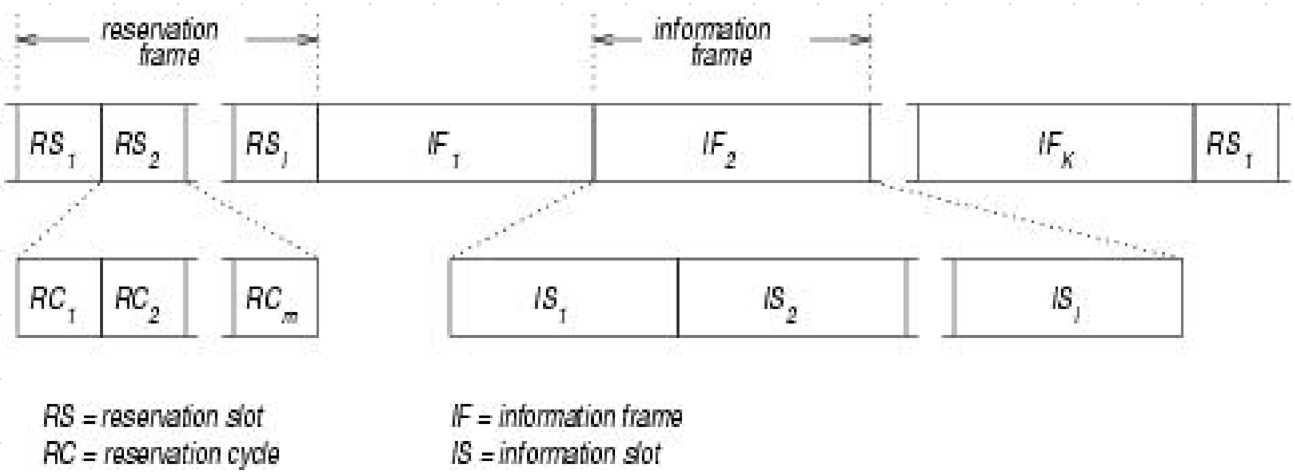
- Network topology is dynamic
  - Unrestricted topology
  - Activation and deactivation of nodes
- Global parameters are not available
- Local parameters are available dynamically
  - Information that is specific to a limited region of the network
  - Example: Number of nodes within x hops from a node (x-hop neighborhood)

Dynamic Allocation Protocols

- Use of local information for computing the TX schedule
- Local parameters vary over time → schedule computation "on the fly"
- Distributed and deterministic
- Two phases:
  1. Reservation slots to contend for slots
  2. TX in gained slots

Five Phase Reservation Protocol (FPRP), 1

- Frames is divided into
  - Reservation frame: l slots, m cycles/slot
  - k information frames: l information slots



FPRP, 2

- A node that wants the information slot i contends for it in the ith reservation slot
- At the end of the reservation frame a TDMA schedule is created for the following k information frames
- The schedule is recomputed in the next reservation frame

FPRP, 3

- Accommodating contentions:
  - Reservation slots are divided into m contention cycles
  - Each cycle has a five rounds reservation dialogue
    1. P-persistent slotted aloha for reserving
    2. Feedback is provided by neighbors
    3. A successful request gives the slot to the requiring node
    4. All two hops neighbors are informed (no hidden terminals → no collisions
    5. Used for optimization

Dynamic Allocation: Drawbacks

- FPRP leads to collision-free schedules
- It involves high overhead
- Each reservation cycle has several hardware switches
- Each round of contention must accommodate
  - the signal
  - the propagation delay
  - Physical layer overhead (synchronization, …)
- System parameters k, l and m are heuristically determined through simulations

Assignments

- Wireless MAC handout, to page xix
- Updated information on the class web page: www.ece.neu.edu/courses/eceg364/2004sp