Lecture 13
Plan: collision free protocols and wireless communication issues
Review

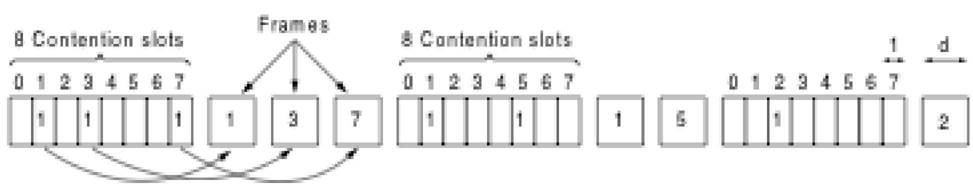
- the need to share a common channel among many hosts
- collision models
  - Aloha
  - Slotted Aloha
  - CSMA
  - CSMA-CD

All models we talked about allow collisions. – **random access or contention protocols**
light traffic: good
heavy traffic: bad

Key: get rid of collisions once for all

Another solution: Collision Free Protocols
1. bit map method

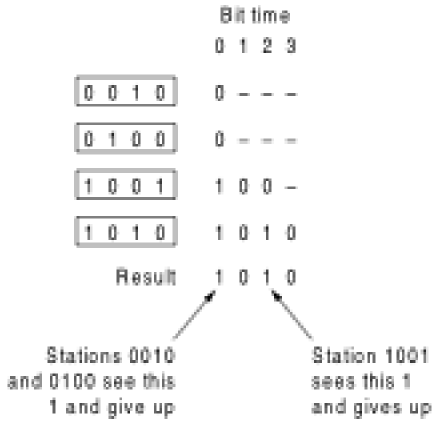
- there is a transmission period and there is a contention period
- contention period has N 1-bit slots
- Every station who wants to transmit issues a bit 1 in its slot
- Suppose k stations want to transmit, then the contention period is followed by a k frame slots
- higher numbered stations can send info faster



2. Binary countdown
Motivation: improve efficiency from bit map (in bit map, each frame sent needs one bit to warrantee its transmission)

- The contention period consists of $\log_2 N$-bit slots
- During contention, each station which wants to transmit issues its station number in binary one bit a time
- 1's are ORed together in the channel and read by everyone
- If a station hears a 1 where it has 0, it gives up.
- Eventually, there is one winner: the highest numbered station → give high priority to high-numbered stations

e.g. 0010, 0100, 1001, 1010



. #10 wins the right to transmit

3. Adaptive tree walk

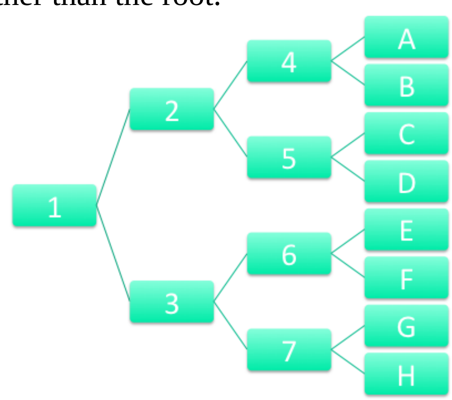
Motivation: trade off between efficiency at high load and delay at low load

As traffic increases,

- contention model: more efficient at low load
- collision free model: more efficient at high load

Middle ground: limit collision

- Each station is assigned a position as a leaf in a complete binary tree.
- Contention period is up to 2N-1 contention slots, one for each node of the tree, starting at the root.
- Each requesting station tries to transmit during slots corresponding to nodes which are its ancestors.
- Nodes are traversed in depth-first order until at least one station transmits during the corresponding slot.
- If a collision occurs at a node, the children of the node are traversed recursively in the next contention slots.
- Eventually only one station is transmitting during a slot, and no collision occurs.
- Adaptive part: If contention is high, tree walk may begin at a lower level in the tree, rather than the root.



e.g. If N=8, then there are 15 nodes → max 15 contention slots

If A B E wants to send

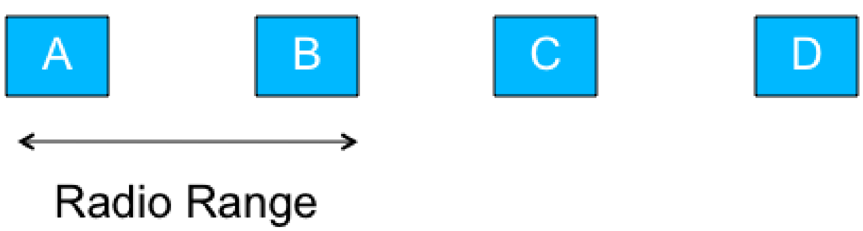
slot 0: all children of #1 contend → collision
slot 1: all children of #2 contend → collision
slot 2: all children of #4 contend → collision
slot 3: A got a free spot
slot 4: B got a free spot
slot 5: all children of #5 contend→no request from any children.
slot 6: all children of #3 contend→E got a free spot since no collision

For collision free models, all of them favor the high position hosts.
Pro: assign important hosts to high positions
con: not good for equally important hosts

Q:/ How to solve the problem?
A:/ solution: mok and ward visual station number
idea: change the position number dynamically.
e.g 8 hosts 1-8
suppose host 5 just contended and got to send a frame, then it goes to position zero.--> 5 1 2 3 4 6 7 8 (now the previous position 5 has a position number of 1)

Extension of our algorithms for wireless communication networks
Difference: wireless signals (radio or infrared signals have a range)
Most of access point has a range within 10 meters.

- This means that sensing the channel by all hosts may not work.
- Also the radio signal is not unidirectional.



Q:/ What might go wrong if we use our collision models, such as CSMA?
A:/
e.g. A B C
A and C both want to send to B. But they are too far away from each other so though B found that there is a collision, but A and C don’t know it. So no re-transmission. →Hidden Station Problem

e.g. A B C D
If B wants to send to A and C wants to send to D. They in fact can send but both of them detect a collision. → Exposed station problem.

Q:/ How to solve it?

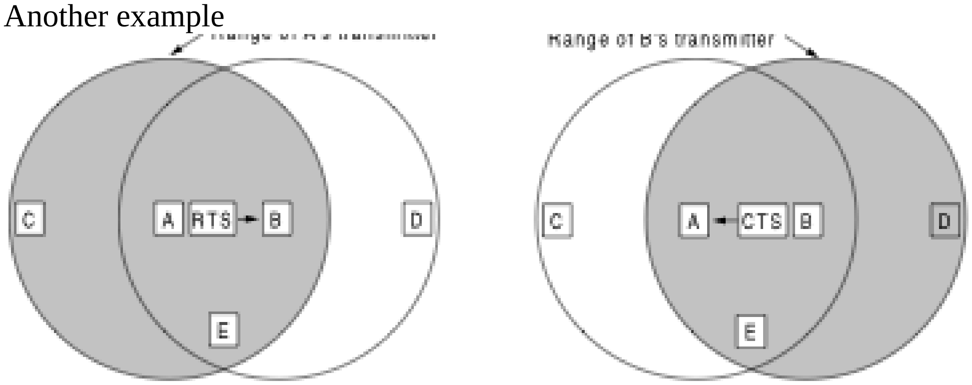
A:/ The key idea here is not about the sensing on the sender side, it is sensing on the receiver side.

MACA (multiple access with collision avoidance)
sender sends a RTS (request to send) to receiver. RTS includes the length of the frame to be sent
The receiver will send a CTS (clear to send) and CTS also includes the length of the frame.
Upon receiving CTS, the sender may send.

Everyone hearing RTS must wait long enough for the CTS to be received. Everyone hearing the CTS must wait long enough for the data frame to be transmitted. (they can get the size from the CTS)
Q:/ How does it solve hidden station and exposed station problem?

In example 1, B won't get the RTS correctly, so it won't issue CTS. → A and C wait and send again
In example 2, Both CTS will be received correctly so B and C can send at the same time.

Another example



Q:/ If A sends a RTS to B, how will other hosts behave?
A:/ C won't send anything until CTS is received by A. E won't do anything at all. D won't send any data until the data frame is done.

Note: MACA doesn't eliminate collision. e.g. when A and C both send RTS to B at the same time.