
# COMPUTER NETWORKS

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## Unit – 5 Link Layer and LAN Roadmap

- Introduction
- Error detection, correction
- Multiple access protocols
- LANs
  - addressing, ARP
  - Ethernet
  - switches
- A day in the life of a web request
- Physical layer
- Wireless LANs: IEEE 802.11

# COMPUTER NETWORKS

## Class 48 : Multiple Access Protocols : Learning Objectives

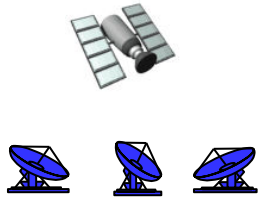
- Multiple Access
- Carrier Sense Multiple Access/Collision Detection

## Multiple access links protocols

shared wire (e.g., cabled Ethernet)

shared radio: 4G/5G

shared radio: WiFi



shared radio: satellite

humans at a cocktail party (shared air, acoustical)

Two types of “links”:

- point-to-point
  - point-to-point link between Ethernet switch, host
  - PPP for dial-up access
- broadcast (shared wire or medium)
  - old-fashioned Ethernet
  - upstream HFC in cable-based access network
  - 802.11 wireless LAN, 4G/4G. satellite

## Multiple access problem

How to coordinate the access of multiple sending and receiving nodes to a shared broadcast channel

- Broadcast channels are often used in
  - LANs,
  - Networks that are geographically concentrated in a single building (or on a corporate or university campus).

- Can I say Television as an example for Broadcasting??
  - Traditional television-one-way broadcast
  - While nodes on a computer network- broadcast channel can both send and receive

## Human Protocols for sharing Broadcast channel

- Give everyone a chance to speak.
- Don’t speak until you are spoken to.
- Don’t monopolize the conversation.
- Raise your hand if you have a question.
- Don’t interrupt when someone is speaking.
- Don’t fall asleep when someone is talking

## Multiple access protocols

- Single shared broadcast channel
- Two or more simultaneous transmissions by nodes: interference
  - *collision* if node receives two or more signals at the same time

When multiple nodes are active in Broadcast channel,

- coordinate the transmissions of the active nodes.

### Multiple access protocol

- Distributed algorithm that determines how nodes share channel, i.e., determine when node can transmit
- Communication about channel sharing must use channel itself!
  - no out-of-band channel for coordination

## An ideal Multiple access protocol

*Given:* Multiple access channel (MAC) of rate *R* bps

*Desirable characteristics:*

1. when one node wants to transmit, it can send at rate *R*.
2. when M nodes want to transmit, each can send at average rate *R/M*
3. Fully decentralized:
   - no special node to coordinate transmissions
   - no synchronization of clocks, slots
4. simple

## MAC protocols : Taxonomy

Three broad classes:

- Channel partitioning
  - divide channel into smaller “pieces” (time slots, frequency, code)
  - allocate piece to node for exclusive use
  - Eg: TDM,FDM,CDMA
- *Random access*
  - channel not divided, allow collisions
  - “recover” from collisions
  - Eg. ALOHA,CSMA deployed in Ethernet
- “Taking turns”
  - nodes take turns, but nodes with more to send can take longer turns

## CSMA ( Carrier Sense Multiple Access)

Simple CSMA: listen before transmit:(Carrier Sensing)

- if channel sensed idle: transmit entire frame
- if channel sensed busy: defer transmission

- Human analogy: don't interrupt others!

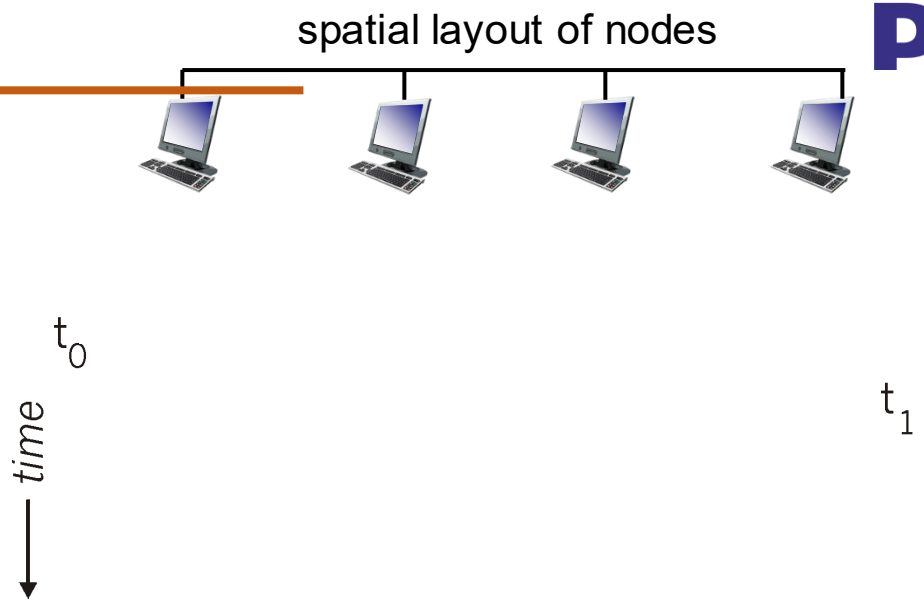
CSMA/CD: CSMA with *collision detection*

- collisions *detected* within short time
- colliding transmissions aborted, reducing channel wastage
- collision detection easy in wired, difficult with wireless

- human analogy: the polite conversationalist

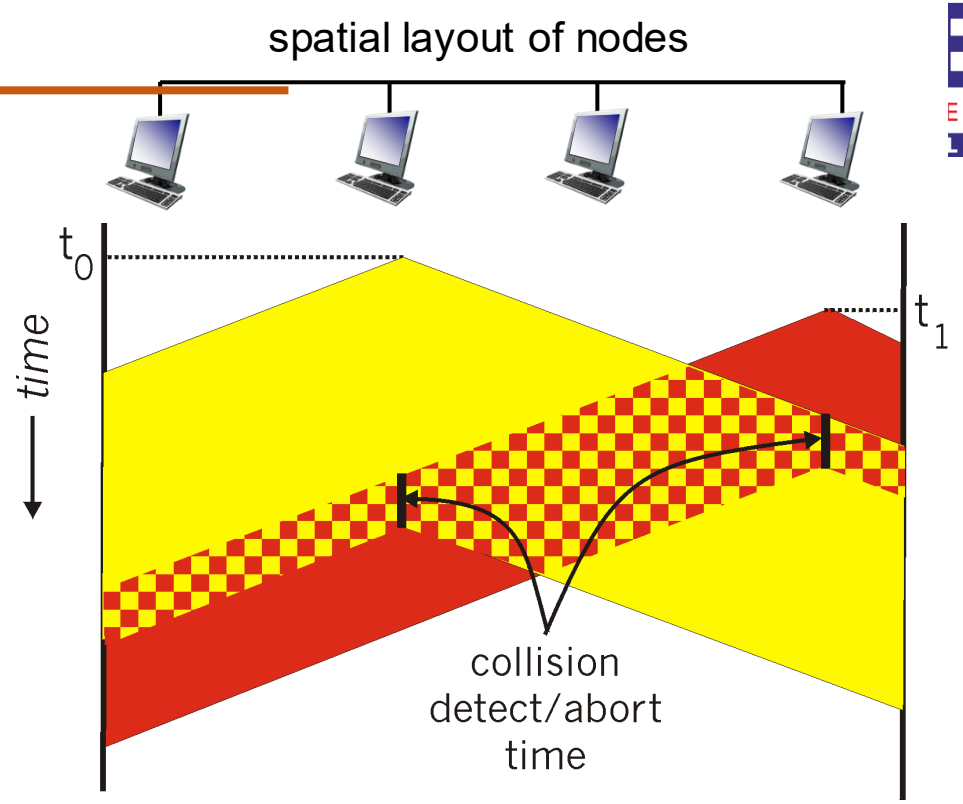
## CSMA : Collisions

- Collisions *can* still occur with carrier sensing:
  - Propagation delay means two nodes may not hear each other's just-started transmission
- Collision: entire packet transmission time wasted
  - Distance & propagation delay play role in in determining collision probability



## CSMA / CD

- CSMA/CD reduces the amount of time wasted in collisions
  - transmission aborted on collision detection



## Ethernet CSMA / CD Algorithm

1. NIC receives datagram from network layer, creates frame
2. If NIC senses channel:

   if idle: start frame transmission.

   if busy: wait until channel idle, then transmit
3. If NIC transmits entire frame without collision, NIC is done with frame !
4. If NIC detects another transmission while sending: abort, send jam signal
5. After aborting, NIC enters *binary (exponential) backoff:*
   - after *m*th collision, NIC chooses *K* at random from $\{0,1,2, \ldots, 2^m-1\}$. NIC waits $K \cdot 512$ bit times, returns to Step 2
   - more collisions: longer backoff interval

## CSMA / CD Efficiency

- $T_{prop}$ = max prop delay between 2 nodes in LAN
- $t_{trans}$ = time to transmit max-size frame

$$efficiency = \frac{1}{1 + 5t_{prop}/t_{trans}}$$

- efficiency goes to 1
  - as $t_{prop}$ goes to 0
  - as $t_{trans}$ goes to infinity
- better performance than ALOHA: and simple, cheap, decentralized!


# THANK YOU

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