ECE 50863
Computer Network Systems

Final Review

Sanjay Rao

Announcements

- Final Examination:
  - All times US Eastern
  - Tue, Dec 14th, 1pm-3pm [on campus]
  - Tue Dec 14th, 6pm-10pm (during any 2 hour window) [online]
- Similar rules as Mid Term:
  - Open Book/printed notes: No electronic devices
  - On campus students: Mandatory in-person
  - Online students: Gradescope.
- Office hours, Monday, from 4pm-6pm [Zoom]
  - No lecture on Friday
- Please watch out for any Piazza announcements over coming days.

More announcements

- Practice finals from earlier year released
  - Note syllabus might be somewhat different
  - Especially, research paper oriented questions not covered in that examination.
- Course Survey Out
  - Bonus opportunity if you complete the survey AND indicate on Brightspace (see Survey Quiz) that you completed it, by the deadline.
  - Really important everyone takes the survey
    - Significant restructuring of content, especially projects, all of which substantially new.
    - First time online offering (as part of the online MS program).
      - Note online offering NOT temporary (i.e., not related to COVID).

Final Exam Content

- Cumulative Examination
  - All topics will be covered
  - But significantly more emphasis on material covered after the Mid Term.

Post-MidTerm Topics

Topic
IP Module: Interconnects [this was NOT covered for the mid term]
TCP Module (All topics)
Router Mechanism
Internet Video Delivery and ABR algorithms [2 papers]
DNS
Security
End-to-End Principles [1 paper]
Software Defined Networking [2 papers]

Expect at least 1 Question on each of these topics.
Likely 2 questions on TCP.

Cross cutting topics

- Although covered before the mid term, you should be understanding these ideas even better now, and they connect to important post mid term topics.
- IMPORTANT for exam. Emphasize for preparation.
- Internet Architecture and Layering
  - Should have deeper understanding now.
  - Connections to End-to-End paper.
- Network Performance
  - Important. Connections to TCP performance problems
- Switching and Routing
  - Contrast approaches in pre-mid term modules with SDN modules.

Other Pre Mid Term topics

- Ethernet: CSMA/CD, Bridges (Spanning Tree, Learning).
- IP addressing and longest prefix matching.
- Routing (Distance Vector, Link State, BGP)

- Lower weightage for this.
  - Less likely to ask many questions with a lot of intricate detail/knowledge of these topics.
  - More likely in the context of short questions, and/or connections with post mid term (e.g., contrasting this approach with SDNs)
  - But for the highest grade, all material is fair game!

Preparation Guide

- Definitely Emphasize post Mid Term.
  - Carefully look through all assigned papers (including SDN)
  - See paper reading guide for SDN papers in that module
- Carefully look through cross-cutting topics
- Finally, review pre mid term (e.g., review quizzes, mid term exam).

Exam Style

- Similar style to Mid Term
  - Conceptual questions based on lecture
    - Multiple choice, True/False.
  - Short conceptual questions [2 -3 lines]
    - E.g. “why is X done”?
  - Problem-oriented
    - Variants of homework problems
- Research paper related questions
  - Problems inspired by research papers
  - Reading assignment type questions
  - Using End to End Argument and interpreting in different contexts.

--- Topic Review---

- Not exhaustive, but some high points to help jog your memory.

TCP and Transport Layer

- TCP Vs. UDP: Ports/Multiplexing
  - Separating reliability & congestion control.
- Connection Setup/Teardown, Three way hand-shake,
- Reliability:
  - Stop & Go
  - Sliding Window
  - Sequence Numbers
  - RTT Estimation

Congestion Control.

- Design Space
  - End-to-end Vs. Router-based.
  - AIMD Vs. other alternatives.
  - How to detect and react to congestion.
- TCP Congestion Control (use lecture notes version)
  - Basic Version
  - Fast Retransmit & Fast Recovery
  - E.g. identify version being used, variants where only one feature is turned on.

- Analyze TCP questions which may have connections to Network Performance.

Router Mechanisms

- Today: Drop-tail,FIFO.
- Why we might want to add router mechanisms.
- DEC-bit, and RED schemes.
- Weighted Fair Queuing
- Strength and weaknesses of each scheme.

Security

- Key Management:
  - Public/private, Shared key
  - Pros & Cons of each approach.
  - Dual use of public key system
  - Hash functions, Digital Signature
- SSL:
  - Certifying Authority (CA), Certificate
  - How does client verify certificate?
  - Using public-key crypto to generating shared key

Domain Name Service

- Iterative vs. recursive queries
- Types of records (A, NS)
- DNS Caching
- Be prepared for problems around DNS
  - E.g., given series of queries
    - Figure out which servers are contacted to resolve the query
    - Take caching and query series into account

End to End Principles

- Be familiar with the argument
- May be asked to interpret it for different contexts
- Very important to interpret using the specifics of the argument (must be clear you have read the paper, and understand what it says).

Internet Video

- Should be expert on the BBA and MPC papers
- Questions of style of reading assignments
- Numeric problems based on understanding of these papers.

SDNs

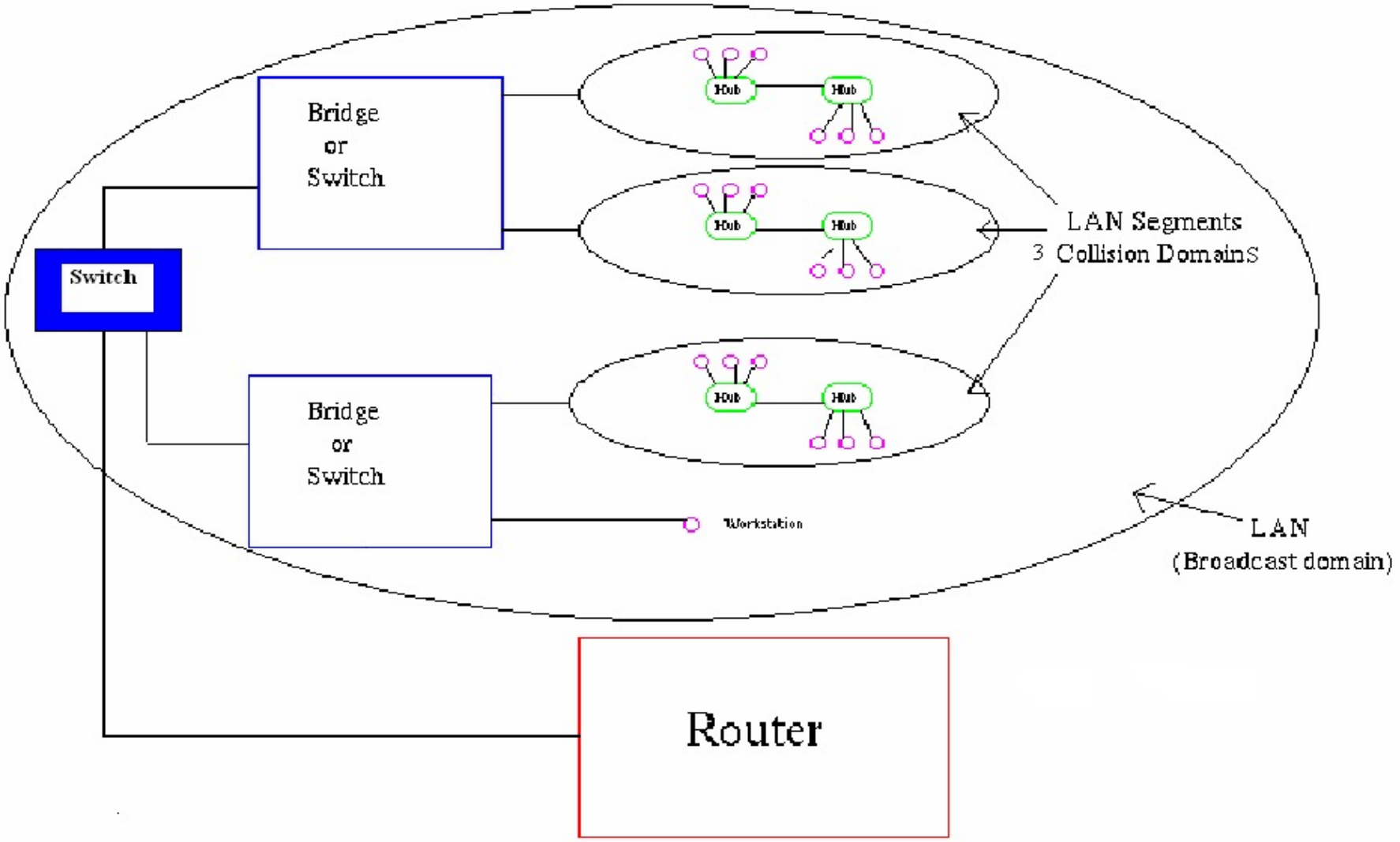
- Be familiar with both the Ethane paper, and Microsoft's SWAN paper
- Problems around them.
- Focus studying around the "reading guide" included in that module for each paper.

Interconnects

- Not tested in the Mid Term
  - Please expect a question on this!

- Hubs Vs. Bridges/Switches
  - How are they different
- “Collision Domain” Vs. “Broadcast Domain”
- ARP Protocol

Physical View of a LAN



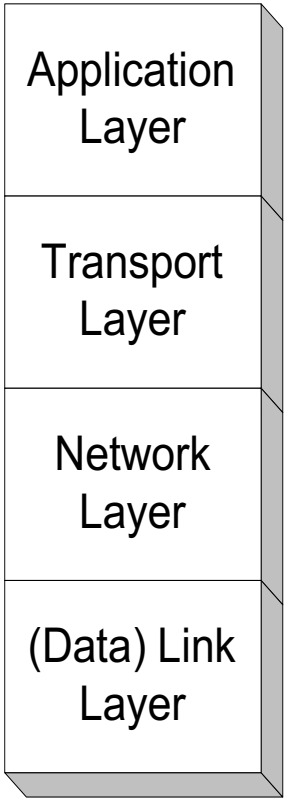
---Pre MidTerm topics---

Network Architecture

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

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.



telnet, ftp, email

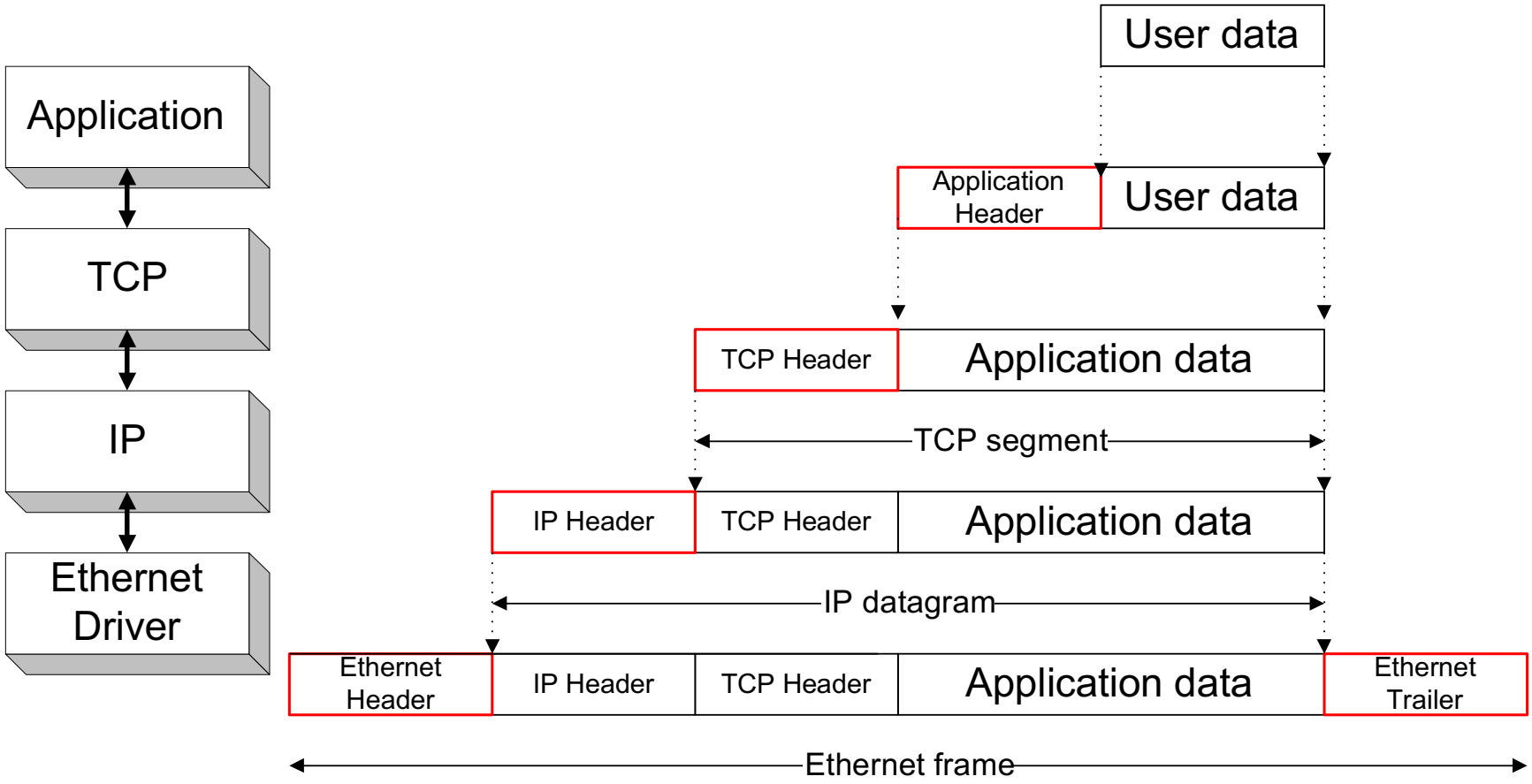
TCP, UDP

IP, ICMP, IGMP

Device Drivers

Encapsulation

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



Network Performance

- 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.
- Problems around transfer time, propagation delay
- Could be in a TCP context

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

IP Layer/Internetworking

- IP Service Model, packet headers
- Addressing
  - Hierarchical Addressing
  - CIDR
  - Longest Prefix Match

Intra-domain Routing

- Distance Vector
  - Forced updates, Split Horizon, count to infinity
- Link State (OSPF)
  - Dijkstra's algorithm
  - Flooding of LSPs

Inter-domain Routing

- Intra Vs. Inter Domain Routing.
- BGP
- “Constraint-based routing”
  - Customer->Provider, Peer->Peer
  - Which routes are permissible.
- Path Vector (AS) based routing
- Limitations of BGP – why it does not reflect performance
- Other limitations of BGP

MAC Layer

- CSMA/CD, Exponential backoff
- Why minimum length on Ethernet frames
- Learning Algorithm with Bridges
- Spanning tree protocol.