

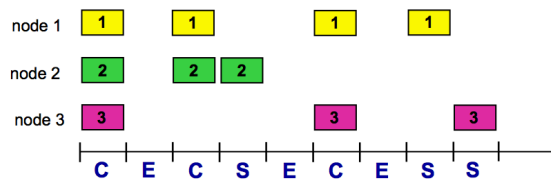
Link Layer (II)

Random access protocols

- when node has packet to send
 - transmit at full channel data rate R
 - no priori coordination among nodes
- two or more transmitting nodes → “collision”
- **random access MAC protocol** specifies:
 - how to detect collisions
 - how to recover from collisions (e.g., via delayed retransmissions)
- examples of random access MAC protocols:
 - slotted ALOHA
 - CSMA, CSMA/CD, CSMA/CA

Slotted ALOHA

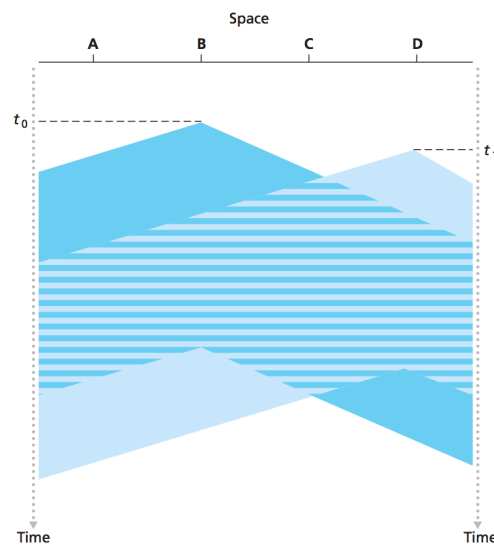
- **Assumption**
 - all packets (frames) same size
 - time divided into equal size slots (time to transmit 1 packet)
 - nodes start to transmit only at the beginning of a slot
 - nodes are synchronized
 - if 2 or more nodes transmit in slot, all nodes detect collision
- **Operation**
 - when node obtains fresh packet, transmits in next slot
 - if no collision: node can send new frame in next slot
 - if collision: node retransmits frame in each subsequent slot with prob. p until success



- Advantages
 - single active node can continuously transmit at full rate of channel
 - highly decentralized: only slots in nodes need to be in sync
 - simple
- Disadvantages
 - collisions, wasting slots
 - idle slots
 - clock synchronization
 -

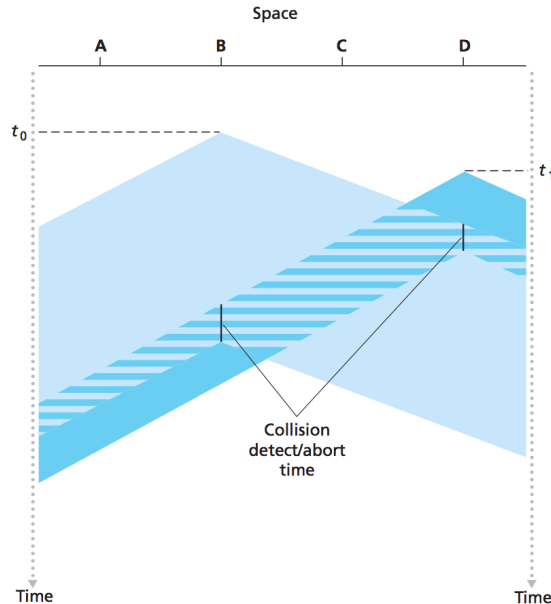
CSMA

- **CSMA: carrier sense multiple access**
- **listen before transmit:**
 - if channel sensed **idle**, **transmit** entire packet
 - if channel sensed **busy**, **defer** transmission
- human analogy: don't interrupt others!
- collisions:
 - **collisions can still occur:** propagation delay means two nodes may not hear each other's transmission
 - when occurs: **entire packet transmission time wasted**
 - distance & propagation delay play role in determining collision probability



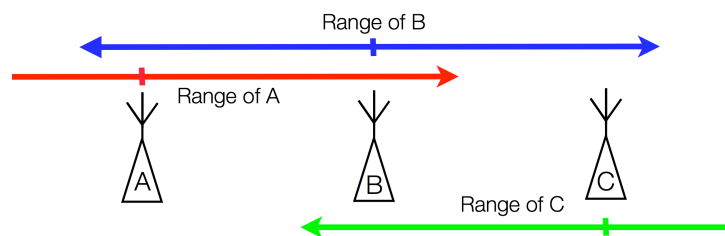
CSMA/CD (collision detection)

- CSMA/CD: **carrier sensing, deferral as in CSMA**
 - collisions detected within short time
 - colliding transmissions aborted, reducing channel wastage
- collision detection:
 - easy in wired LANs: measure signal strengths, compare transmitted, received signals
 - difficult in wireless LANs: received signal strength overwhelmed by local transmission strength (hidden terminal)
- human analogy: the polite conversationalist



- If senses channel idle, starts frame transmission. If senses channel busy, waits until channel idle, then transmit.
- If detects another transmission while transmitting, aborts and enters exponential backoff stage.
 - longer backoff interval with more collisions.

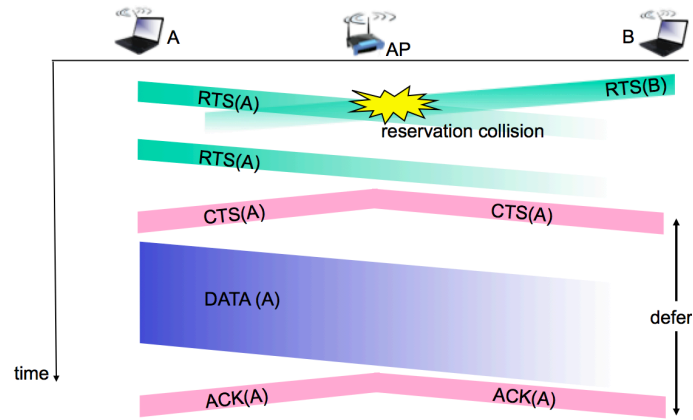
Hidden Terminal Problem



- A & C are in B's communication range. So, B can send messages to both A & C and can sense A and C's transmission.
- A can transmit to B and can sense B's transmission, but cannot detect C.
- C can transmit to B and can sense B's transmission, but cannot detect A.
- So, A doesn't know whether C is transmitting to B, even if using CSMA/CD. So as for C.
- Therefore, the collisions can happen when both A and C transmit to B simultaneously.
- We call this issue Hidden Terminals.

CSMA/CA (collision avoidance)

- avoid data frame collisions completely using small reservation packets



- RTS (request-to-send): sent by the sender
- CTS (clear-to-send): AP broadcasts in response to RTS
- all nodes hear CTS: sender transmits data frame, others defer transmissions