CSE398: Network Systems Design

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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


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](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
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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

Diagram:

- Application
- Presentation
- Session
- Transport
- Network
- Data Link
- Physical

Virtual network service
Virtual session
Virtual link for end-to-end message
Virtual link for end-to-end packets
Virtual link for reliable packets
Virtual unreliable bit pipe
Physical link

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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

M

H_t M

H_n H_t M

H_l H_n H_t M

M

H_t M

H_n H_t M

H_l
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

2. Queueing
   - Time waiting at output for trans.
   - Depends on congestion at router

3. Transmission delay:
   - R = link bandwidth (bps)
   - L = packet length (bits)
   - Time to send bits into link: \( \frac{L}{R} \)

4. Propagation delay:
   - \( d = \) length of physical link
   - \( s = \) propagation speed in medium
   - Propagation delay = \( \frac{d}{s} \)
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.