CS3640

The finals: format and choice

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Based on your feedback, **I'm letting you choose your own path**

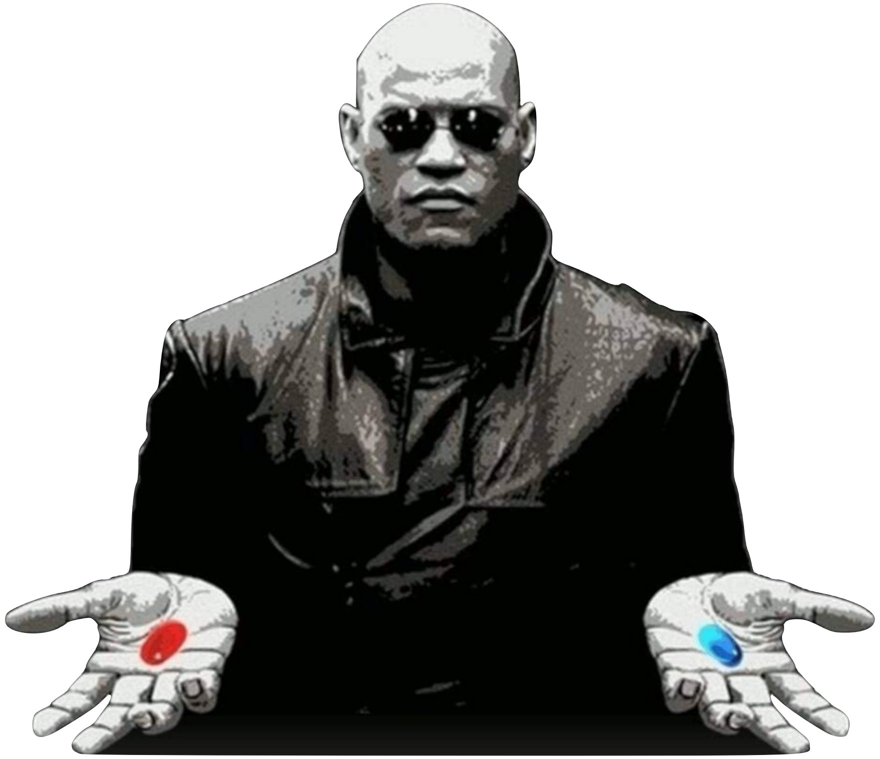
Attempts: 38 out of 38

What is your most preferred format for the final exam?

In-class, pen-paper exam (similar to midterm)	25 respondents	66 %
In-person technical interview	8 respondents	21 %
I'm ok with either format	5 respondents	13 %

Comments worth noting

- Would have loved a take-home, but I understand why this had to change
- No multiple choice exam please
- Make it 50% multiple-choice and 50% free-style
- Very unprofessional



I will offer both **in-class written exam** and **in-person interview**

Structure of the Tech Interview

1-on-1

conducted by your instructor

20%

your interview determines a fifth of your final grade

May 1 - 5

pick a slot between 10am - 2pm that works best for you

15 mins

in which you will be asked 4 questions, all carrying equal weights

Q banks

Each question comes from a distinct category (or bank); more in the next slide

Structure of the Written Exam

1 hour

you will answer 4 questions, all carrying equal weights

20%

your interview determines a fifth of your final grade

May 2

12:30 - 1:30pm (in-class); alternate slots for SDS

Question Choice

Similar in difficulty level to the midterm; a well prepared student should expect to score the same irrespective of the format choice

Question Categories

Category	Example questions and topics	Weight
Networking **Principles**	*Internet's hour-glass model; Middleboxes*	25%
Networking **Protocols**	*A day in the life of a packet*	25%
Networking **Problems**	*Construct Dijkstra's LS table*	25%
Networking **Practice**	*SDN; Cloud computing; Solar superstorms*	25%

Each category has a bank of 5-8 question; for each interviewee, I will generate a sequence of four random numbers that will determine the specific questions picked from each bank.

*There will be an optional **bonus question** carrying 10% extra points (only for the written exam)*

What would I advice?

A well prepared student should expect to score the same irrespective of the format choice

“In theory, theory and practice are the same. In practice, they are not.” — Albert Einstein

IOWA

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Link Layer (1): Services and Protocols

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Multiple Access Protocols

sharing a single broadcast channel amongst multiple nodes

1 Channel Partitioning Protocols

divide channel into small pieces (e.g., time slots, frequency), and allocate each piece to one node

2 Random Access Protocols

do not divide the channel, and allow nodes to transmit at any time, but detect/recover from collisions

3 Taking-turns Protocols

nodes take turn to send frames; this dynamism achieves balance between the first two class of protocols

Random Access Protocols

Random Access Protocols

- When node has packet to send,
  - ➡ it transmits at full channel data rate R
  - ➡ no *a priori* coordination among nodes
- If two or more nodes transmit simultaneously: collision
- Random Access Protocols specify
  - ➡ how to detect collisions
  - ➡ how to recover from collisions
- Examples of random access protocols
  - ➡ ALOHA, slotted ALOHA (impolite speakers)
  - ➡ CSMA, CSMA/CD (more polite speakers)

Slotted ALOHA

Channel assumptions

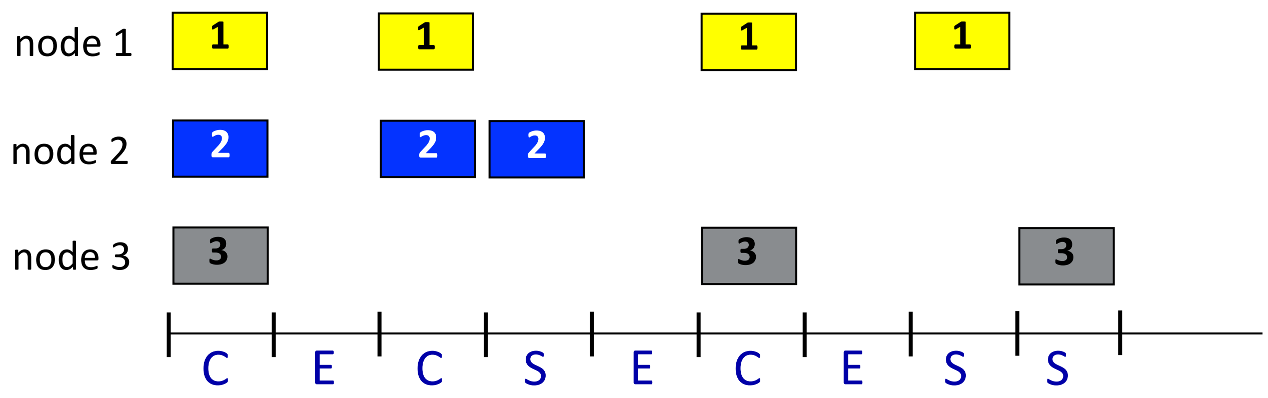
- all frames are of same size
- time is divided into equal length slots *(e.g., time to transmit 1 frame)*
- clocks at all nodes are synchronized
- nodes start to transmit only at the beginning of a slot
- if two or more nodes transmit in slot, all nodes detect collision

Protocol operation

- When a node has a new frame, it transmits it in next slot
- If no collision is detected: node can send any new frame in next slot
- If collision is detected: node retransmits the frame in each subsequent slot with probability **p** until success

randomization – *why?*

Slotted ALOHA



C: collision
S: success
E: empty

Pros

- single active node can continuously transmit at full rate of channel
- highly decentralized
- simple

Cons

- a collision wastes the full slot
- leaves idle slots even when nodes have data to transmit
- clock synchronization

Carrier Sense Multiple Access (CSMA)

Simple CSMA: listen before transmit

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

human analogy: don't interrupt while others are talking!

CSMA/CD: CSMA with collision detection

- collisions detected within short time
- colliding transmissions are immediately aborted, thus reducing channel wastage

human analogy: a polite conversationalist

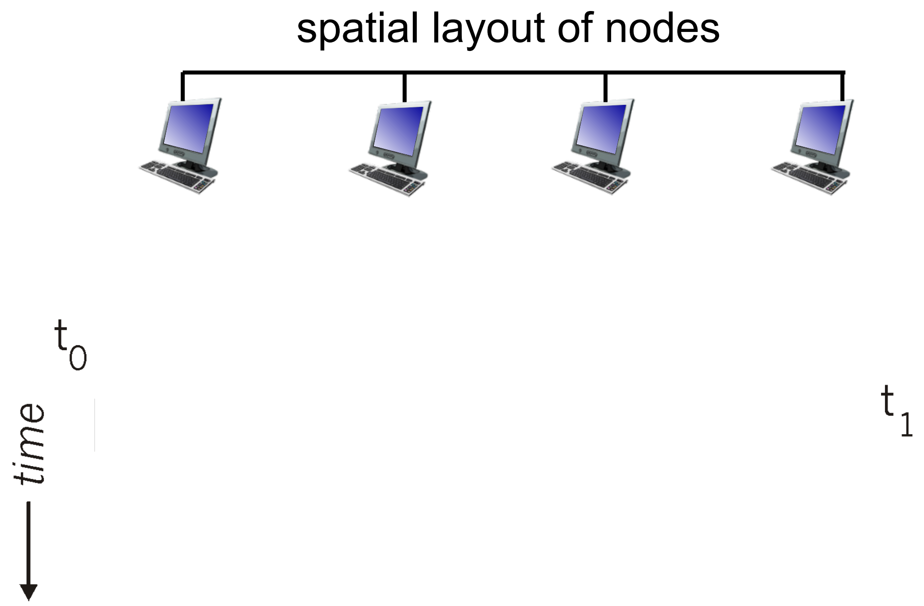
Simple CSMA

Collisions can still occur with carrier sensing:

- propagation delay means two nodes may not hear each other's just-started transmission

When there is a collision: entire packet transmission time is wasted

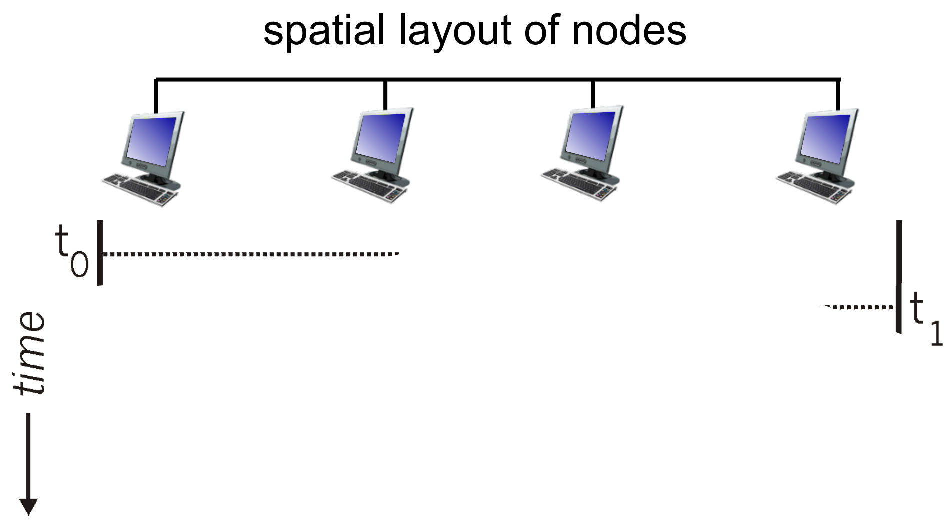
- distance and propagation delay play role in in determining collision probability



CSMA/CD

CSMA/CD reduces the amount of time wasted in collisions

- transmission aborted on collision detection



Ethernet CSMA/CD algorithm

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

   if idle: start frame transmission.

   if busy: wait until channel idle, then transmit
3. If entire frame transmitted without collision - done!
4. If another transmission detected while sending: abort, send jam signal
5. After aborting, enter binary exponential backoff
   - after m^{th} collision, chooses K at random from $\{0,1,2, \ldots, 2^m - 1\}$. Ethernet waits K slots, returns to Step 2
   - more collisions for the same frame: longer backoff interval

Taking-Turns Protocols

Taking Turns MAC Protocols

Channel Partitioning MAC Protocols

- inefficient at low load: if only one node is active, 1/N bandwidth is allocated to it!
- allows sharing the channel *efficiently and fairly* at high load

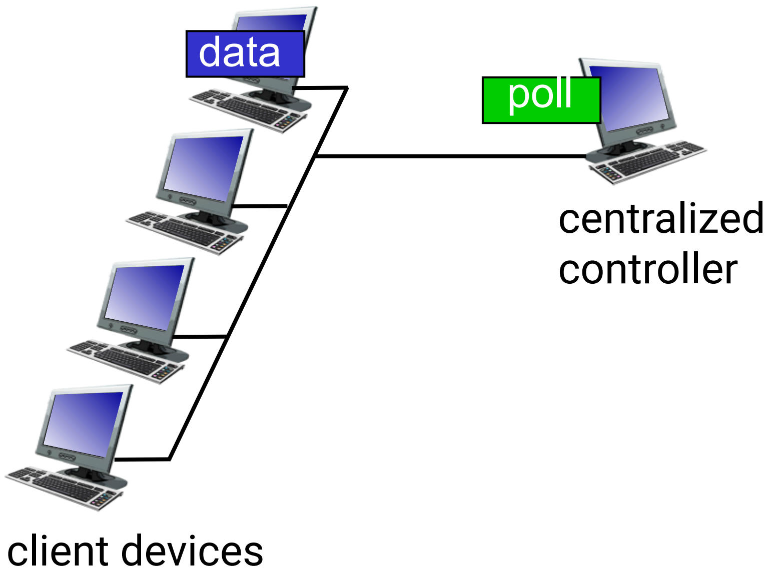
Random Access MAC Protocols

- *efficient at low load*: a single node can fully utilize channel
- experiences overhead at high load due to collisions

Taking Turns Protocols *look for best of both worlds!*

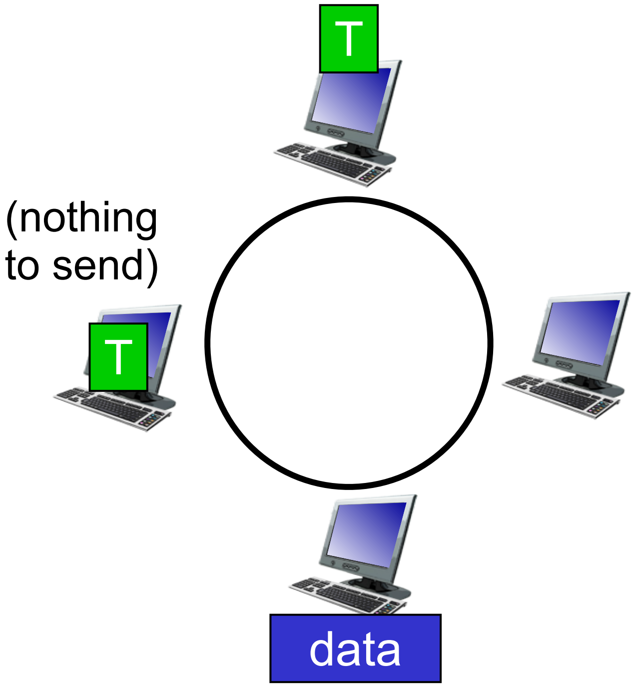
Polling Protocols

- a controller "invites" other nodes to transmit in turn
- typically used with "dumb" devices
- suffers from polling overhead, latency, and single point of failure (controller)



Token Passing Protocols

- control token message explicitly passed from one node to next, sequentially
- transmit while holding token
- suffers from token overhead, latency, and single point of failure (token)



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Link Layer (2): Addressing and Ethernet

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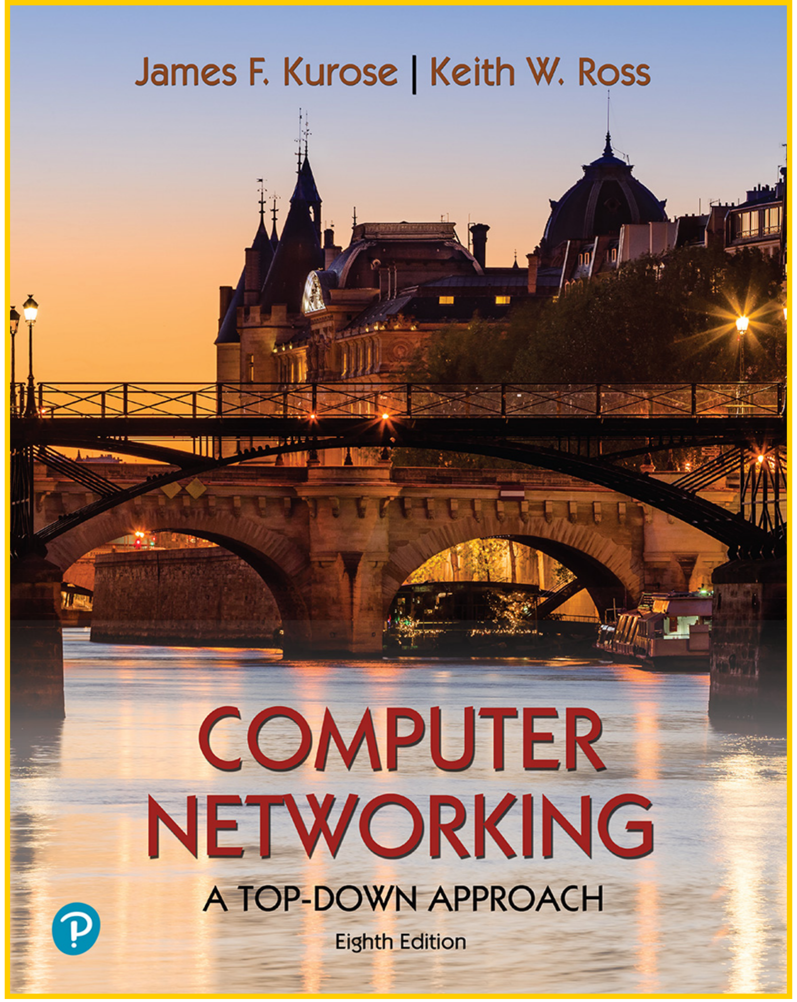
Lecture goals

second chapter on link layer covering principles, practices, and protocols

- *Link layer addressing*
- *Ethernet*



Chapter 6.4

Addressing in the Link Layer

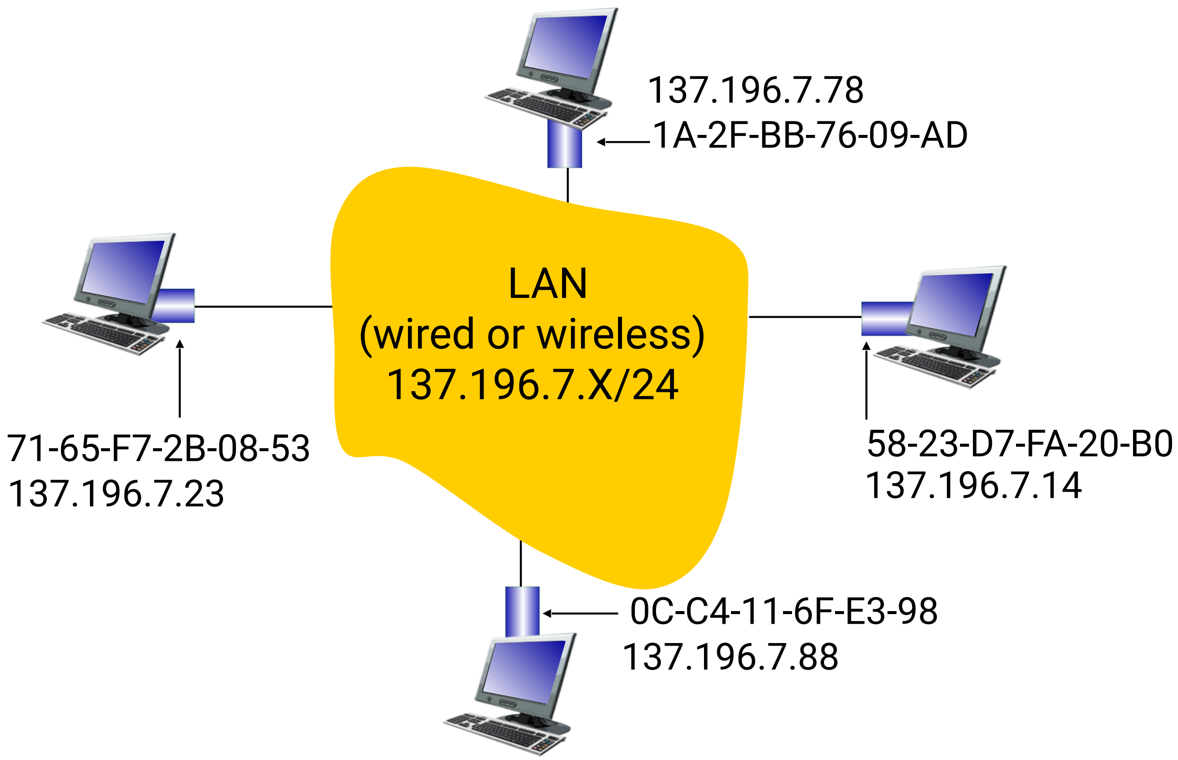
every network interface will have a network layer address and a link layer address

IP Address

- 32 bits (IPv4) or 128 bits (IPv6)
- E.g., 142.250.191.206 *(usually in decimal)*
- used in layer-3 routing and forwarding

MAC/Ethernet/Physical Address

- 48-bit addressed burned in NIC
- E.g., 14:7d:da:69:d4:55 *(usually in hex)*
- used in layer-2 switching



Addressing in the Link Layer

- MAC address allocation is administered by IEEE
- Every manufacturer buys a portion of MAC address space (to assure uniqueness)
- Portability
  - ➡ *NICs retain their MAC address when they move from one LAN to another*
  - ➡ *IP address is not portable: depends on IP subnet to which node is attached*

MAC address : IP address :: Social Security Number : Postal address

The Three Network Identities

Host name

IP Address

Phy Address

```
[sshastri@fastx05 sshastri]$ hostname
fastx05.divms.uiowa.edu
[sshastri@fastx05 sshastri]$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 128.255.96.97  netmask 255.255.255.0  broadcast
        ether 3c:ec:ef:12:4c:4e  txqueuelen 1000  (Ethernet)
        RX packets 112392458  bytes 98735093396 (91.9 GiB)
        RX errors 0  dropped 200  overruns 0  frame 0
        TX packets 95649591  bytes 84092615268 (78.3 GiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisi
```

Q: Is having multiple network identities redundant? Are they useful?

Spot Quiz (ICON)