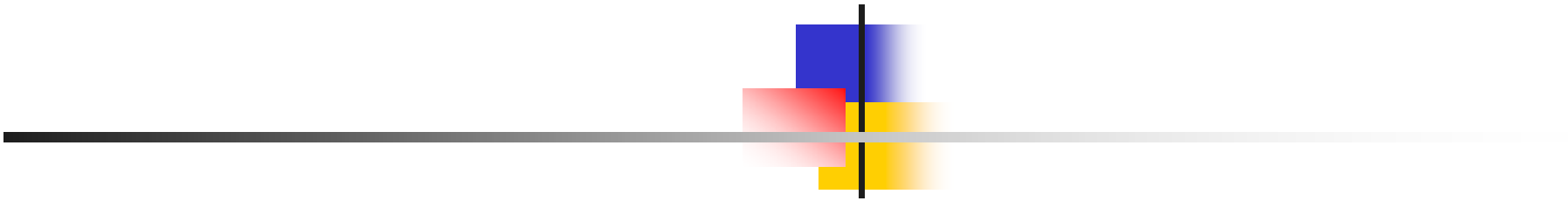
CSE398: Network Systems Design



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Lehigh University

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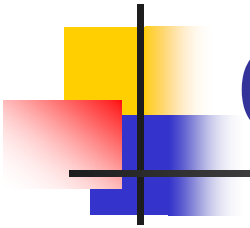
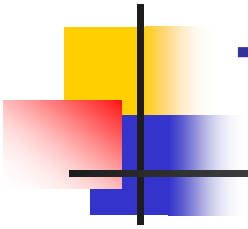


Outline

- Course information
  - NSF: Pre-test and lab-log
- Network architecture
  - Layering and protocols
  - OSI architecture
  - Internet architecture
- Summary and homework

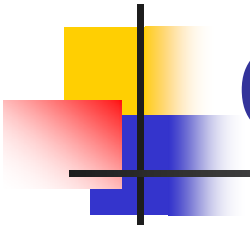
Basic Course Information

- Network systems: router and switches in the Internet.
- Objective: introduction to network systems from both academic and industry's point of views.
- Course homepage
  - http://www.cse.lehigh.edu/~cheng
- Office hours
  - Tuesday 12 PM to 3 PM, PL 326, cheng@cse.lehigh.edu



Textbooks

- D. Comer, Network Systems Design using Network Processors, Agere Version, Prentice Hall, October 2004.
- Prerequisites
  - Computer architecture knowledge
  - CSE342 (Fundamentals of Internetworking) or CSE/ECE404 (Computer Networks), or Instructors' permission.

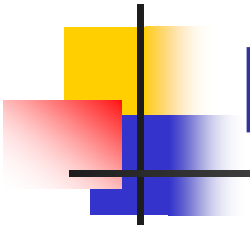


Grading

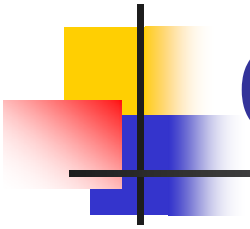
- Homework: 20%
- Midterm: 20%
- Lab projects: 30%
- Final exam: 30%
- All exams are open book.
- Collaboration & academic honesty

Tentative Course Schedule

- http://www.cse.lehigh.edu/~cheng/Teaching/CSE398-05/schedule.html
  - 01/31: Hands-on lab (traffic monitoring and throughput measurement)
  - 02/16: Hands-on lab (basic router configuration)
  - 03/02: Mid-term Exam
  - 03/14: Hands-on lab (firewall and ethereal)
  - 04/06: Hands-on lab (SPA network processor simulator)
  - 04/18: Hands-on lab (SystemC models and simulation)
  - 04/27: Hands-on lab (Stateful FPL application)
  - Agere on-site visit: TBD
  - Final exam: TBD



NSF Related Information



Outline

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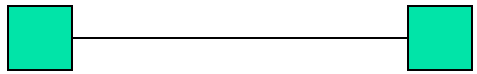
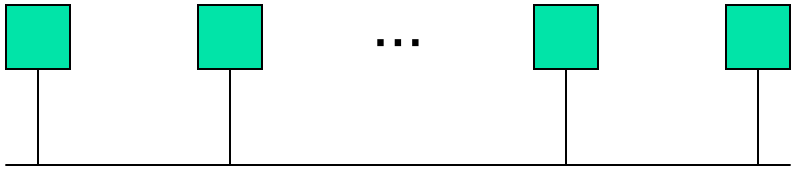
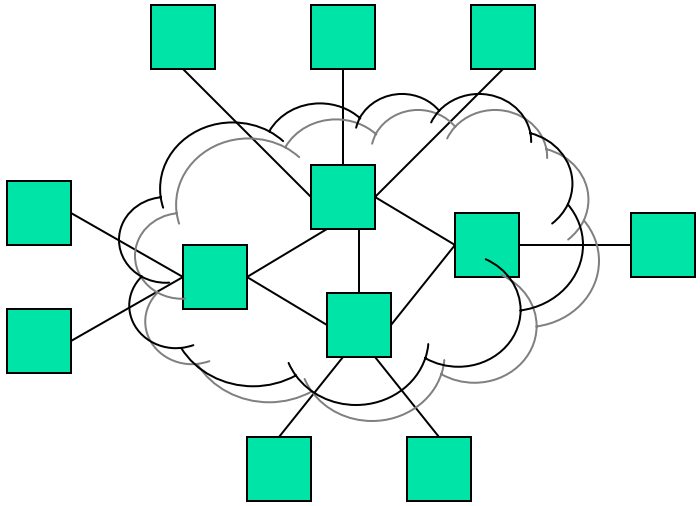
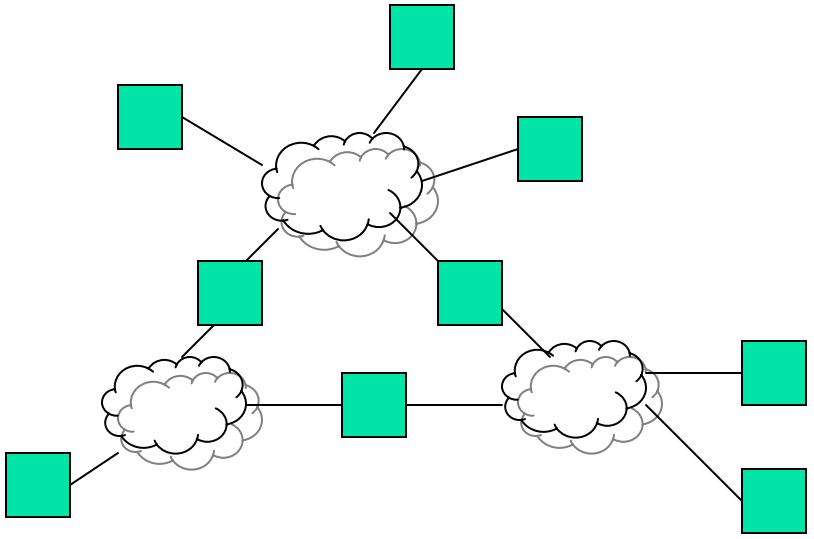
  - Layering and protocols
  - OSI architecture
  - Internet architecture
- Summary and homework

Computer Networks

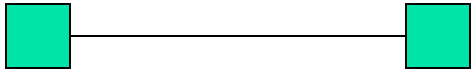


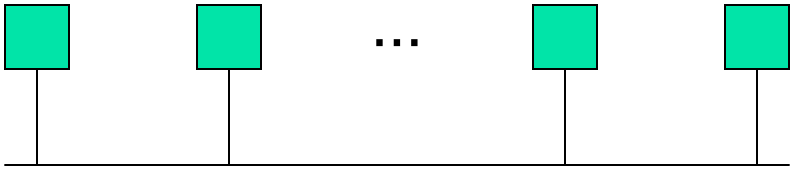


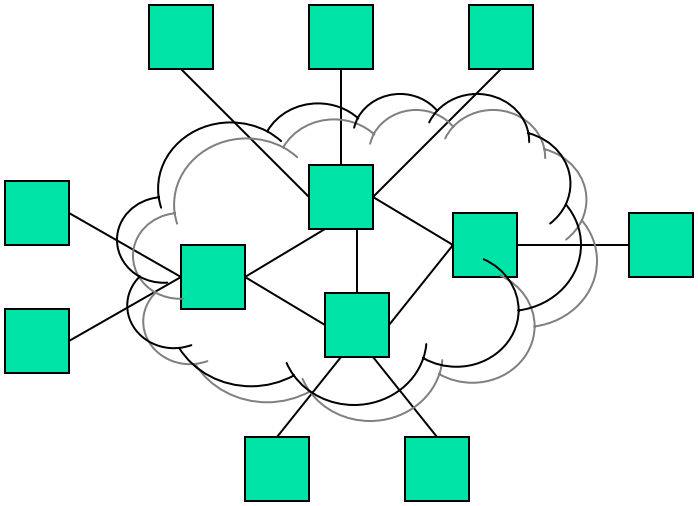




Hardware Building Block



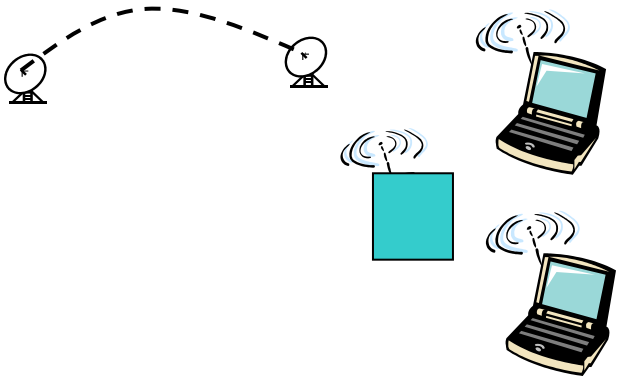




- Communication links
- Hosts, end-systems
- Routers, switches

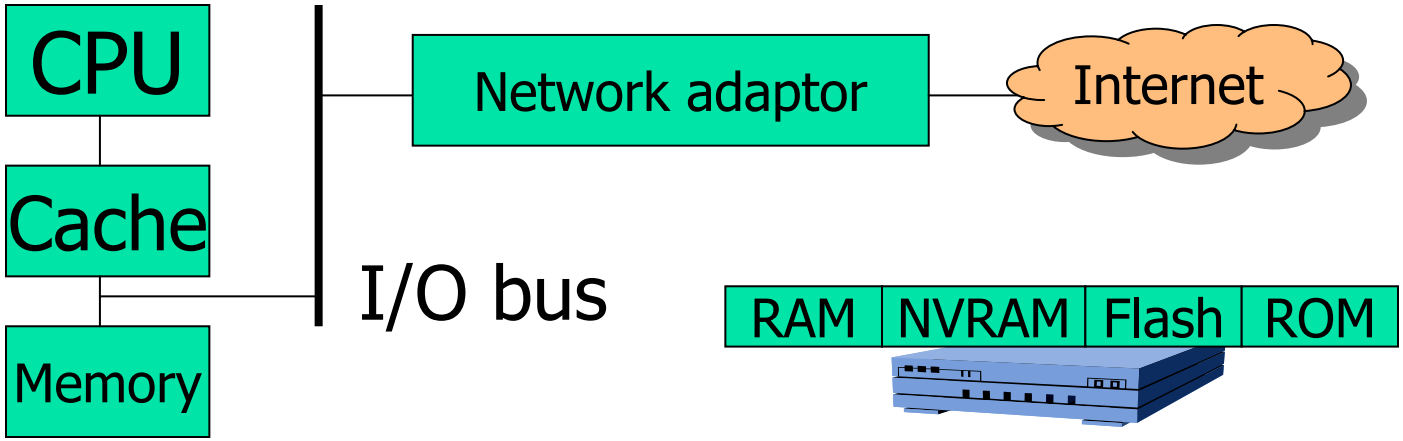
Communication Links

- Physical media propagates bits between transmitter / receiver pairs
  - Cable: twisted-pair (Cat-5,6), coax, fiber [guided media]
  - Wireless links: satellite links; wireless LANs, WANs; terrestrial microwave [unguided media]



Hosts and Routers

- RAM: Random Access Memory for dynamic configuration/information
- NVRAM: Non-Volatile RAM for backup copy of configuration to be kept when power is turned off
- Flash: Erasable and programmable read-only memory containing IOS software, content retained
- ROM: containing initializing bootstrap program and monitoring system for recovery, IOS software

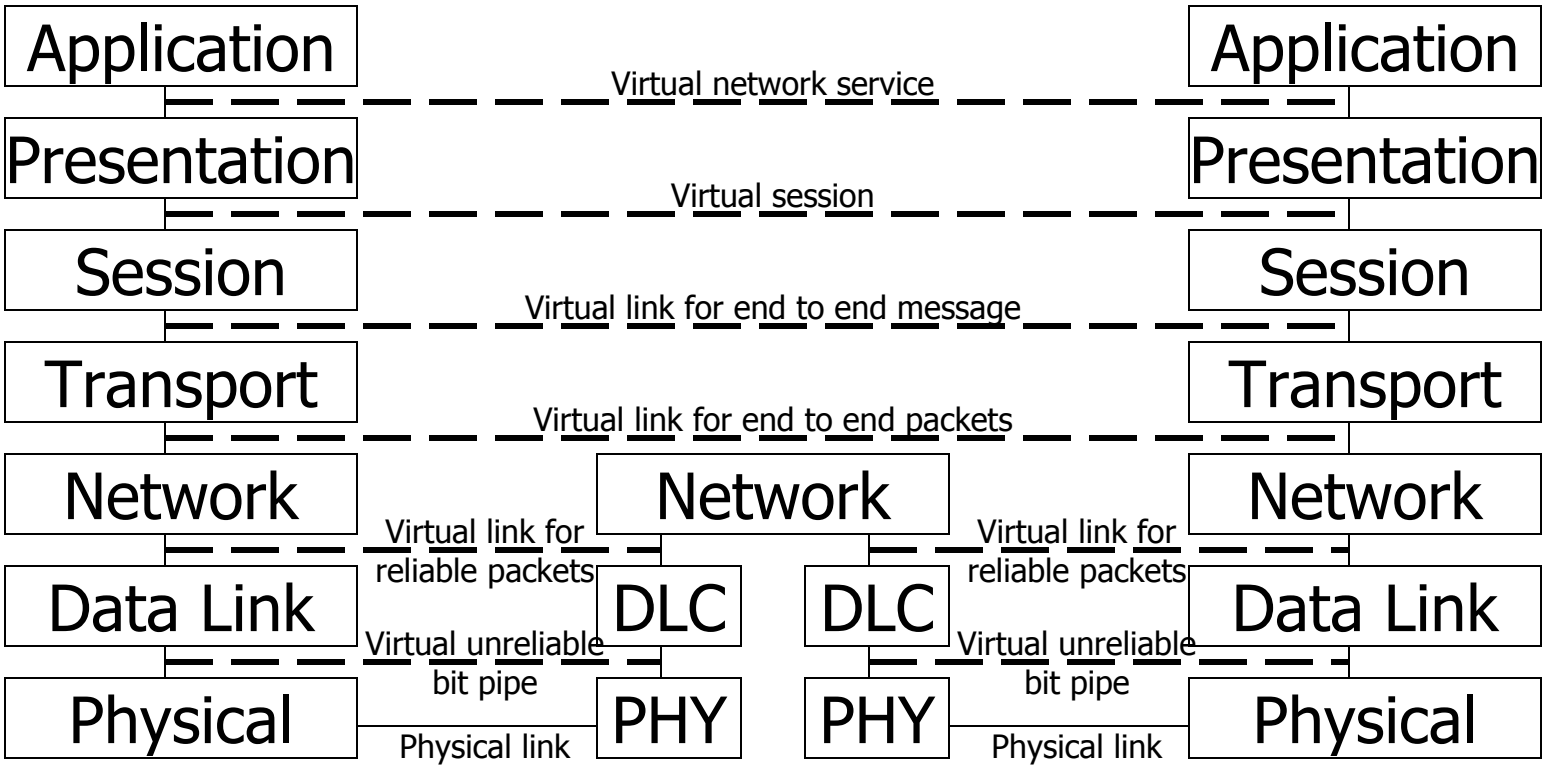


Concepts Related to Links

- Bandwidth and throughput
  - Bandwidth of a communication link refers to the number of bits per second that can be transmitted on the link
  - Throughput of a session refers to the number of bits or bytes per second that has been achieved in transmitting data of the session.
  - 10 Mbps (10^6 bits); a 1 KB file (2^{10} bytes?)
- RTT vs. one-way latency. Why?
  - Significance: transcontinental case: One-way distance as 10,000Km and SOL as 200,000Km/s, then RTT is
  - ~100ms.
- High-speed link: large bandwidth link
  - 1MB file via 1Mbps: ~ 8 RTT
  - 1Gbps: ~1 RTT

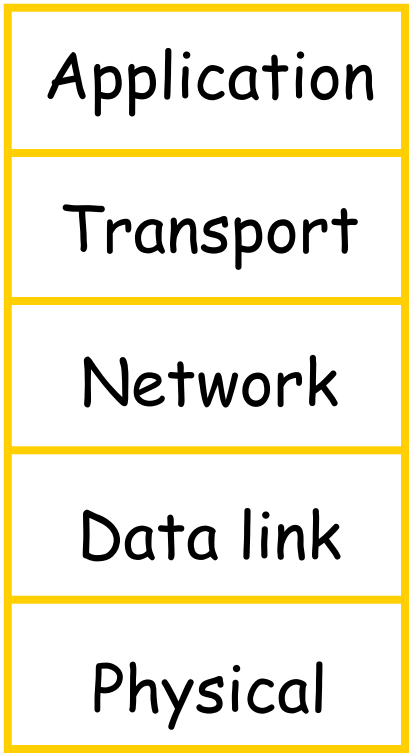
OSI Architecture

- Seven-layer OSI (Open Systems Interconnection) network architecture



Internet Architecture Protocol Stack

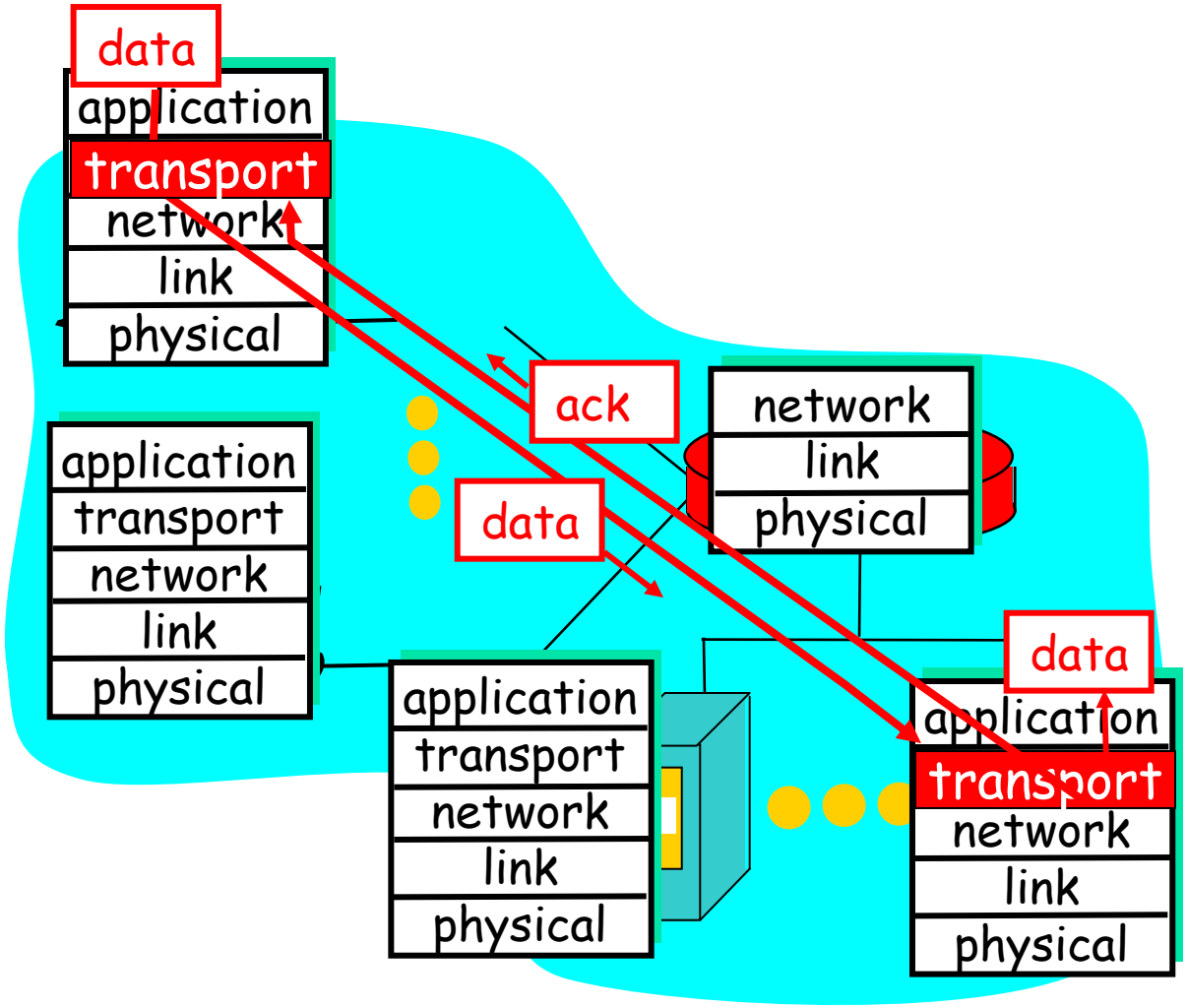
- Five-layer model
  - An implementation of TCP/IP protocol suite was bundled with Berkeley Unix
- Application: supporting network apps
  - FTP, SMTP, HTTP
- Transport: host-host data transfer
  - TCP, UDP
- Network: routing of packets
  - IP, routing protocols
- Data link: data transfer between neighboring network elements
  - PPP, Ethernet
- Physical: bits "on the wire"

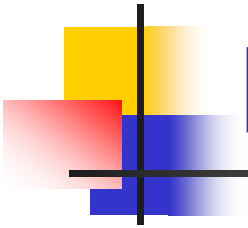


Layering: *Logical* Communication

E.g.: Telnet

- Transport take data from app
- Add address, reliability check info to form TCP segment
- Send segment to peer
- Wait for peer to ack receipt

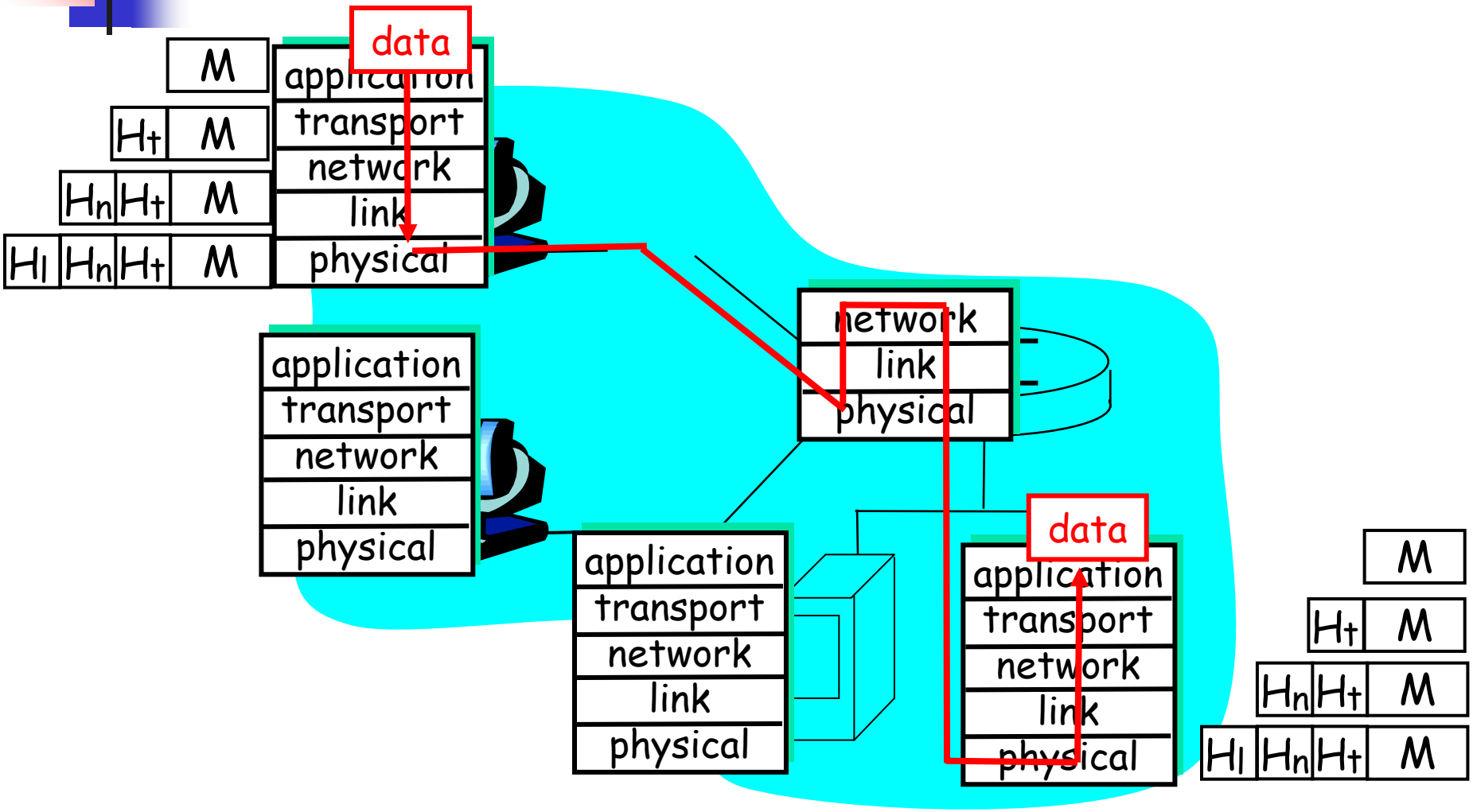




Encapsulation

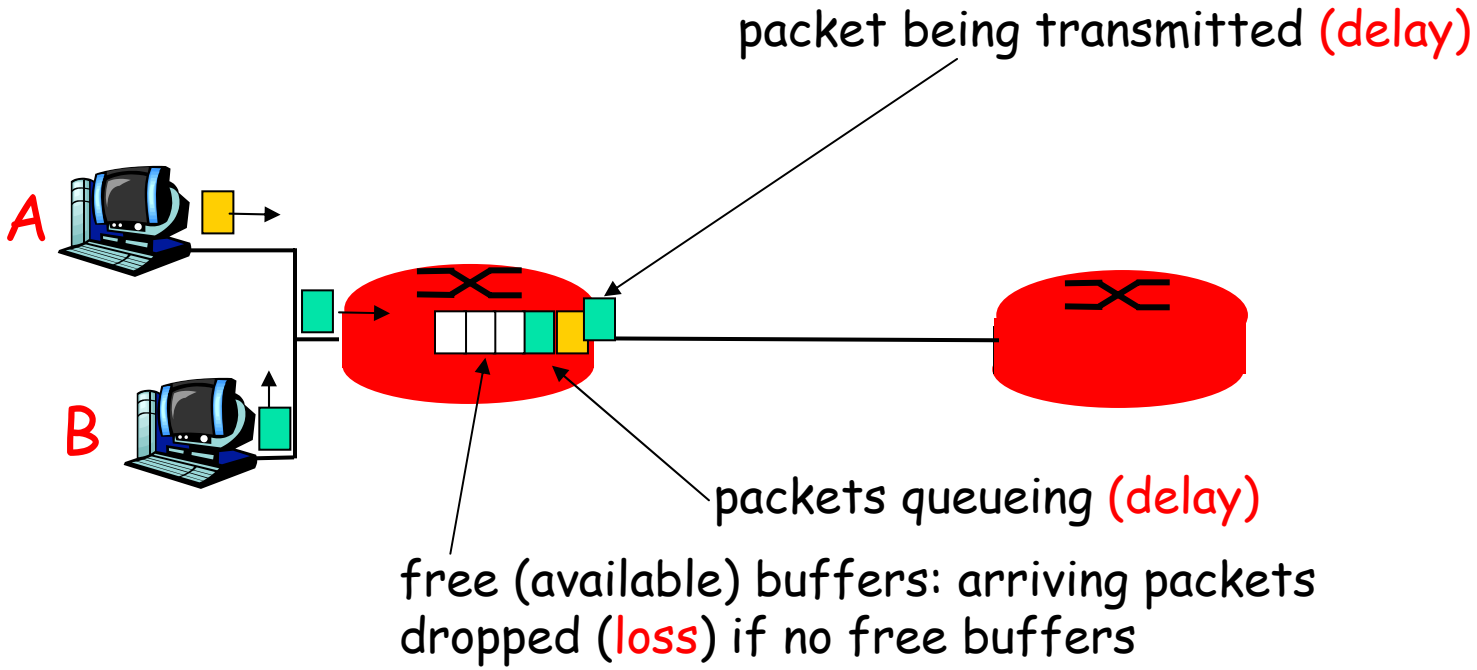
- Header, trailer, payload or body
- Session, presentation, application layers: message, header
- Transport layer: datagram, UDP header; segment, TCP header
- Network layer: packet, IP header
- Data link layer: frame, header, trailer
- Physical layer: bit

Illustration of Encapsulation



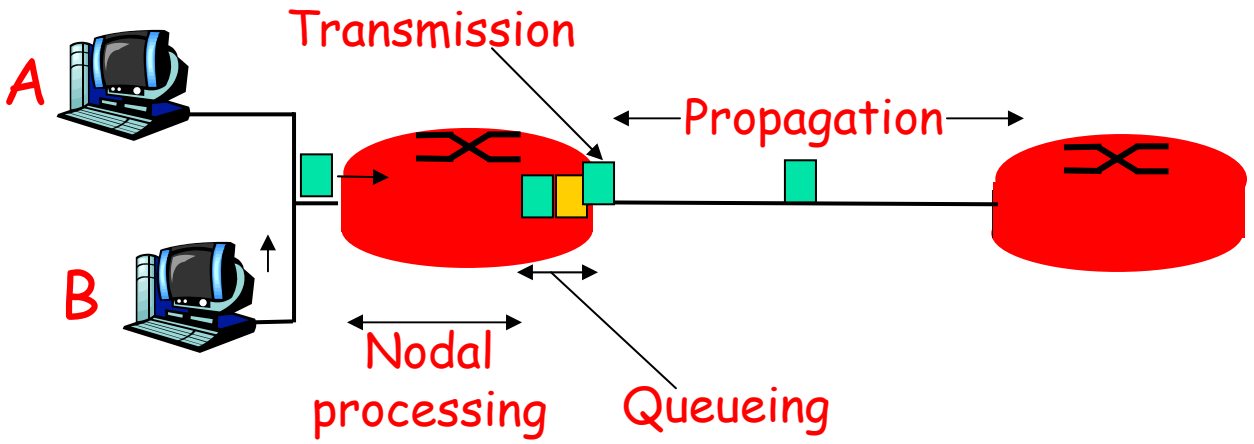
Loss and Delay

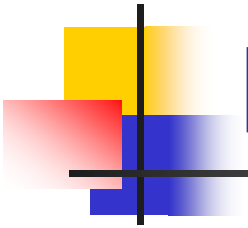
- Packet arrival rate to link exceeds output link capacity: packets queue, wait for turn; or drop



Four Sources of Delay

- 1. Nodal processing:
  - Check bit errors
  - Determine output
- 3. Transmission delay:
  - R=link bandwidth (bps)
  - L=packet length (bits)
  - Time to send bits into link: L/R
- 2. Queueing
  - Time waiting at output for trans.
  - Depends on congestion at router
- 4. Propagation delay:
  - d = length of physical link
  - s = propagation speed in medium
  - Propagation delay = d/s





Homework

- Problem 1.1 has been posted at the Blackboard System. Due on Jan. 24 (upload it to Digital Drop Box) to before the class.

- 5-min discussion in the next class: What are the differences between OSI and Internet architectures? You do not need to hand in the answer for this question.