CECS 327 Intro to Networking and Distributed Computing

Seminar Notes

August 29, 2018

Goal of Networking:

- Enable communication between network applications on different end points

  Endpoint = computers, cell phones, …

  Application = web, peer to peer, streaming video

  Communication = transfer bits

- Network must understand application needs/demands

  - What data rate?

  - Traffic patter? (bursty or constant bit rate)

  - Traffic target? (multipoint or single destination)

  - Application sensitivity? (to delay, “jitter”, loss)

  - Difficulty

- How does application “use” networking?

  - client-server: web….

  - peer to peer: Skype….

Defining a “Network”

- Network = nodes + links
- Different networks:

  - The Internet

  - UWT network

  - Telephone network

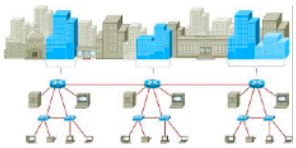
  - Home Wireless Networks

  - Others - sensor nets, cellular networks

- WAN (Wide Area Network)
    - All network talking to each other
- MAN (Metropolitian Area Network)
    - Like LAN but a bigger network

        IE: LAN = home & WAN = School

MAN



"The Internet"

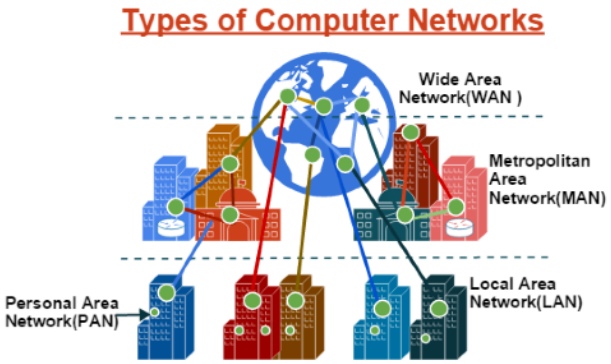
- Internet vs internet
- The interconnected set of networks of the Internet Service Providers (ISPs) and end-networks, providing data communications services
    - IE: www.csulb.edu —> .edu will provide ISPs which server to look for
    - About 17k different ISP networks make up the internet
    - ISP contact each other to find if that webaddr is cached
        - if not then it goes to DNS

Requirements

- Application Programmer

Connectivity

Terminologies



- Scale
- Link
- Nodes
- Point-to-Point (type of connection where 2 nodes talk to each other)
- Multiple Access (nodes have access to shared resources)
- Switched Network
    1. Circuit Switched
        - Circuit needs to be open until call ends
        - Second call can't be made until circuit is free

- while you are talking, package is send
    - Even if you are not talking, you send empty pack.

2. Packet Switched
    - Doesn't care about one on one circuit, as circuit is shared
    - If package needs to be send, then it is send on same circuit
    - Thus no one is waiting on circuit to open
    - Big Different: send pieces of packages, not one whole

- Packet, Message
- Store-and-Forward
- Cloud
- Hosts
- Switches
- Internetwork
- Router/Gateway
- Host-to-host connectivity
- Address
- Routing
- Unicast/Broadcast/Multicast

September 03, 2018

Labor Day

September 05, 2018

Missed

September 10, 2018

What is Layering?

• A way to deal with complexity

- Add multiple levels of abstraction

IE: Organization of Air Travel

* Ticket (Purchase)	* Ticket (Complain)
* Baggage (Check)	* Baggage (Claim)
* Gates (Load)	* Gates (Unload)
* Runway Takeoff	* Runway Landing
* Airplane Routing	* Airplane Routing

Airplane Routing

- Series of Steps

Layers: each layer implement a service

IE: Network Layering

Aplication Programs	
Request/Replay Channel	Message Stream Channel
Host-to-Host Connectivity	
Hardware	

Features of Layering

• Sub-Divided the problem

- Each layer relies on services from layer below

- Each layer exports services to layer above

- Advantages of layering?
    - Simplifies design and implementation
    - Easy to modify/evolve

Protocol

- Standardized method for transmitting data and/or establishing communications between different devices
- protocols are the key to interoperability
    - Networks are very heterogeneous

Hardware/Link	Ethernet: 3com, Dlink
Network	Routers: Cisco, Juniper etc.
Application	APP: Email, IM, IE, etc.

- Must speak the same language
- All hardware/software must communicate with each other with same specification
    - even if they are from different vendor

Protocol Layering

- Protocols exist at many levels
    - Application level protocols
    - Protocols at the hardware level
- Each protocol provides different service to higher layers and relied on services from lower layers
- Protocols build upon each other
    - adds value, improves functionality overall
        - IE: a reliable protocol running on top of IP
    - Reuse, Avoid Re-writing
        - IE: OS provides TCP, so application don’t have to rewrite

Protocols Interfaces

- Each protocol offers interfaces to communicate with each other
  - Service Interface:
    - Defines operations on this protocol
  - Peer-to-Peer Interface:
    - Defines messages exchanged with peer

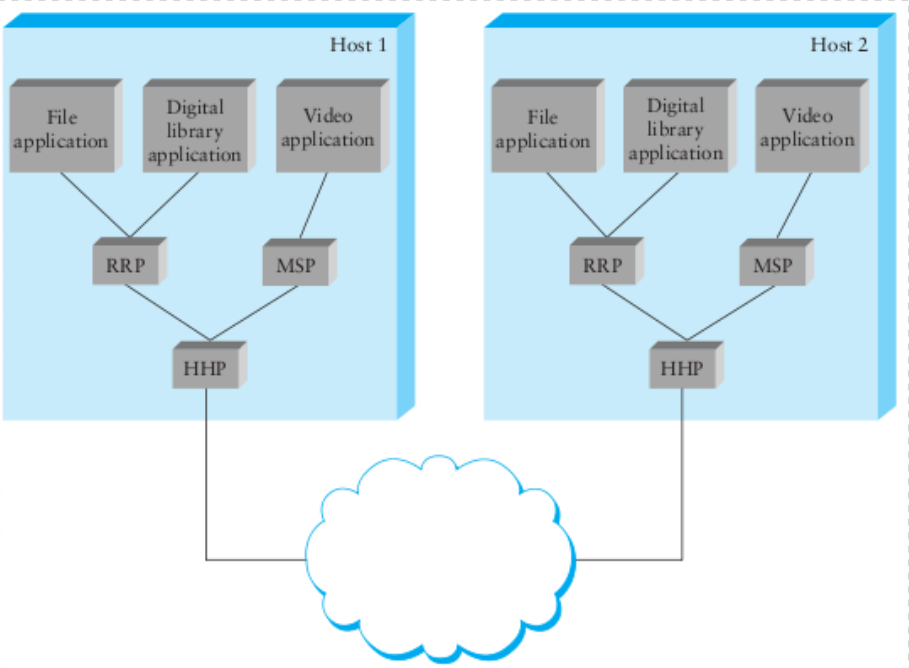
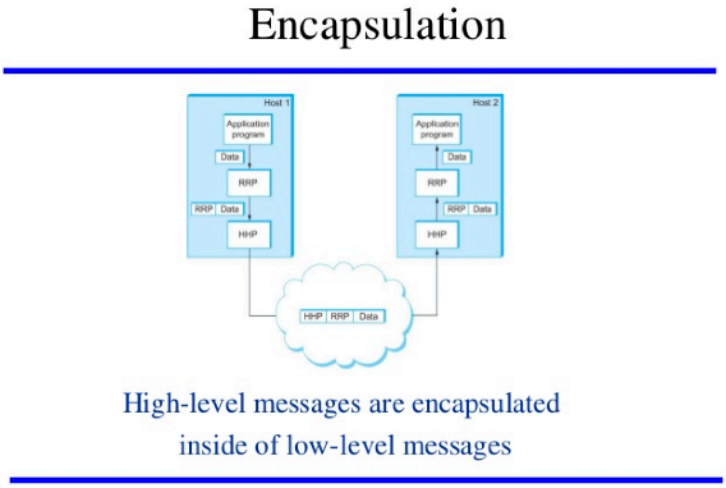


Figure 1.11 Example of a protocol graph.

Encapsulation

- High-Level messages are encapsulated inside of Low-Level messages



OSI (Open Systems Interconnection) Architecture: 7-layers

Description of Layers (1)

- Physical Layer
  - • Handles the transmission of raw bits over communication link
- Data Link Layer
  - • Collects bits of data into larger “Frame”
  - • Network adaptor implement the protocol in this layer
  - • Frames are actually delivered to hosts
- Network Layer
  - • Handles routing among nodes within a pack-switched network
  - • “Packet” are exchanged here

  Frame vs Packet:

  - Frames are used in switch and hub while packet is used in router
  - Switches and Hubs use MAC address to send Frame
  - Routers use IP address to send Packet

Description of Layers (2)

- Transport Layer
  - • Implements a process-to-process channel
  - • Unit of data exchanges in this layer is called a “Message”
- Session Layer
  - • Mechanism of Opening, Closing, and Managing communication between hosts
- Presentation Layer
  - • Concerned about the format of data exchanged between peers
- Application Layer

• Ensure applications communication with other apps.

September 12, 2018

More about OSI Model

Why 7 Layers?

• Many Fundamental issues can be addressed at multiple layers

- Flow Control
- Reliability
- Addressing

Not Widespread Acceptance? Why?

TCP/IP Model

Application protocols

Two Transport protocols: provide logical channels to applications

OSI vs TCP/IP

7 layers for OSI

TCP/IP =

- Application
- TCP/UDP
- IP
- Network

Switch is faster because it doesn't slow anyone else down

Encapsulation:

Know:

Message vs segment vs datagrain vs frame

Multiplexing and Demultiplexing

• Packet header includes a demultiplexing field

September 17, 2018

Performance:

• Bandwidth

- How many bits can be crammed over the network in one second?

- What if throughput?

• Latency or Delay

- How long does it take a message to travel from one end of a network to the other?

• The Delay-Bandwidth product is a measure of network capacity

Bandwidth:

Def: Maximum number of bits per second that can be transmitted over a communication link

• Width of the frequency band

Latency:

• Sources of delay

Router

- Put data in queue if its capacity is full

- Queue affect latency, bigger queue means slower internet

Latency = Propagation + Transmit + Queue

Propagation = distance/speed of light

- Propagation Delay = delay over distance at current time

Transmit = size/bandwidth

Queue

• Depends on congestion

Using “ping” command:

3 Results:

1. Reply back
2. Request Time Out
3. Destination Unreachable

TTL = Time To Live

- If we don’t have time to live, the packet could loop through many different router indefinitely

Traceroute:

IE: going to google.com, how many hoops you need to take to get there

- It is not always a straight shot

Throughput

Def: Actual rate (bits/time unit) at which bits transferred between sender/receiver

• Instantaneous: rate at given point in time

• Average: rate over longer period of time

Bandwidth vs Latency

Delay X Bandwidth

• Network Capacity = Delay-Bandwidth product

•How many bits the sender must transmit before the first bit arrives at the receiver if the sender keeps the pipe full

• takes another one way latency to receive a response from the receiver

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September 19, 2018

Interconnecting LANs

Why not have one big LAN?

- Too much traffic

Collision Domain

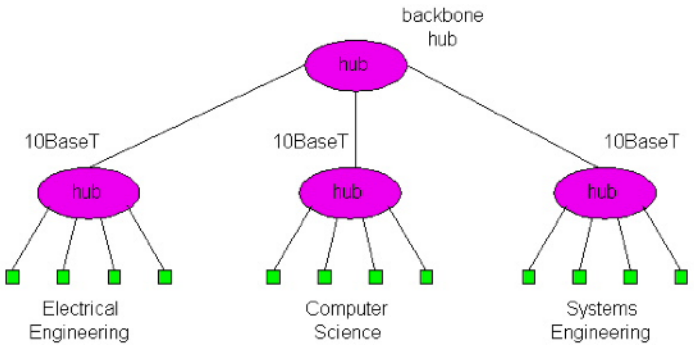
- part of a network where packet collisions can occur
- when two devices set information at the same time

Hubs

- Physical Layer Devices

  - Repeaters operating at bit level

- can be arranged in a hierarchy (or multi-tier design) with backbone hub at its top



Limitations

- single collision domain results in no increased

Switch

- Link Layer devices: operate on Ethernet frames, examining frame header and selectively forwarding frame based on its destination
- Switch isolates collision domains since it buffers frames
- When frame is to be forwarded on segment, switch uses CSMA/CD to access segment and transmit

  - CSMA/CD = Carrier-Sense Multiple Access with Collision Detection

Advantages

- Due to CSMA/CD, lead to higher total max throughput
- does not limit the number of nodes nor geographical coverage

- can connect different type Ethernet since it is a store

Switch BackBone does exist as well.

Interconnection without Backbone

• Not recommended

Switch Filter Packets:

• Same-LAN - segment frames not forwarded onto other LAN Segments

Forwarding:

• How does the switch know where to send frame?

Switch Filtering:

• Switch learn which hosts can be reached through which interfaces

- maintain filtering tables

Switch Learning

September 24, 2018

Review:

Collision Domain

• the part of a network where packet collision can occur.

- happens when 2 devices send a packet at the same time on share network segment

Bridges

• connect two segments, but work at the frame level

• use promiscuous mode and forward all frames

- designed for testing/debugging

- allows interface to accept all frames

- available on most interface hardware

• Frame filtering

Basic Internetworking (IP):

IP Address is a 32-bit address

- it is unique

Address Space Rule:

• address space of IPv4 is 2^{32} = 4,295,967,296

123.12.32.44

Classful Addressing

• divided into 5 classes

Finding the class in binary notation: First Byte determine class

	First Byte	Second	Third	Fourth
Class A	0 (0 - 127)			
Class B	10 (128 - 191)			
Class C	110 (192 - 223)			
Class D	1110 (224 - 239)			
Class E	1111 (240 - 255)			

Ranges of A to B, if you are lower than B then you are class A

Private IP Address: Reserve

10.0.0.0 - 10.255.255.255

172.16.0.0 - 172.31.255.255

192.168.0.0 - 192.168.255.255

September 26, 2018

Simple Internetworking

• Focus on a single internetwork

- internetwork = combination of multiple physical networks

IP Address

• Internet addressing is specified in the IP protocol

• Each hose is unique 32 bit address

IPv4

- Fixed Length: 32 bits

- Total IP address size: 4 Billion

Router:

• Router typically have multiple interfaces

• host typically has one interface

• IP addresses associated with each interface

IP Address Hierarchy

• Each 32 bit address is divided into two parts

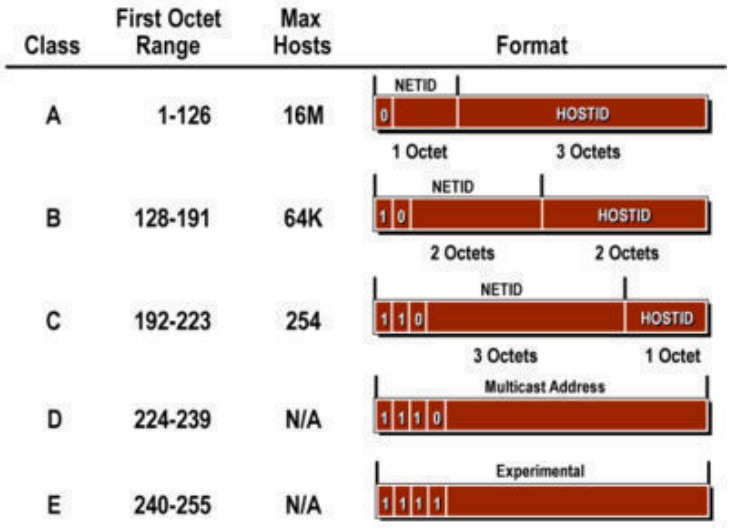
- Prefix: physical network to which the host is attached

IE: the network number

- Suffix: a host attached to a given physical network

IE: Host number

• Prefixes are coordinated globally and suffixes locally



Addressing Example

- Global Internet
  - ISP coordinates with Internet Assigned Number Authority agency to assign IP

Prefix	Suffix	Type of Address	Purpose
All - 0s	all - 0s	this computer	used during bootstrap
network	all - 0s	network	identifies a network
network	all - 1s	directed broadcast	broadcast on specified net
all - 1s	all - 1s	limited broadcast	broadcast on local net
127	any	loopback	testing

Issues with Classful Addressing

- Original Goal: Network part would uniquely identify a single physical network
- But
  - being exhausted IP address
  - inefficient address space usage
    - Class A & B networks too big

Solution: Subnetting

Subnetting

- Add another “subnet” layer to hierarchy
- Variable length subnet masks

  Benefits:

  - Security - Organization - Performance
- Each IP class has a default subnet:

  Class A: 255.0.0.0

  Class B: 255.255.0.0

Class C: 255.255.255.0

October 1, 2018

October 3, 2018

September 17, 2018