CS 5651 Computer Networks

The Internet and its Structure

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Outline

1. The Internet

2. Protocol Stack

The Internet

History

- What did you think of the video?

Future

- Make sure to post your comments to Moodle for HW1.

The Internet

What is it?

- Data communication computer network
- A network of computer networks - hierarchically organized
- Controlled by many organizations, corporations, and governments
- Global system as well as smaller, local networks
- *Internet* is a shortened version of *internetwork*

The Internet

sprintlink.net

cw.net

(not an ISP)

Structure

- Edge Systems - computers that sit on periphery, send/receive data
- Core Systems - computers that are in the interior, route data

Data Movement

- Packet Switching - break data up into small piece and route them across the core
- Circuit Switching - reserve communication links and then send data across the core

Network Edge

- Starting and ending points for data communication
- *Host* is used to describe end systems
- Many different connection types between hosts and next set of machines
- clients - hosts that request data from other machines
- servers - hosts that supply or serve data to other machines

Network Core

- The machines (computers) that *route* data between hosts on the network edge
- Built up of many packet switched networks
- And, some circuit switched networks
- Current Internet uses a best-effort delivery service idea for movement of data

Where *does* the data go?

Once data leaves a host machine, where does it travel?

1. Data travels upstream into either Tier-2 or Tier-3 networks
2. May travel through other Tier-2 networks
3. Eventually data will reach the Tier-1 networks
4. Will then travel along the Internet *backbone* through other Tier-1 networks
5. Finally, may pass back through Tier-2 or Tier-3 networks to reach destination

Network Terms

Tier-1 Network Major companies/organizations with large infrastructure to move data. Typically, the *backbone* of the Internet. Tier-1 networks link with other Tier-1 networks.

Tier-2 Network Smaller networks that peer with other Tier-2 networks and some Tier-1 networks. Can be larger than Tier-1 networks.

Tier-3 Network ISPs who provide access to the Internet to home or business users.

Internet Exchange Point Physical locations where ISPs exchange Internet traffic

POP Point of Presence - points of entry and exit from larger Tier networks

CDN Content Delivery Network - networks that are beginning to exist that sit outside the big Tier networks and primarily provide content distribution

Tier-1 ISPs

The following are likely Tier-1 ISPs:

- Centurylink
- Verizon
- Sprint
- NTT Communications
- Level 3 Communications
- Savvis
- AT&T

Wikipedia lists a few others:

- http://en.wikipedia.org/wiki/Tier_1_network

What Organizations Manage the Internet

These are some of the standards committees and organizations that manage the internet (as best they can):

- IEEE - Institute of Electrical and Electronics Engineers - Oversees standards for computing and communication (*WiFi - IEEE 802.11*

- IETF - Internet Engineering Task Force - forum of working groups that propose solutions and protocols to be adopted by the Internet

- ICAAN - Internet Corporation for Assigned Names and Numbers - manages Internet domain names and addresses

- IANA - Internet Assigned Numbers Authority - manages the IP (internet protocol) and AS (autonomous system) numbers, protocol numbers, and DNS root information

The Internet is a hierarchy of *services* and *protocols*

Service Allow layers of the Internet to interoperate and build on one another

Protocols Provides a structured means for network services and applications to exchange data
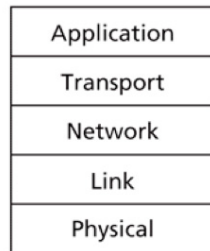
Internet Protocol Stack

The Internet is a hierarchy of *services* and *protocols*

- Five layer TCP/IP Model
    - Application Layer
    - Transport Layer
    - Network Layer
    - Link Layer
    - Physical Layer

- Seven Layer Model
    - Open System Interconnections model
    - Preceeded the current Internet Model
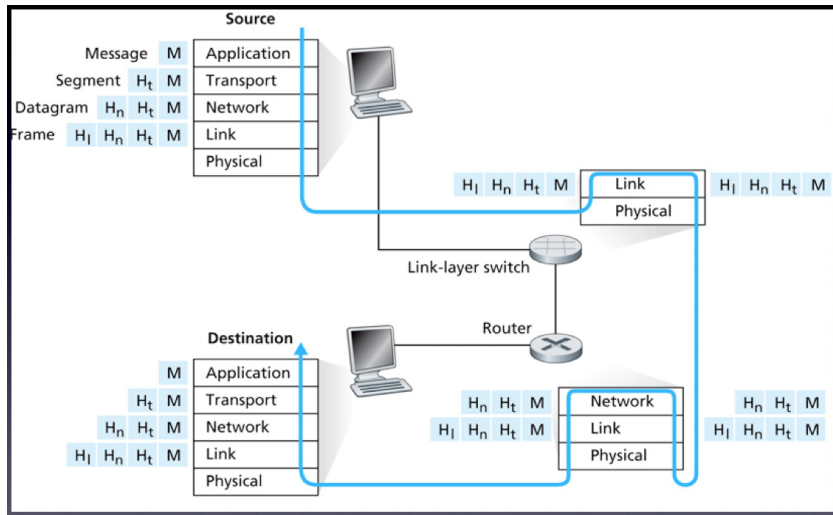   - Developed in about the late 70s

Application
Transport
Network
Link
Physical

a. Five-layer Internet protocol stack

| Application |
| :---: |
| Presentation |
| Session |
| Transport |
| Network |
| Link |
| Physical |

b. Seven-layer ISO OSI reference model

Encapsulation

Link Layer Details

- Data communication to connected neighbors - makes physical layer appear reliable
- Link is one hop on path between source and destination
  - Many different link types
  - Examples: Ethernet, 802.11 (WiFi), PPP
  - Often referred to as Level 2
- Addressing
  - Media Access Control Address - MAC Address
  - Example: 00:1C:42:00:00:23
- Packet Name - Frame
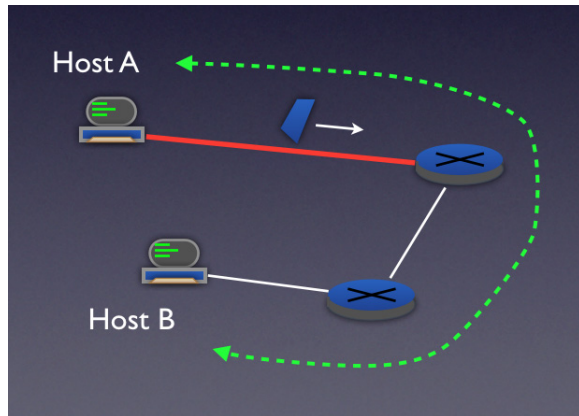
Link layer only deals with a single hop!
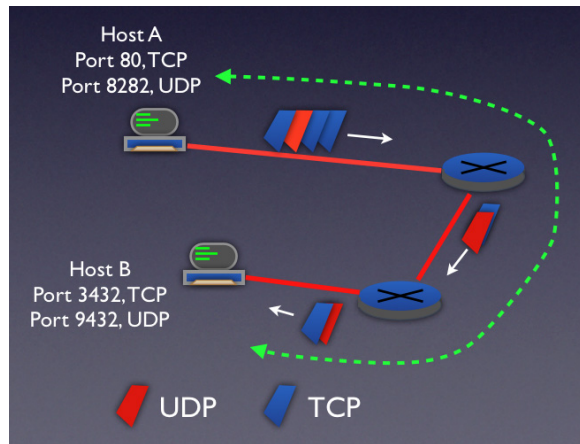
Network Layer Details

- Host to host communication - complete source to destination delivery of packets

- Routing
  - Pushing packets across multiple links
  - Allows different networks to interoperate
  - Primary protocol is the IP (Internet Protocol)

- Service Model - Best Effort Delivery
  - Unreliable for data transmission!

- Addressing
  - IP Address (IPv4, IPv6)
  - IPv4 Example: 131.212.41.105, 192.168.0.19
  - IPv6 Example: f380::223:6cff:fe81:fbbb
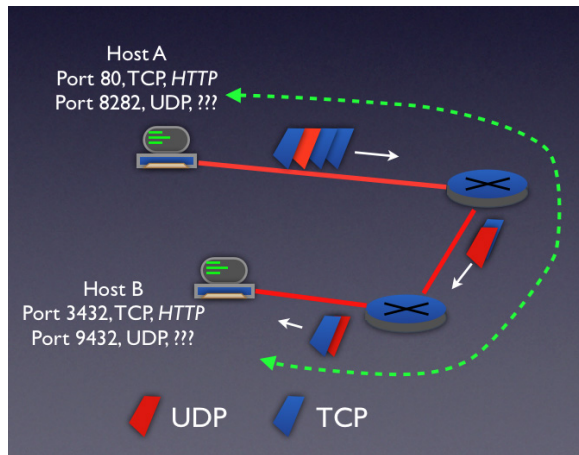
- Packet Name - Datagram
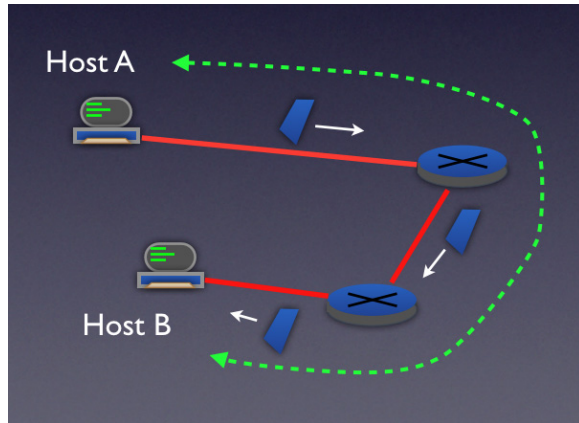
Transport Layer Details

- Process to process delivery
  - Logical communication channels between different processes

- Service Model
  - Reliable, connection oriented communication (TCP)
  - Unreliable, connectionless oriented communication (UDP)

- Addressing
  - Port numbers!
  - Ports 0 - 1023 are reserved and special!
  - Ports 1024 - 65535 are free for your use
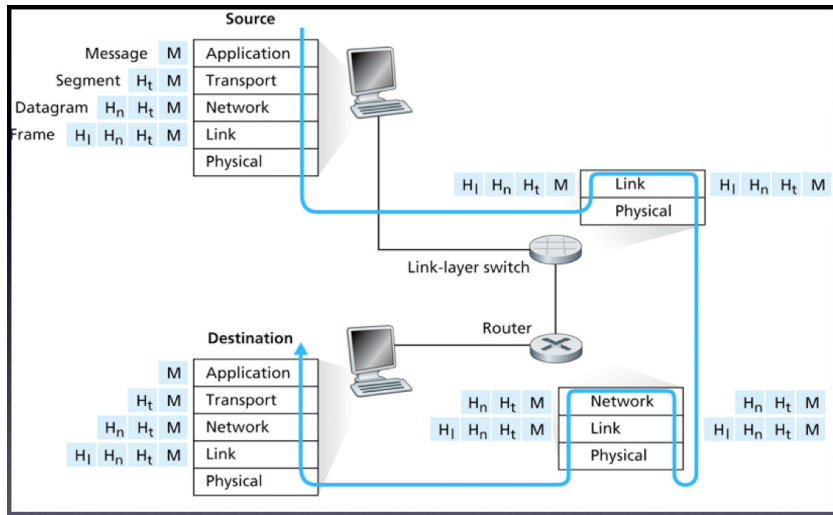
- Packet Name - Segment

Host A
Port 80, TCP
Port 8282, UDP

Host B
Port 3432, TCP
Port 9432, UDP

UDP   TCP

Application Layer Details

- User access to network
  - Network applications (web servers, web browswers, ...)

- User defined application protocols
  - Many previously defined, well known protocols (HTTP, FTP, IMAP, DNS, etc...)
  - You can and will define your own protocols

- Addressing
  - Host names and IP addresses
  - Human readable: www.cnn.com
  - Machine readable: 157.166.226.25
  - DNS - Application layer protocol that performs name to IP mapping

- Packet Name - Message

Host A
Port 80, TCP, *HTTP*
Port 8282, UDP, ???

Host B
Port 3432, TCP, *HTTP*
Port 9432, UDP, ???

UDP   TCP

Encapsulation

Physical Layer

- Many different types of physical media
  - Twisted pair copper wire
  - Coaxial cable
  - Fiber optic cable
  - Radio Transmissions
  - Satellite Transmissions

Terminology

Bandwidth describes the capacity of a physical link to transport data! The greater the bandwidth the more data that can be transferred at one instance in time across the link.

Examples of Internet Service lines:

- T1 line - 1.54 Mbps
- Optical Carrier Lines (OC)
  - OC-n: link capacity determined by n * 51.7 Mbps (Million bits per second)
  - OC-1, OC-3, OC-12, ..., OC-768
  - Compare to standard T1 lines which can handle 1.54 Mbps!

Where next?

- Programming the network...
- Through-put, delay, loss, congestion on the network