Computer Networks (CISC3001)

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Tutorial

- Midterm
- ICMP application

Midterm

1. Regarding the Circuit Switching and Packet Switching, the following descriptions are true: (b)(c)(d)

(a) Packet Switching requires call-setup and resource reservation before transmission
(b) Packet Switching may suffer from packet loss and network congestions
(c) Packet Switching can achieve the multiplexing-gain when the Internet users' traffic is bursty
(d) Circuit Switching can usually provide a guaranteed performance for sending the users' data

Packet switching versus circuit switching

is packet switching a "slam dunk winner?"

- great for bursty data
  - resource sharing to achieve the "multiplexing gain"
  - simpler, no call setup and no tear-up
- excessive congestion possible: packet delay and loss
  - protocols needed for reliable data transfer, congestion control

	Circuit Switching	Packet Switching
Resource (e.g., bandwidth) reservation	Yes	No (on-demand manner)
Call setup and tear up	Yes	No (very simple)
Number of served users	Limited due to limited link capacity	Multiplexing gain
Performance	Guaranteed performance	Packet delay, loss, and network congestion
Application	Telephone networks	Internet, and computer networks

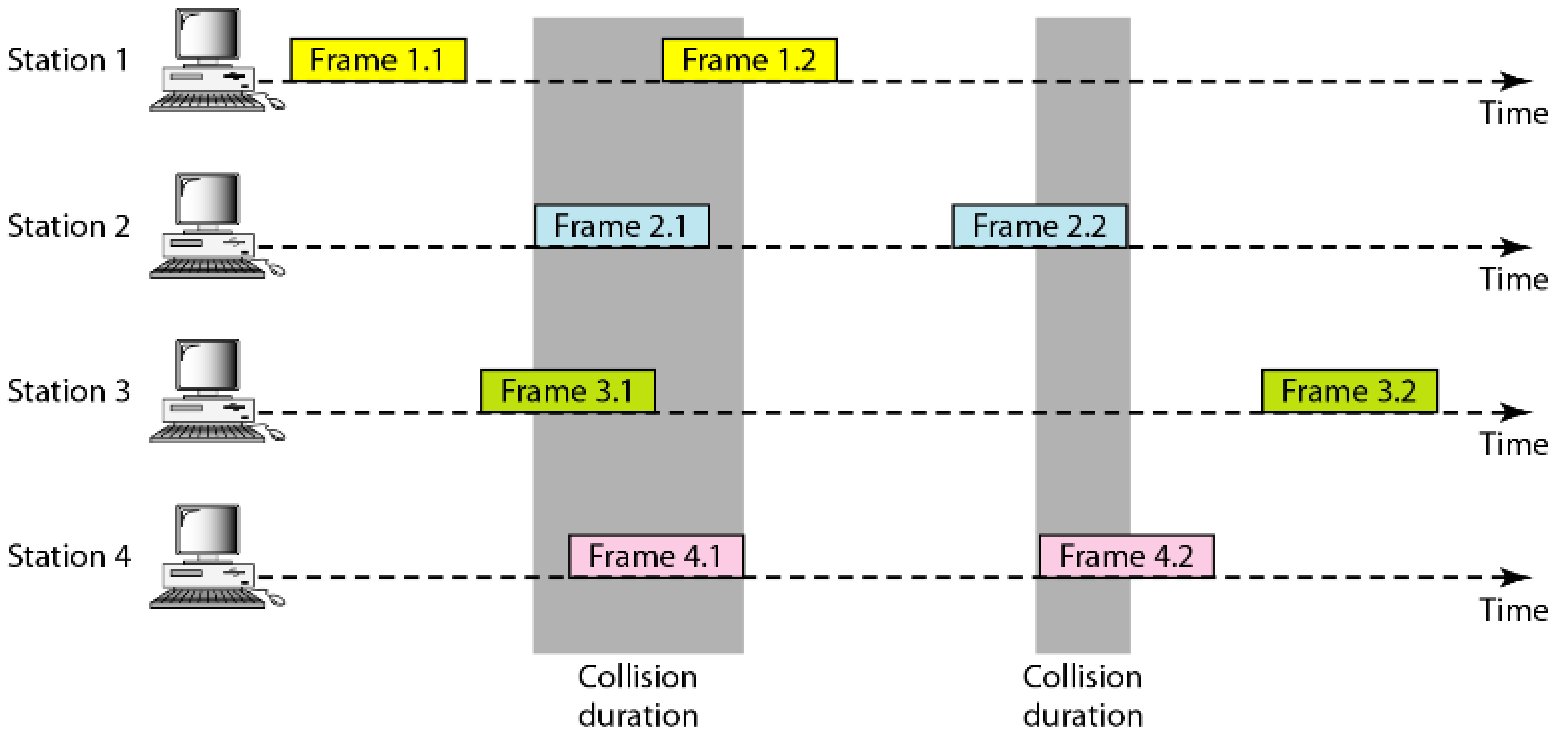
Midterm

2. What are the maximum efficiency of the slotted ALOHA protocol and the efficiency of the pure ALOHA protocol? (d)

(a) 36% and 72%
(b) 36% and 24%
(c) 24% and 18%
(d) 36% and 18%

Pure (unslotted) ALOHA

- unslotted Aloha: simpler, no synchronization
- same size of all frames
- when frame first arrives
  - transmit immediately (no time synchronization)



Pure ALOHA efficiency

P(success by given node) = P(node transmits) ·

P(no other node transmits in $[t_0\text{-}1, t_0]$ ·

P(no other node transmits in $[t_0, t_0+1]$

$$= p \cdot (1\text{-}p)^{N-1} \cdot (1\text{-}p)^{N-1}$$

$$= p \cdot (1\text{-}p)^{2(N-1)}$$

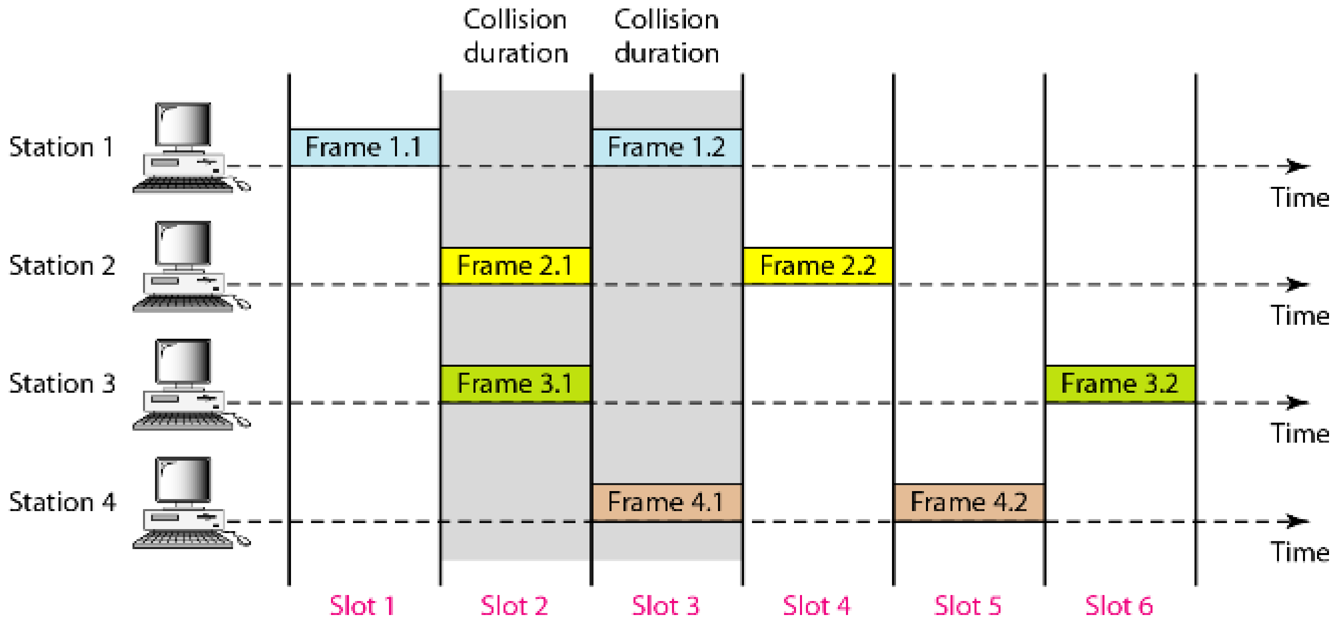
… choosing optimum p and then letting $n \longrightarrow \infty$

$$= 1/(2e) = .18$$

Slotted ALOHA

assumptions:

- all frames same size
- time divided into equal size slots (time to transmit 1 frame, i.e., same size of all frame)
- nodes start to transmit only slot beginning
- nodes are synchronized
- if 2 or more nodes transmit in slot, all nodes detect collision



Slotted ALOHA efficiency

efficiency: long-run fraction of successful slots (many nodes, all with many frames to send)

- *suppose: N* nodes with many frames to send, each transmits in slot with probability p
- prob that given node has success in a slot = $p(1-p)^{N-1}$
- prob that *any* node has a success = $Np(1-p)^{N-1}$

- max efficiency: find p^* that maximizes $Np(1-p)^{N-1}$
- for many nodes, take limit of $Np^*(1-p^*)^{N-1}$ as N goes to infinity, gives:

  max efficiency = 1/e = .37

at best: channel used for useful transmissions 37% of time!

!

Midterm

3. Suppose that we consider the store-forward-delay in packet switching. As shown in Figure 1, a source host send 5 packets to a destination host via one router. The size of each packet is L bits, and the bandwidth of each link is R bps. The source host sends the five packets in sequence. Assume that only the transmission delay in considered in this scenario. The overall latency for the destination host to receive all the 5 packets is: (d)

(a) 3*L/R
(b) 4*L/R
(c) 5*L/R
(d) 6*L/R

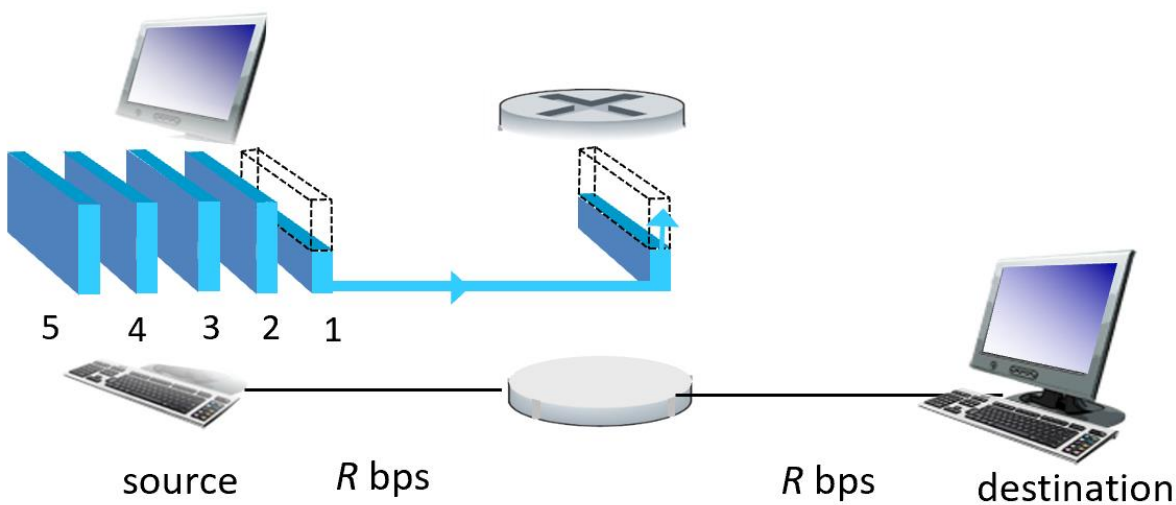
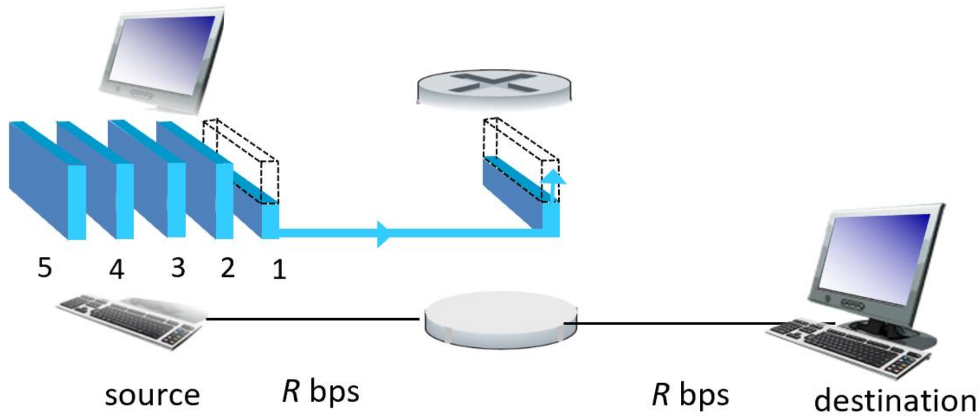
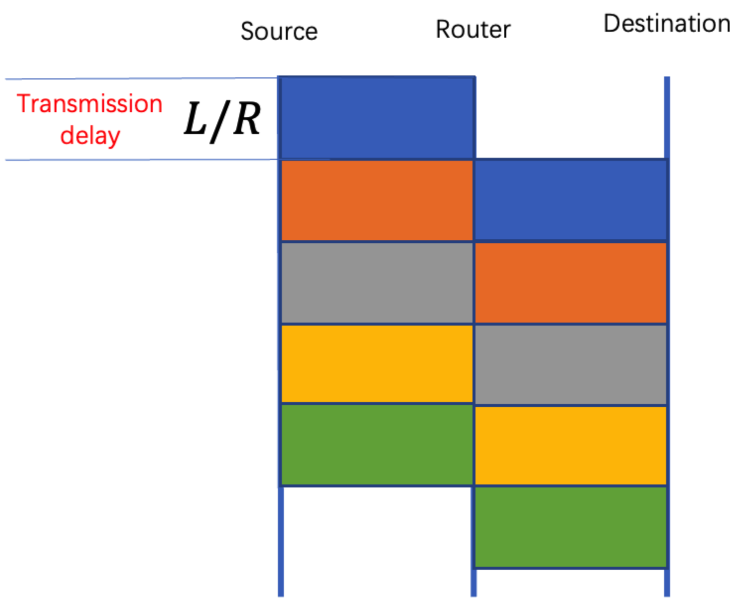


Figure 1

Midterm





	Source	Router	Destination
L/R	2345	1	
2*L/R	2345	2	1
3*L/R	345	3	12
4*L/R	45	4	123
5*L/R	5	5	1234
6*L/R			12345

Midterm

4. Consider a packet delivery shown in Figure 2 below. A sending-host sends a packet to a receiving-host via three routers. The packet size is of L. The distance between two different routers and the distance between host and router are denoted by d. The link bandwidth is denoted by R. The signal propagation in each link is denoted by v. For each individual router, its total node processing delay and queuing delay is denoted by T. The overall delay for the whole packet to be received by the receiving-host is (c)

(a) $3\frac{d}{v} + 3\frac{L}{R} + 3T$

(b) $3\frac{d}{v} + 4\frac{L}{R} + 3T$

(c) $4\frac{d}{v} + 4\frac{L}{R} + 3T$

(d) $4\frac{d}{v} + 4\frac{L}{R} + 4T$

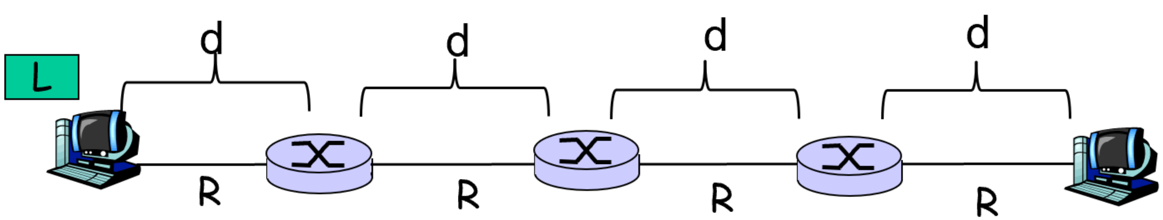
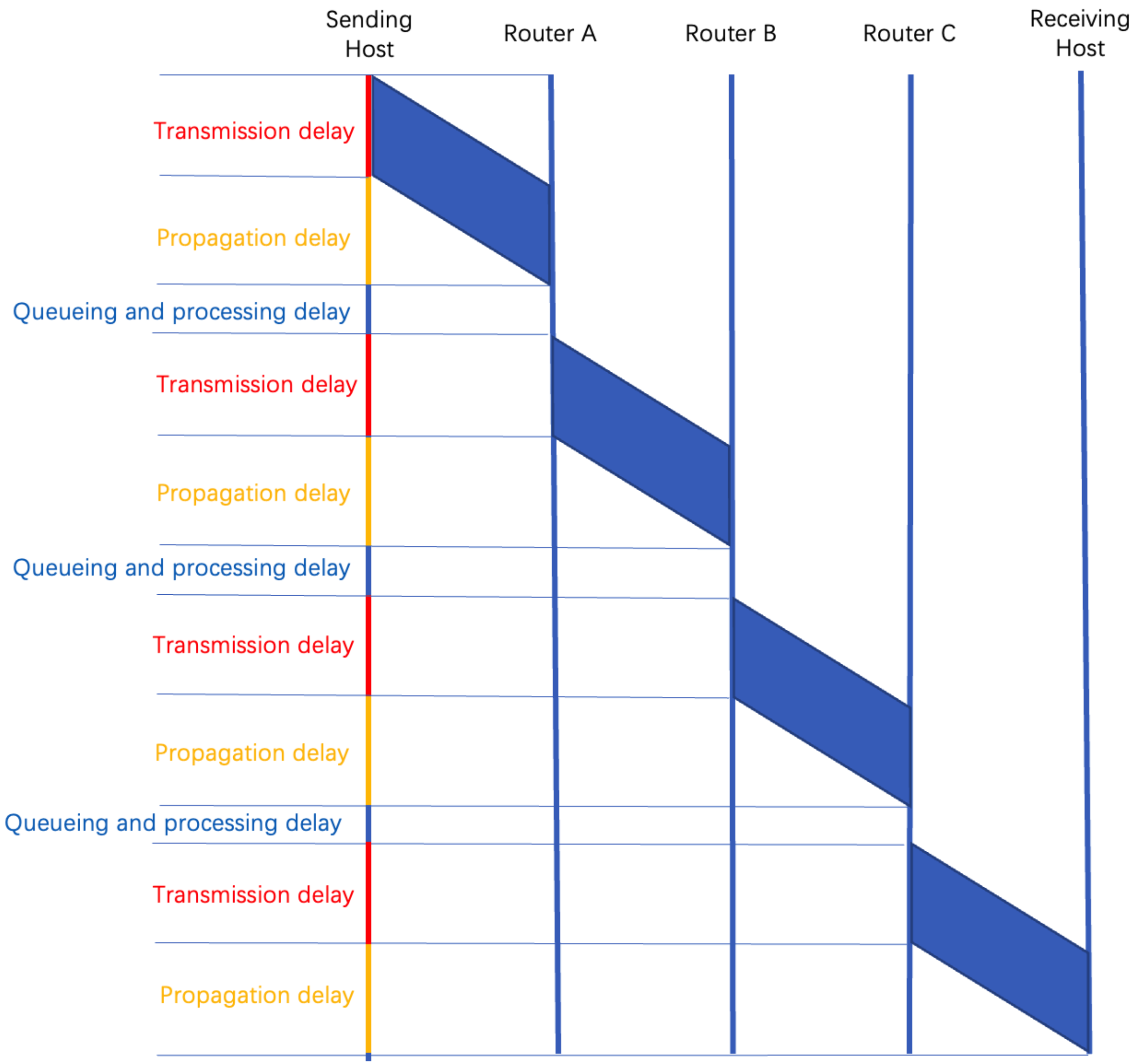


Figure 2

Midterm



Sending Host
Router A
Router B
Router C
Receiving Host
Transmission delay
Propagation delay
Queueing and processing delay
Transmission delay
Propagation delay
Queueing and processing delay
Transmission delay
Propagation delay
Queueing and processing delay
Transmission delay
Propagation delay

Midterm

5. The following descriptions are true: (a)(c)(d)

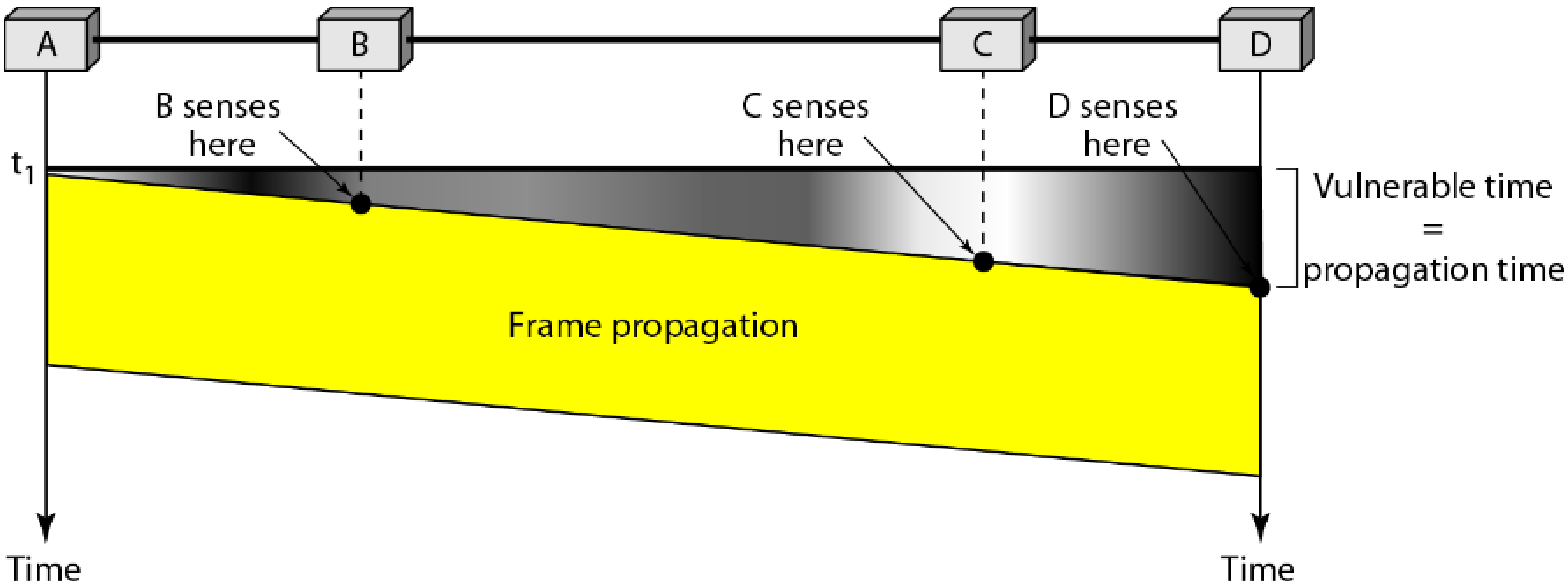
(a) Ethernet uses CSMA/CD with backoff as the medium access control protocol.
(b) Carrier sensing can completely avoid collisions.
(c) Layer-2 switch uses self-learning to generate the switch table
(d) IEEE 802.11 uses CSMA/CA with backoff as the medium access control protocol.

Summary of MAC protocols

- *channel partitioning,* by time, frequency or code
  - Time Division, Frequency Division
- *taking turns*
  - polling from central site, token passing
  - Bluetooth, FDDI, token ring
- *random access* (dynamic),
  - ALOHA, S-ALOHA, (no sensing required)
  - CSMA (sensing avoid collision)
  - carrier sensing: easy in some technologies (wire), hard in others (wireless)
  - CSMA/CD used in Ethernet
  - CSMA/CA used in 802.11 (WiFi)

CSMA collisions

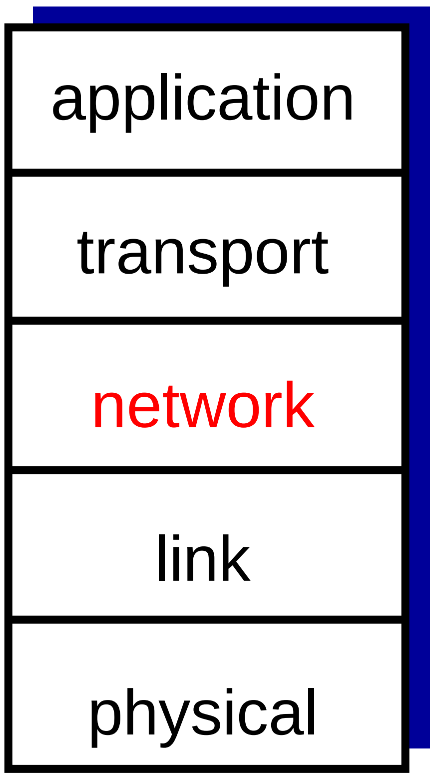
- collisions *can* still occur: propagation delay means two nodes may not hear each other's transmission



Midterm

6. Regarding the layered protocol in Internet, please specify the names of the five layers in the TCP/IP reference model.

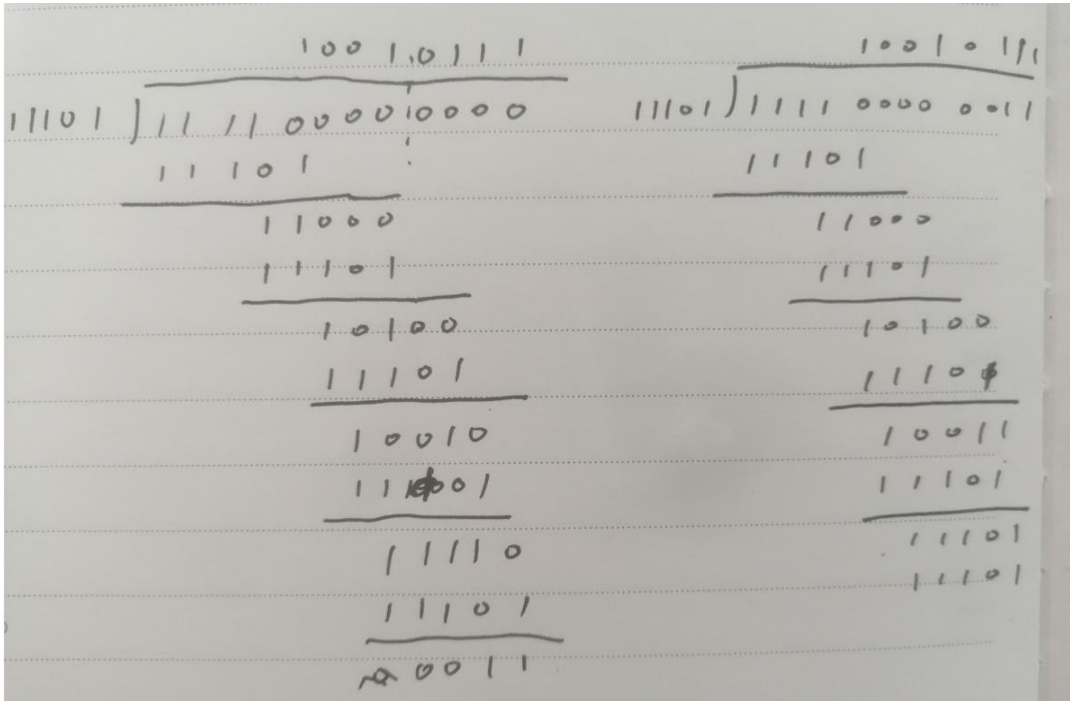
- *application:* supporting network applications
  - FTP, SMTP, HTTP
- *transport:* process-process data transfer
  - TCP, UDP
- *network:* routing of datagrams from source to destination
  - IP, routing protocols, ICMP
- *link:* data transfer between neighboring network elements
  - Ethernet, 802.11 (WiFi), PPP
- *physical:* bits "on the wire"



Midterm

7. Regarding the cyclic redundancy check (CRC), suppose that the data bits D = “11110000”, and the generator G= “11101”.

(a) What are the corresponding CRC bits?
(b) What are the bits sent out by the sender?



Midterm

8. Consider an MAC address represented by "1A-2F-BB-76-09-AD". What is this MAC address in the format of 48 bits?

Midterm

9. Regarding the ARP, please answer the following two questions.

(a) What does the abbreviation of “ARP” represent for and what is the purpose of ARP?
(b) If a host sends out ARP query message, what is the destination MAC it should use?

(a) Address Resolution Protocol. Find the mapping from IP address to MAC address.
(b) “FF-FF-FF-FF-FF-FF”

ARP protocol: same LAN

- A wants to send datagram to B
  - B's MAC address not in A's ARP table.
- A broadcasts ARP query packet, containing B's IP address
  - destination MAC address = FF-FF-FF-FF-FF-FF
  - all nodes on LAN receive ARP query
- B receives ARP packet, replies to A with its (B's) MAC address
  - frame sent to A's MAC address (unicast)
- A caches (saves) IP-to-MAC address pair in its ARP table until information becomes old (times out)
  - soft state: information that times out (goes away) unless refreshed
- ARP is "plug-and-play":
  - nodes create their ARP tables *without intervention from net administrator*

Midterm

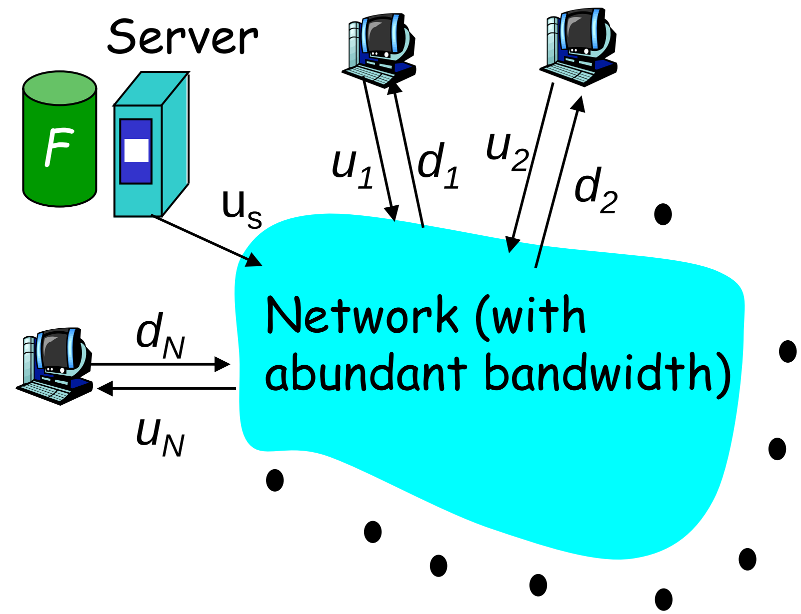
10. Suppose that we have a file of size F (Mbits) and we need to distribute this file from one server to a group of users. The number of the users is N. Assume that the server's uploading bandwidth is u_s (Mbits), and all users have an equal uploading bandwidth u_i (Mbits) and equal downloading bandwidth d_i (Mbits).

(a) Suppose that all users use the peer-to-peer service model, what is the minimum duration for all users to obtain a complete copy of the entire file? Please give the detailed reasons.

(b) Suppose that all users use the client-server model, what is the minimum duration for all users to obtain a complete copy of the entire file? Please give the detailed reasons.

Server-Client Model: File distribution time

- server sequentially sends N copies:
  - NF/u_s time
- client i takes F/d_i time to download

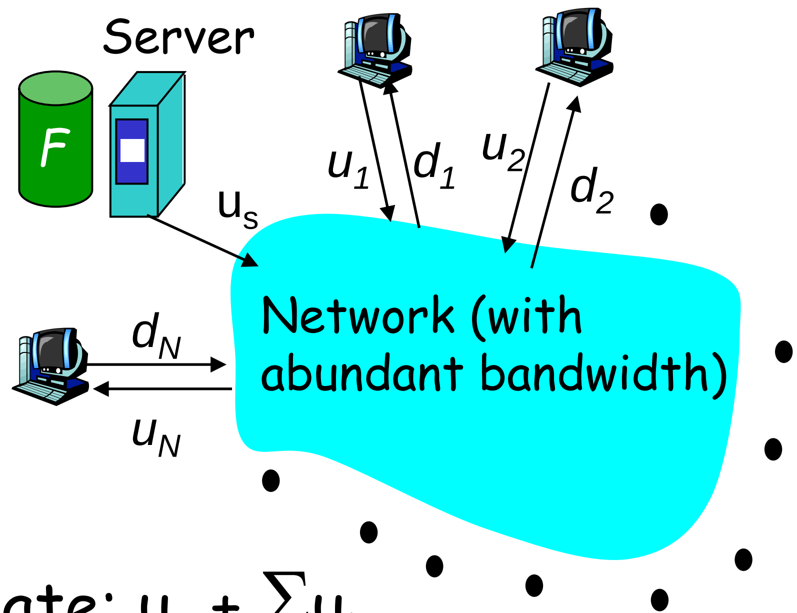


Time to distribute F to N clients using client/server approach $= d_{cs} = \max \{ NF/u_s, F/\min_i(d_i) \}$

increases linearly in N (for large N)

P2P model: File distribution time

- server must send one copy: F/u_s time
- client i takes F/d_i time to download
- NF bits must be downloaded (aggregate)



- fastest possible upload rate: $u_s + \Sigma u_i$

$$d_{P2P} = \max \{ F/u_s, F/\min_i(d_i), NF/(u_s + \Sigma u_i) \}$$