ECE 50863
Computer Network Systems

Mid Term Review

Sanjay Rao

What to expect

- Around 8-9 questions
- Conceptual questions based on lecture
  - True/False. Make sure to provide justifications unless told otherwise.
- Short conceptual questions [2 -3 lines]
  - E.g. “why is X done”?
- Problem-oriented
  - Variants of homework/practice problems

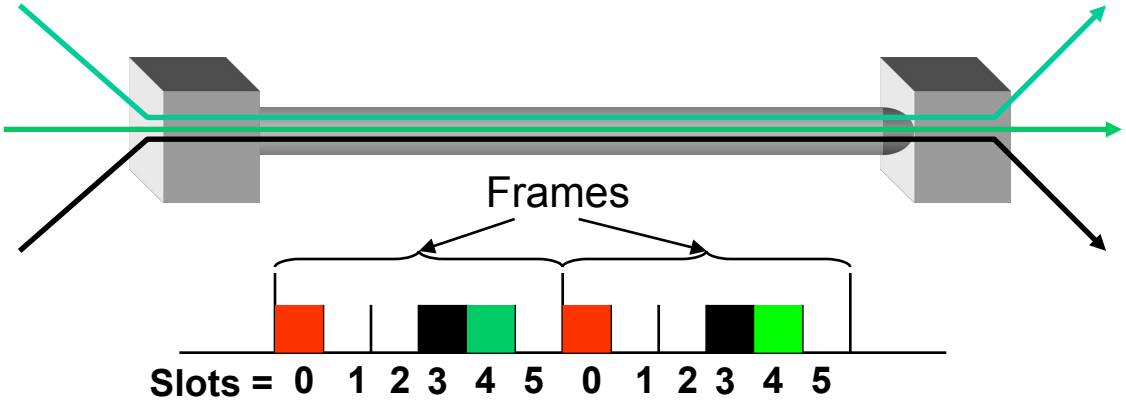
Advice

- Being well-prepared important
- Important to handle homework variants fast/well.
- Conceptual questions:
  - Based on lecture material, class discussions, tests understanding
- Questions will try to test basic understanding, go beyond straight-forward homework tweaks.

Network Architecture

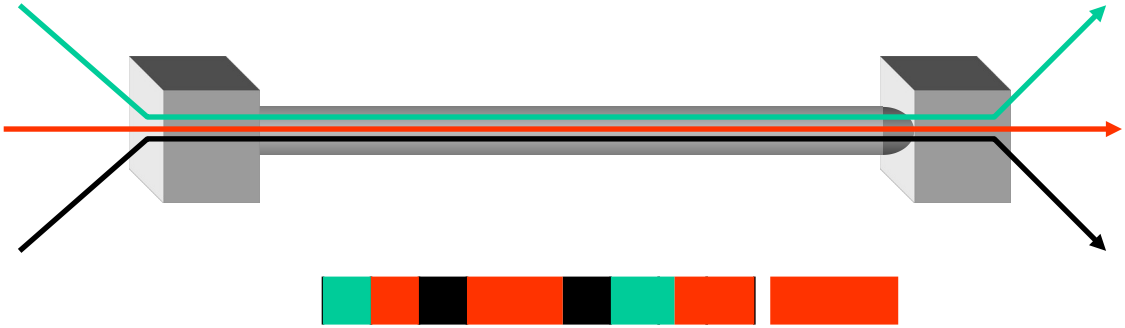
- Terminology: End Systems, Hosts, etc.
- Multiplexing/Demultiplexing, Pkt Vs. Circuit Switch
- Internet Layered Architecture and Layering
  - Functionality in various layers
- Protocols, Standards
- Network Performance:
  - RTT, Delay-Bandwidth Product, Transfer time

Circuit Switching: E.g. Time Division Multiplexing



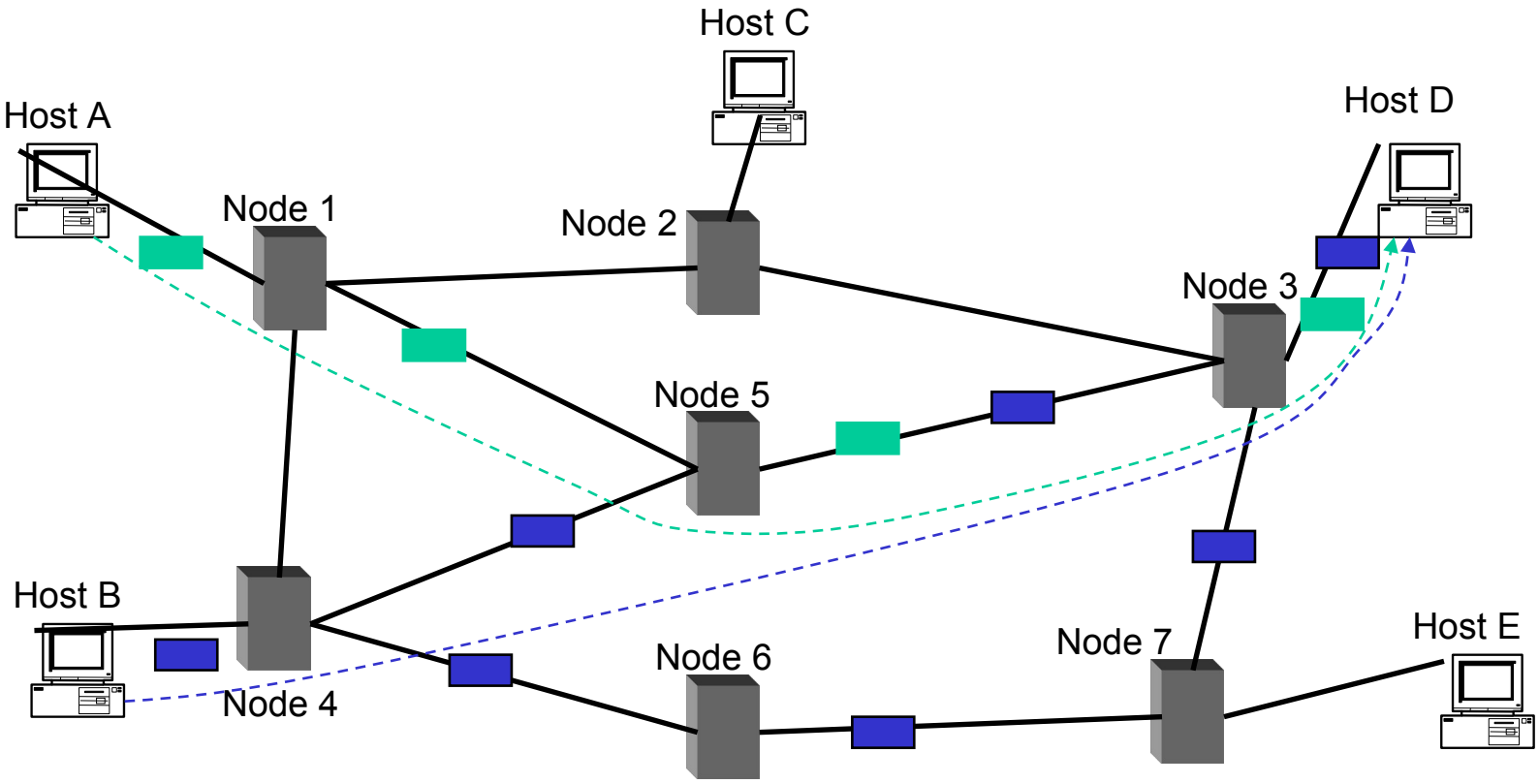
- Time divided in frames and frames divided in slots
- Relative slot position inside a frame determines which conversation the data belongs to
  - E.g., slot 0 belongs to red conversation
- Issue:
  - If a conversation does not use its circuit the capacity is lost!

Packet Switching: Statistical Multiplexing



- Data from any conversation can be transmitted at any given time
  - A single conversation can use the entire link capacity if it is alone

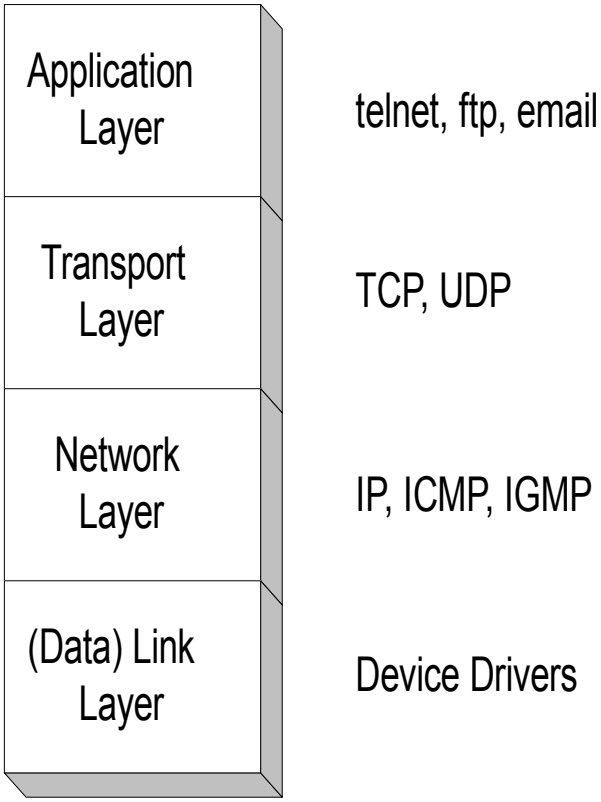
Datagram Packet Switching



- Each packet is independently switched
  - Each packet header contains destination address

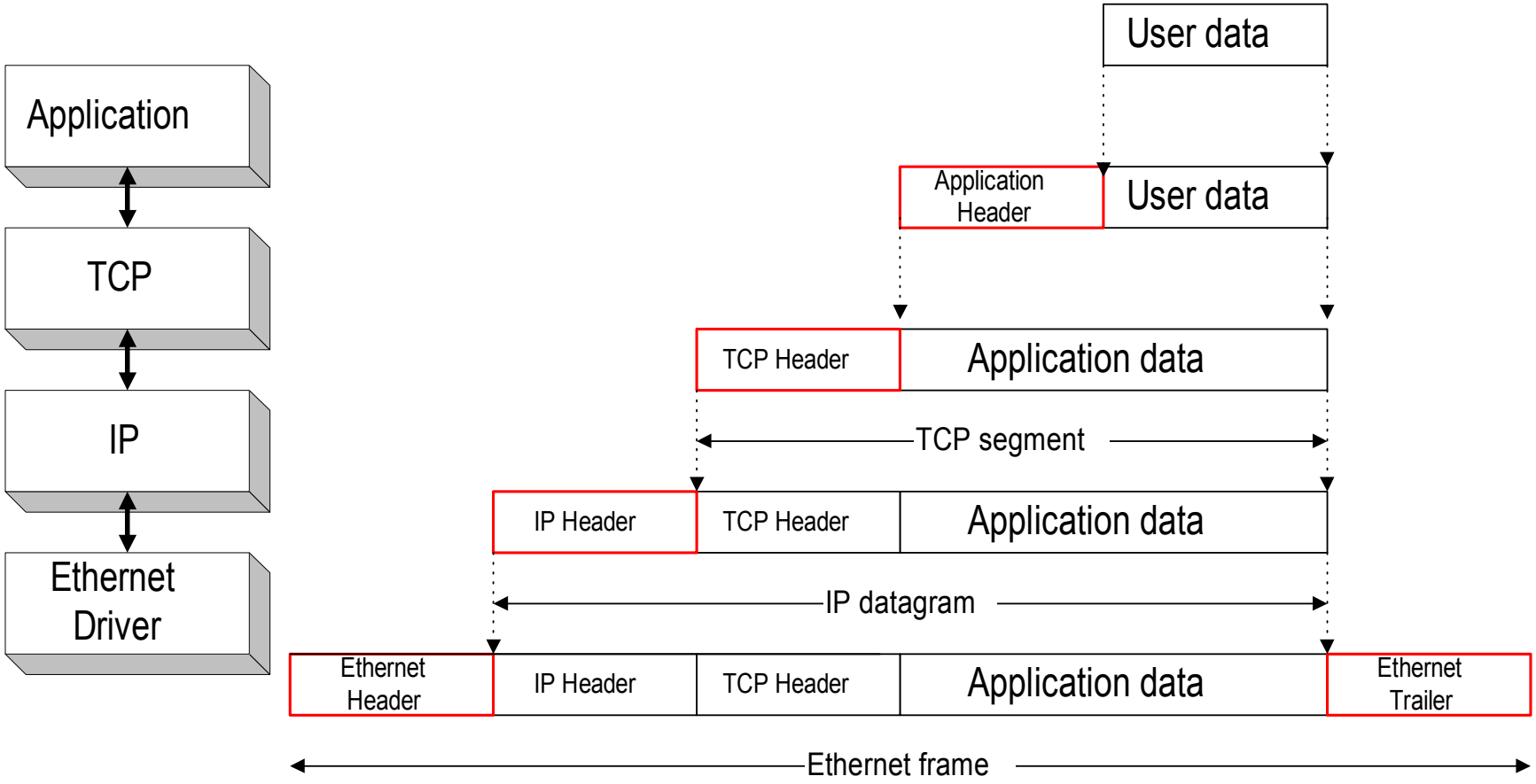
Layered Protocol Architecture

- The TCP/IP protocol suite is the basis for the networks that we call the Internet.
- The TCP/IP suite has four layers:
- Computers (hosts) implement all four layers. Routers (gateways) only have the bottom two layers.



Encapsulation

- As data is moving down the protocol stack, each protocol is adding layer-specific control information.



Characterizing a Network

- Fundamental characteristics of a network:
  - Bandwidth
    - No of bits per second that can be transmitted on the link.
  - Propagation Delay:
    - Minimum time it would take to transmit a bit across due to speed-of-light considerations.
    - Distance/Speed-of-Light

- Note – these are independent of each other.

Message Transfer Time

- Message Transfer Time or Message Latency
  - How long it takes for a message to go across
  - Also called "Delay" (confusing)

- Message Transfer Time(Latency) =
  - Propagation Delay + Transmission Time + Queuing

- Propagation Delay => Distance/Speed-of-Light
- Transmission Time => Size/Bandwidth

MAC Layer - Ethernet

- Sharing Transmission Media
  - Single shared communication channel
  - Only one node can send successfully at a time
  - Multiple simultaneous transmissions by nodes: interference

- Multiple access protocol:
  - distributed algorithm that determines how stations share channel, i.e., determine when station can transmit

CSMA/CD Algorithm (used in Ethernet)

- Sense for carrier.
- If carrier present, wait until carrier ends.
  - Sending would force a collision and waste time
- Send packet and sense for collision.
- If no collision detected, consider packet delivered.
- Otherwise, abort immediately, perform “exponential back off” and send packet again.
  - Start to send at a random time picked from an interval
  - Length of the interval increases with every retransmission

Exponential Backoff Algorithm

- Ethernet uses the exponential backoff algorithms to determine when a station can retransmit after a collision

Algorithm:

- Set “slot time” equal to 512bit time
- After first collision wait 0 or 1 slot times
- After i-th collision, wait a random number between 0 and 2^i-1 time slots
- Do not increase random number range, if i=10
- Give up after 16 collisions

Minimum Packet Size

- Why put a minimum packet size?
- Give a host enough time to detect collisions
- In Ethernet, minimum packet size = 64 bytes (two 6-byte addresses, 2-byte type, 4-byte CRC, and 46 bytes of data)
- If host has less than 46 bytes to send, the adaptor pads (adds) bytes to make it 46 bytes
- What is the relationship between minimum packet size and the length of the LAN?

LAN Interconnects

- Hubs Vs. Bridges/Switches
  - How are they different
- “Collision Domain” Vs. “Broadcast Domain”
- Learning Algorithm with Bridges
- Spanning tree protocol.

IP Layer/Internetworking

- IP Service Model, packet headers
- Addressing
  - Hierarchical Addressing
    - MAC address vs. IP address
  - CIDR
  - Longest prefix match

Longest Prefix Matching Example

Routing Table

Network	Next Hop	3rd Octet
128.96.170.0/23	Interface 0	1010 1010
128.96.168.0/23	Interface 1	1010 1000
128.96.166.0/23	R2	1010 0110
128.96.164.0/22	R3	1010 0100
(default)	R4	

Packet to destination 128.96.167.151: 1010 0111

- Matches two entries.
- Forwarded to R2 (Longer Prefix Match)

IP Delivery Model

- *Best Effort Service*
  - Network will do its best to get packet to destination
- Does NOT Guarantee
  - Any maximum latency or even ultimate success
  - Sender will be informed if packet doesn't make it
  - Packets will arrive in same order sent
- Implications
  - Scales very well
  - Higher level protocols must make up for shortcomings
    - Reliably delivering ordered sequence of bytes
  - Some services not feasible
    - Latency or bandwidth guarantees

Routing

- Intra-domain routing:
  - Distance Vector
    - Forced updates, Split Horizon, count to infinity
  - Link State (OSPF)
    - Dijkstra's algorithm
    - Flooding of LSPs
- Inter-domain routing:
  - Border Gateway protocol

OTHER TOPICS

- ARP/Interconnects
  - [Last video of Module 4]
  - NOT COVERED and NOT INCLUDED
- TCP Reliability
  - Material like cumulative/selective ACK not included.
  - But, ”network performance” related questions fair game (e.g., analyze performance of a protocol where a packet is sent and ACK received before next packet sent).