

# CECS 327 Intro to Networking and Distributed Computing

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## 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 pattern? (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

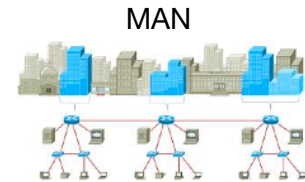
- Different networks:

- 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 (Metropolitan Area Network)
  - Like LAN but a bigger network

IE: LAN = home & WAN = School



## “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](http://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

## Types of Computer Networks



- 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

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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

Application 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.

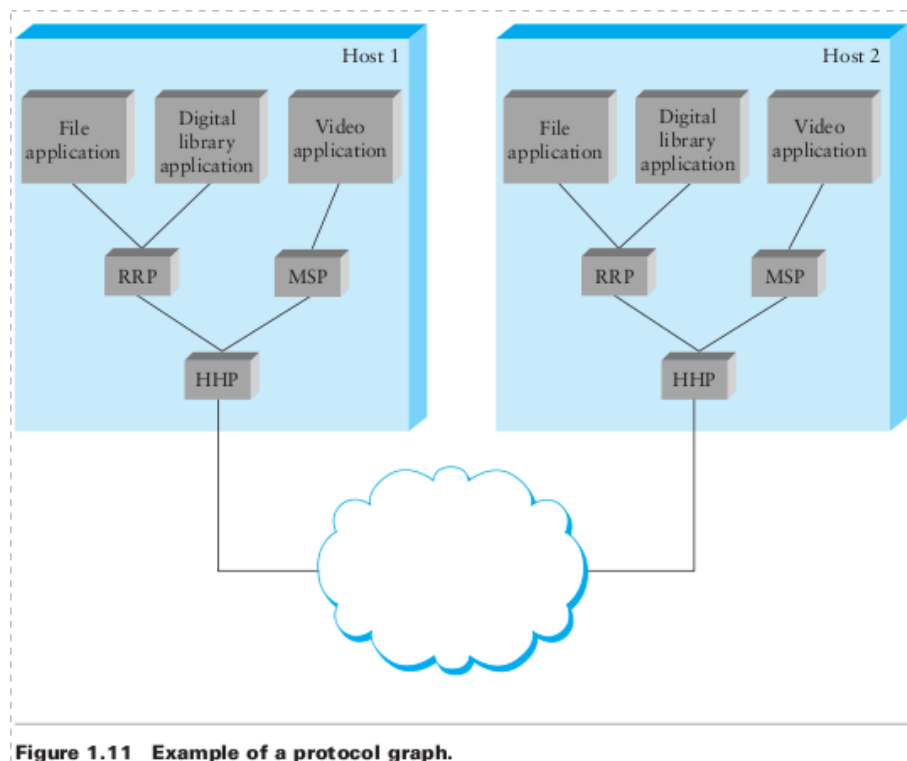
- Must speak the same language
- All hardware/software must communicate with each other with same specification
  - even if they are from different vendor

## 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

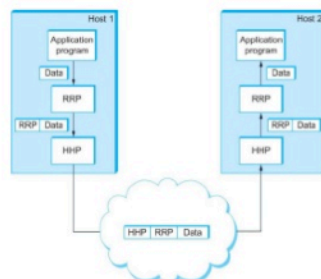
- Each protocol offers interfaces to communicate with each other
  - Service Interface:
    - Defines operations on this protocol
  - Peer-to-Peer Interface:
    - Defines messages exchanged with peer



## Encapsulation

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

### Encapsulation



## 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.

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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 datagram vs frame

Multiplexing and Demultiplexing



- Packet header includes a demultiplexing field
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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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Interconnecting LANs

Why not have one big LAN?

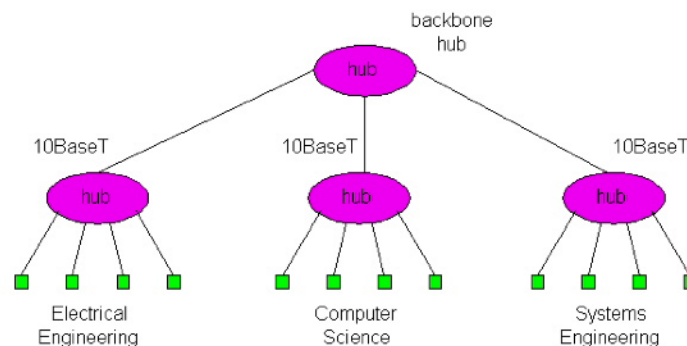
- Too much traffic

## 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

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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
<b>Class A</b>	0 (0 - 127)			
<b>Class B</b>	10 (128 - 191)			
<b>Class C</b>	110 (192 - 223)			
<b>Class D</b>	1110 (224 - 239)			
<b>Class E</b>	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

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September 26, 2018

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October 1, 2018

October 3, 2018

September 17, 2018