Introduction to Computer Networks

CS640 Recap

https://pages.cs.wisc.edu/~mgliu/CS640/F22/

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Today

Last lecture

- What is network security?
- How do networking attacks happen?
- How does the networking defense work?

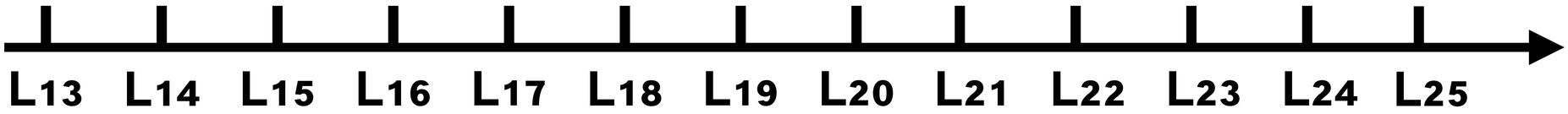
Today

- Recap

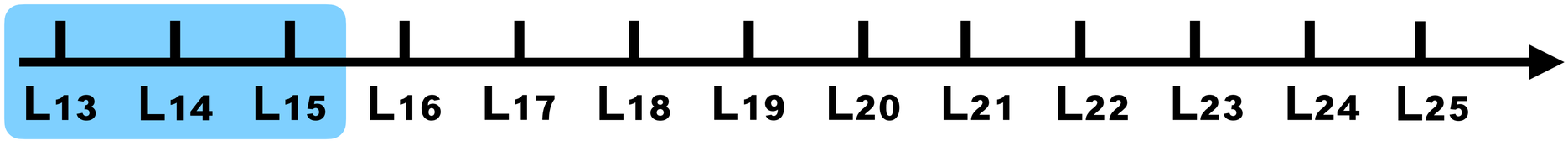
Announcements

- Lab5 is due 12/14/2022, 11:59 PM
- Lab6 is due 12/19/2022, 11:59 PM
- Final exam: Dec 17, 2022 5:05 PM – 7:05 PM @Engineering Hall 1800

Midterm2 Review



Midterm2 Review



IP Layer (L_3): Datagrams between hosts

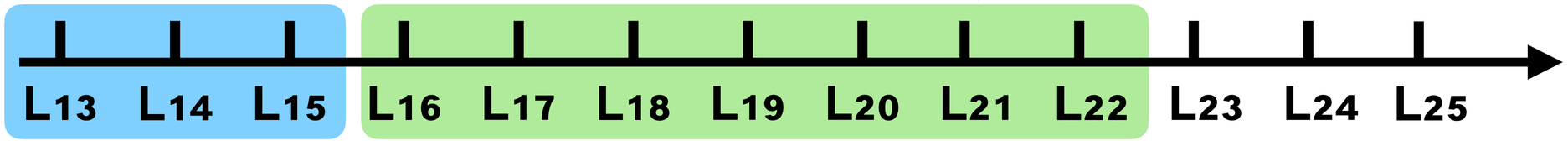
Q_1: How to decide the forwarding paths among intra-domain/inter-domain routers?

Q_2: How to improve the packet transmission efficiency?

Midterm2 Review

Transport Layer (L4): Packets between processes

Q1: How to set up the process-to-process channel?
Q2: How to multiplex concurrent channels over the physical link?
Q3: How to control the transmission rate?
Q4: How to achieve reliable delivery?
Q5: How to share the in-network bandwidth resources?



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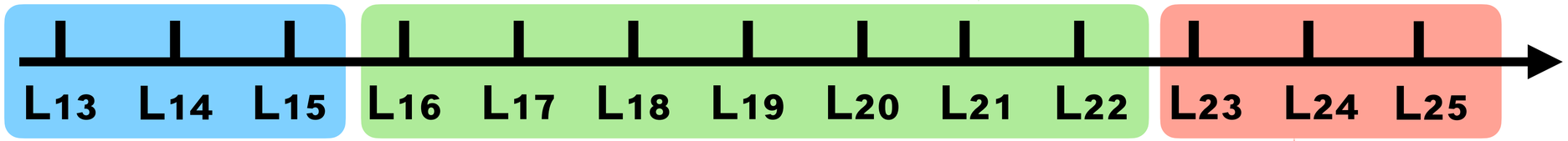


IP Layer (L3): Datagrams between hosts

Q1: How to decide the forwarding paths among intra-domain/inter-domain routers?
Q2: How to improve the packet transmission efficiency?

Application Layer (L5): Data between workload

Q1: What are infrastructure services used for?
Q2: What are learning from building network applications?
Q3: What is networking security?
Q4: How do common networking attacks and defenses work?

Learning outcomes (L1)

#1: Explain how campus or other networks work

#2: Develop small-scale network applications

#3: Evaluate design trade-offs of networked systems

Goals of this class

#1: Explain how campus or other networks work

Goals of this class

#1: Explain how campus or other networks work

Key takeaways:

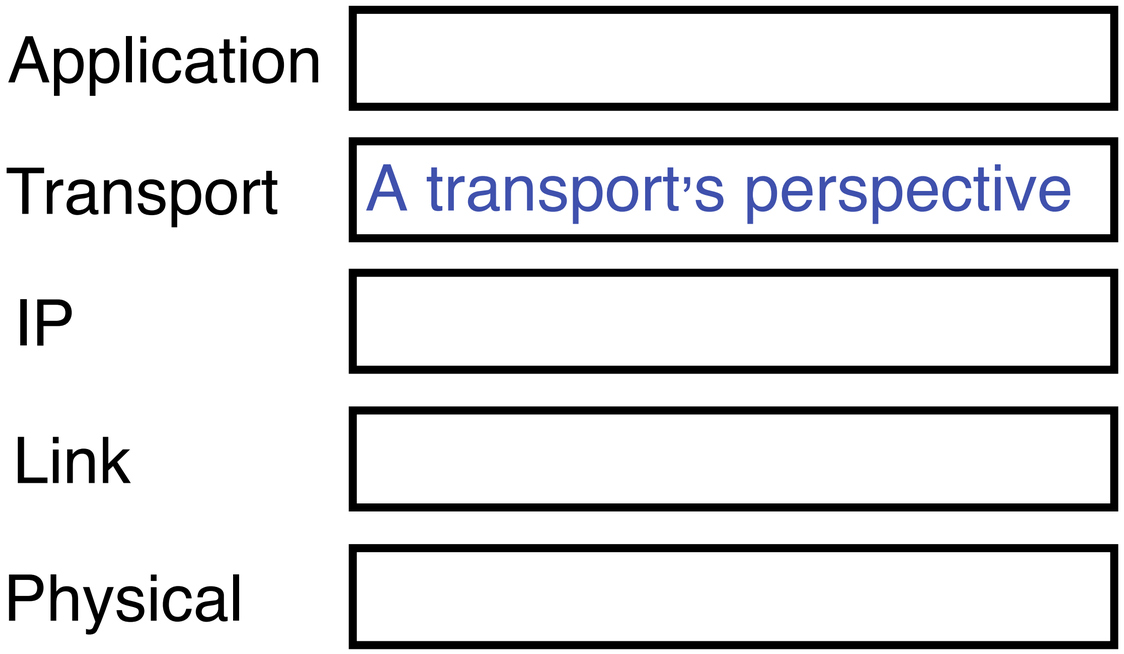
- Layering –> complexity
- Hierarchy –> scalability
- End-to-end –> labor of division
- Mechanism and policy –> flexibility

Goals of this class

#2: Develop small-scale network applications

Goals of this class

#2: Develop small-scale network applications



Key takeaways:

- Application representation
- Transport protocol selection
- Application-specific optimization to enable better transport protocol

Goals of this class

#3: Evaluate design trade-offs of networked systems

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#3: Evaluate design trade-offs of networked systems

Key takeaways:

- “Network performance” depends on the “compute efficiency”
- Take decentralization as the first requirement when designing protocols
- Don’t forget packet headers and channel/flow in-network states

Final Words on Grading — Option #1

6 programming labs (40%)

- 5 required labs (8% each) + 1 optional (5% bonus)
- teams of 1-2 people

Topic	Assigned	Due	Notes
Lab1: Sockets, Mininet & Performance	09/13/2022	09/27/2022 11:59PM	
Lab2: Link & Network Layer Forwarding	09/27/2022	10/11/2022 11:59PM	
Lab3: ARP, ICMP & RIP	10/11/2022	10/27/2022 11:59PM	
Lab4: Software Defined Networking	10/27/2022	11/15/2022 11:59PM	
Lab5: Flow Control & DNS	11/15/2022	12/01/2022 11:59PM	
Lab6: Distributed Sorting	12/01/2022	12/15/2022 11:59PM	

2 in-class midterms (50%)

- In-person
- midterm1: 25%, 10/20/2022
- midterm2: 25%, 12/13/2022

In-class Quizzes (10%)

- In-person
- ~5 times

} Open-book, open-notes

Final Words on Grading — Option #1

A: [90 — 100)

AB: [85 — 90)

B: [80 — 85)

BC: [75 — 80)

C: [70 — 75)

D: [60 — 70)

F: [0 — 60)

Final Words on Grading — Option #2

6 programming labs (55%)

- 5 required labs (11% each) + 1 optional (5% bonus)
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Final Words on Grading — Option #2

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Final Words on Grading — Option #3 (Curving)

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A: [0, 40%)

AB: [40%, 60%)

B: [60%, 80%)

BC: [80% — 90%)

C:

D:

F:

Your final grade = Max (op#1, op#2, op#3)

E.g., (AB, B, A) = A

Networking Research

Building fast, efficient, secure, and reliable networked systems and protocols at different scale

Networking Research

Latency: [s, ns]
Bandwidth: [Kbps, Tbps]

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Energy-efficiency: pps/J
Cost-efficiency: pps/$

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Minimize the attack vector
Fast attack detection/prevention

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Close to zero downtime

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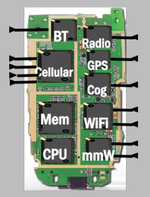


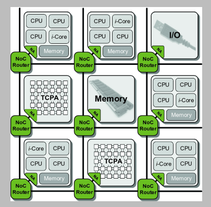


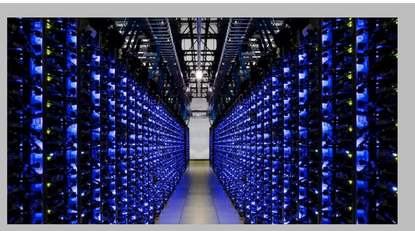

Driving Factors for Networking Research

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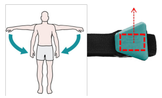
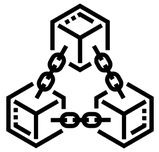
#1: New applications

Enable new apps



Design networks for new apps



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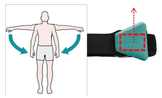


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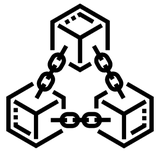
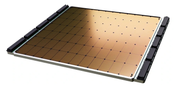



#2: New hardwares

Network HW


Compute/Storage HW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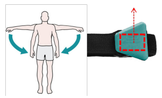


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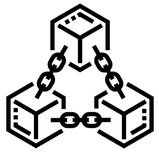


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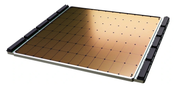


#3: New experiences

Optimization


Better PL/Verification

ROSETTE


Terminology

1. Host
2. NIC
3. Multi-port I/O bridge
4. Protocol
5. RTT
6. Packet
7. Header
8. Payload
9. BDP
10. Baud rate
11. Frame/Framing
12. Parity bit
13. Checksum
14. Ethernet
15. MAC
16. (L2) Switch
17. Broadcast
18. Acknowledgement
19. Timeout
20. Datagram
21. TTL
22. MTU
23. Best effort
24. (L3) Router
25. Subnet mask
26. CIDR
27. Converge
28. Count-to-infinity
29. Line card
30. Network processor
31. Gateway
32. Private network
33. IPv6
34. Multicast
35. IGMP
36. SDN
37. (Transport) port
38. Pseudo header
39. SYN/ACK
40. Incarnation
41. Flow
42. SYN flood
43. TCP Segment
44. Window
45. Advertised Window
46. Effective Window
47. TCP Reno
48. Duplicated ACK
49. Congestion Window
50. Congestion Threshold
51. Selective Acknowledgment
52. Active Queue Management (AQM)
53. URL
54. HTML
55. Peer-to-peer (P2)
56. Swarm
57. CDN
58. ARP/IP Spoofing
59. MAC/SYN/HTTP Flooding
60. Route/Session/DNS Hijacking
61. Presage resistance
62. Collision resistance
63. Middlebox
64. Firewall

Principle

1. Layering
2. Minimal States
3. Hierarchy
4. Mechanism/policy separation

Technique

1. NRZ Encoding
2. NRZI Encoding
3. Manchester Encoding
4. 4B/5B Encoding
5. Byte Stuffing
6. Byte Counting
7. Bit Stuffing
8. 2-D Parity
9. CRC
10. MAC Learning
11. Store-and-Forward
12. Cut-through
13. Spanning Tree
14. CSMA/CD
15. Stop-and-Wait
16. Sliding Window
17. Fragmentation and Reassembly
18. Path MTU discovery
19. DHCP
20. Subnetting
21. Supernetting
22. Longest prefix match
23. Distance vector routing (RIP)
24. Link state routing (OSPF)
25. Boarder gateway protocol (BGP)
26. Network address translation (NAT)
27. User Datagram Protocol (UDP)
28. Transmission Control Protocol (TCP)
29. Three-way Handshake
30. TCP state transition
31. EWMA
32. Sliding window

Technique

33. Flow control
34. AIMD
35. Slow start
36. Fast retransmit
37. Fast recovery
38. Nagle's algorithm
39. Karn/Partridge algorithm
40. TCP Vegas
41. Bit-by-bit Round Robin
42. Fair Queueing (FQ)
43. Random Early Detection (RED)
44. Explicit Congestion Notification (ECN)
45. Domain Name System (DNS)
46. Simple Network Management Protocol (SNMP)
47. HyperText Transfer Protocol (HTTP)
48. Persistent Connection
49. BitTorrent
50. Cryptographic Hash
51. DES/3DES/AES
52. Intrusion detection/prevention system (IDS/IPS)

Summary

Please teach us!

We are happy to learn from you!

Announcements

- No office hours today
- Q&A session #1: Dec 15th, Thursday, 1-4pm @CS3310, for quiz3&quiz4
- Q&A session #2: Dec 15th, Friday, 2:30-4:30pm @CS4310, for lectures