Networking Basics(SysSec)

UBNetDef, Spring 2021
Week 2
Lead Presenter: Gursimran Singh
Special Thanks: Phil Fox, Aibek Zhylkaidarov, Anthony Magrene

What is Networking?

- An interconnection of multiple devices, also known as hosts, that are connected using multiple paths for the purpose of sending/receiving data or media.
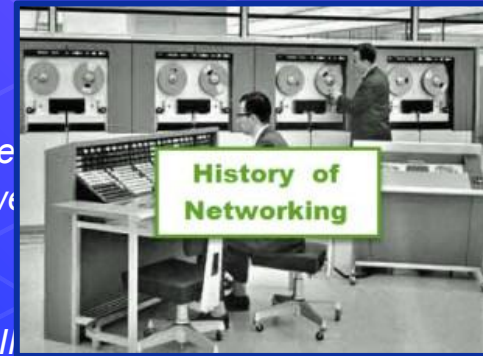
- Example - Internet is a Network of Networks.

Why Networking?

- Sharing of information and resources - faster communication, Overcoming geographic separation, VoIP, etc.

- Good knowledge of basic Networking and Network devices and protocols is really important if you want to protect any company from adversaries who may try to steal sensitive information.

Some Major Events in History

- *The idea of ARPANET, one of the earliest computer networks, was proposed by Leonard Kleinrock in 1961, in his paper titled "Information Flow in Large Communication Nets."*
- *The first RFC surfaced in April 1969, as a document to define and provide information about computer communications, network protocols, and procedure*
- *The Internet was officially born, with the first data transmission being sent betwe UCLA and SRI on October 29, 1969, at 10:30 p.m.*
- *Ray Tomlinson sent the first e-mail in 1971.*
- *Internet Protocol version 4, or IPv4, was officially defined in RFC 791 in 1981. I was the first major version of the Internet protocol.*
- *The first version of the 802.11 standard for Wi-Fi is introduced in June 1997, providing transmission speeds up to 2 Mbps.*


History of Networking

How it works?

1. **Internet**
2. **Physical Link**
   1. **Guided/Unguided**
3. **Devices**
   1. **Router, Modem, Switch, Hub, WAP, Firewall**
4. **Protocols**
5. **Organizing the Complexity**
   1. **Layering and Models**
6. **Types of Networks**
   1. **LAN,MAN,WAN**

Internet

- Network of Networks.

- Billions of connected computing devices(hosts/end systems) running network apps communicating via communication link (fiber/copper/radio/satellite) by forwards packets (chunks of data) through routers and switches.

- Network Edge, Network Core, Access Networks
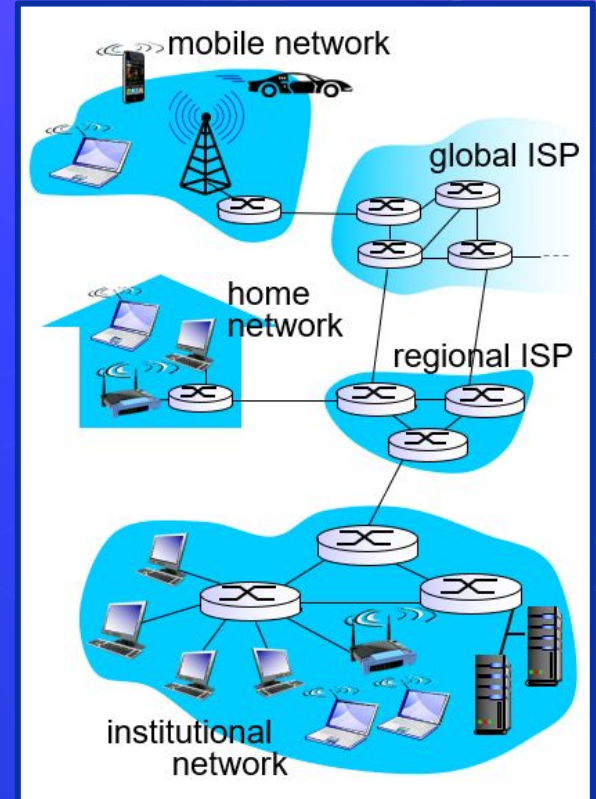
Internet

- Network Edge - hosts: Clients and Servers

- Network Core - Interconnected routers, Network of Networks

- Access Networks/Physical Media - Wired/Wireless Links
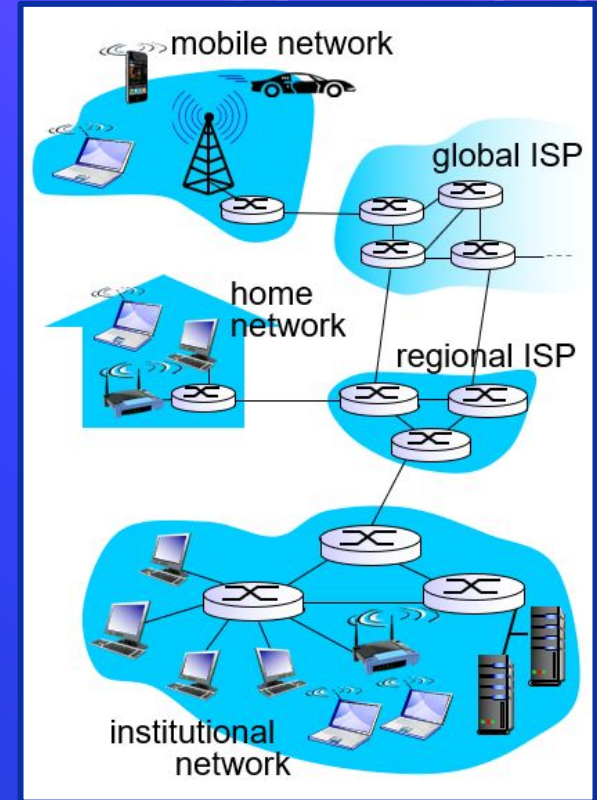
Physical Link

- It is what lies between transmitter and receiver propagating bits of data in form of signals.

- Guided media - Signals propagate in solid media. Example - Twisted Pair, Coaxial, Fiber optic Cable, etc.

- Unguided media - Signals propagate freely. Example - radio links (Microwave,WiFi, Cellular, Satellite), etc.

Differences between:

Coaxial Cable

Twisted-Pair Cable

Fiber-Optic Cable

- transmission of signals happens in the electrical form over the inner conductor of the cable
- higher noise immunity than twisted-pair cable
- moderate cost
- moderately high bandwidth
- low attenuation
- easy to install
- get disturbed by external magnetic field

- transmission of signals happens in the electrical form over the metallic conducting wires
- low noise immunity
- cheapest
- low bandwidth
- very high attenuation
- easy to install
- get disturbed by external magnetic field

- signal transmission happens in optical forms over a glass fiber
- highest noise immunity
- expensive
- very high bandwidth
- very low attenuation
- difficult to install
- not affected by the external magnetic field
- most efficient
- glass fibler

Important terms

◇ IP Address - An **Internet Protocol address** (**IP address**) is a numerical label assigned to each device connected to a computer network.

◇ Subnet Mask - An IP address has two components, the network address and the host address. A subnet mask separates the IP address into the network and host addresses (<network><host>). Subnetting further divides the host part of an IP address into a subnet and host address (<network><subnet><host>).

Important terms

⬡ **Subnet Mask**

Shorthand	Network Mask	# Hosts per subnet
/8	255.0.0.0	16,777,214
/16	255.255.0.0	65,534
/24	255.255.255.0	254

Example:

IP Address: 192.168.1.1   (192.168.0.0/16)

Subnet Mask: 255.255.0.0

Important terms

⬡ **Subnet Mask**

11111111   11111111   00000000   00000000

255   .   255   .   0   .   0

⬡ Default Gateway - A gateway is a network node that serves as an access point to another network, often involving not only a change of addressing, but also a different networking technology.

⬡ DNS - DNS translates domain names to IP addresses so browsers can load Internet resources.

Important terms

- DHCP - The **Dynamic Host Configuration Protocol** (**DHCP**) is a network management protocol used on Internet Protocol (IP) networks, whereby a DHCP server dynamically assigns an IP address and other network configuration parameters to each device on the network, so they can communicate with other IP networks.

- Ports - In computer networking, a **port** is a communication endpoint.

- MAC Address - A **media access control address** (**MAC address**) is a unique identifier assigned to a network interface controller (NIC) for use as a network address in communications within a network segment.

Devices

- **Modem** - A modem is often provided by your ISP (Internet Service Provider) which enables a network access to the internet(using DSL, cable connection or fiber).

- **Router** - When connecting more than one device to a modem, a router is generally required. A router acts as the "traffic director" of a network.

- **Switch** - A switch is used to provide additional ports, expanding the capability of the router. (No routing - based on **MAC**)
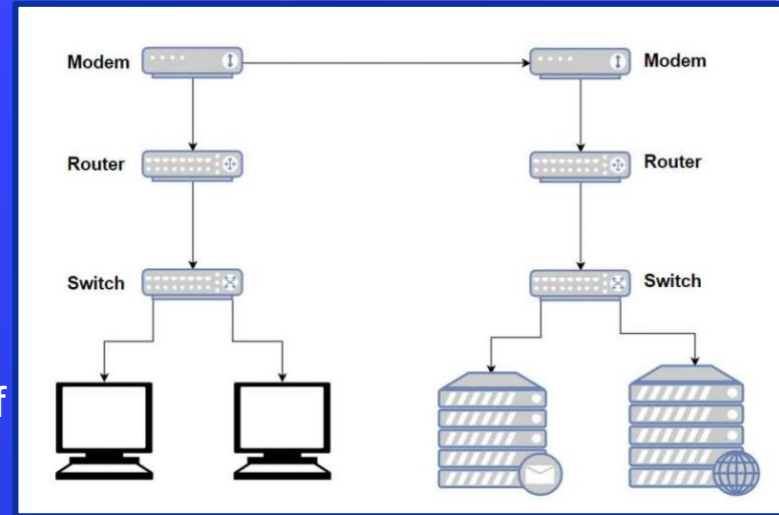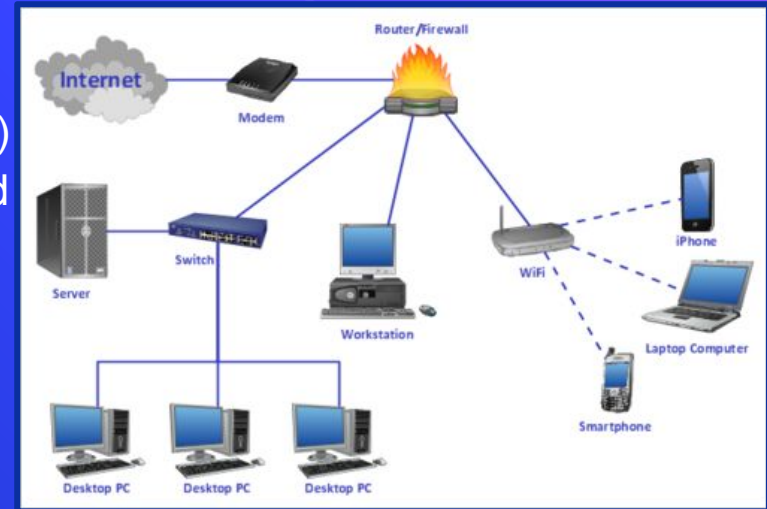
Devices

- **Hub** - It is the most basic networking device that connects multiple computers or other network devices together.

- Unlike a network switch or router, a network hub has no routing tables or intelligence on where to send information and broadcasts all network data across each connection.

- **Firewall** - **firewalls** monitor the traffic **and** helps block unauthorized traffic coming from the outside trying to get into your network
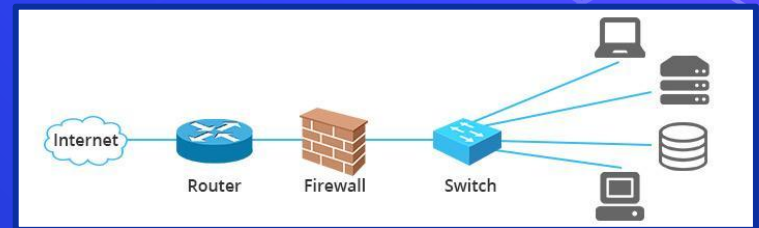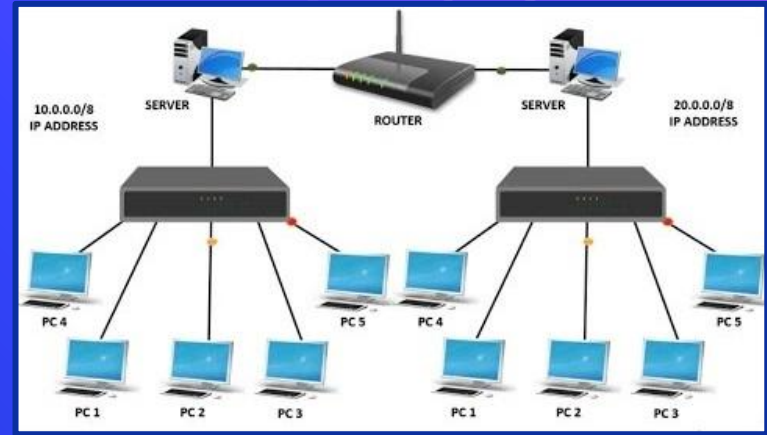
Devices

- **WAP (Wireless Access Point) -** A wireless access point (WAP) is a hardware device or configured node on a local area network (LAN) that allows wireless capable devices and wired networks to connect through a wireless standard, including Wi-Fi or Bluetooth.

- Home Router is often a combination of Modem, Router, Firewall and WAP.

Protocols

- A set of rules or procedures for transmitting data between electronic devices, such as computers.

- **Human protocols:** "What's the time?" , " I have a question?" , introductions

- **Computer Protocols:** Specific msg sent, what action to take if msg is received, how to determine the destination, etc.

- Examples :- DHCP , TCP/IP, etc.
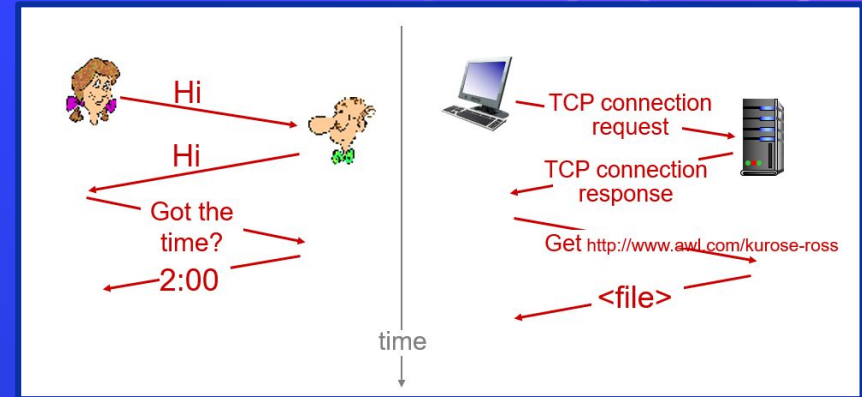
Protocols

- **DHCP** - DHCP (Dynamic Host Configuration Protocol) is a protocol that provides quick, automatic, and central management for the distribution of IP addresses within a network.

- **TCP/IP** - Short for **transmission control protocol/Internet protocol**, **TCP/IP** is a set of rules (protocols) governing communications among computers on the Internet. More specifically, TCP/IP dictates how information should be packaged (turned into bundles of information called packets), sent, and received, and how to get to its destination.

Organizing the Complexity

Networks are complex with many pieces - hosts, routers, links, applications, protocols, etc.

Layering - Key idea in computer science to simplify network design complexity.

- ⬡ Organize protocols and hardware/software implementing the protocols in layers.
- ⬡ Upper layers use services provided by lower layers.
- ⬡ The protocol layers form a protocol stack (protocol suite, protocol architecture).

Organizing the Complexity

TCP/IP Protocol Stack -

- *Application*: supporting network applications - FTP, SMTP, HTTP
- *Transport*: process-process data transfer - TCP, UDP
- *Network*: routing of datagrams from source to destination - IP, routing protocols
- *Link*: data transfer between neighboring network elements - Ethernet, 802.111 (WiFi), PPP
- *Physical*: bits "on the wire"
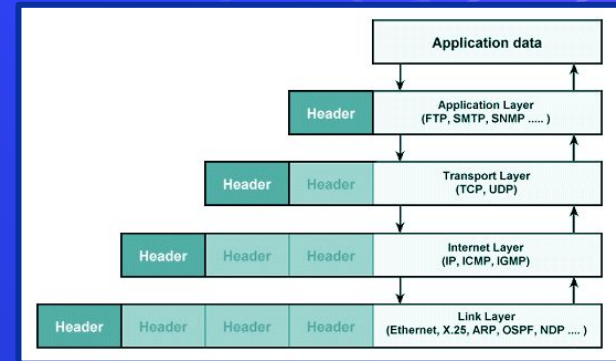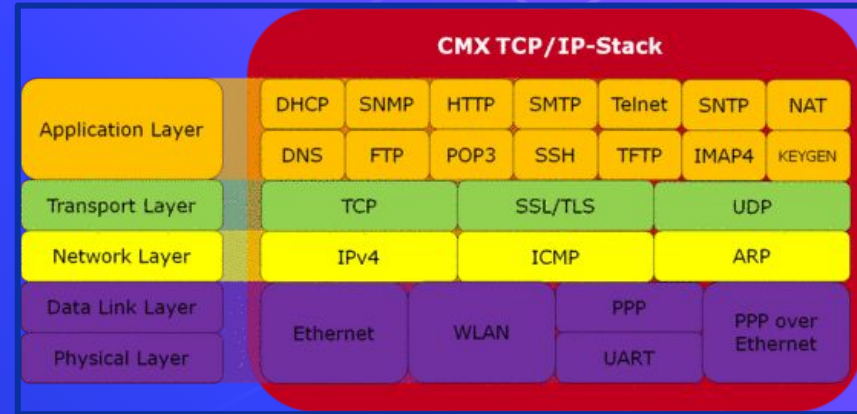
Types of Networks

LAN or **Local Area Network** connects network devices in such a way that personal computer and workstations can share data, tools and programs.

WAN or **Wide Area Network** is a computer network that extends over a large geographical area, although it might be confined within the bounds of a state or country.

MAN or **Metropolitan Area Network** covers a larger area than that of a LAN and smaller area as compared to WAN.

PAN is a computer network formed around a person consisting of a computer, mobile, or personal digital assistant.
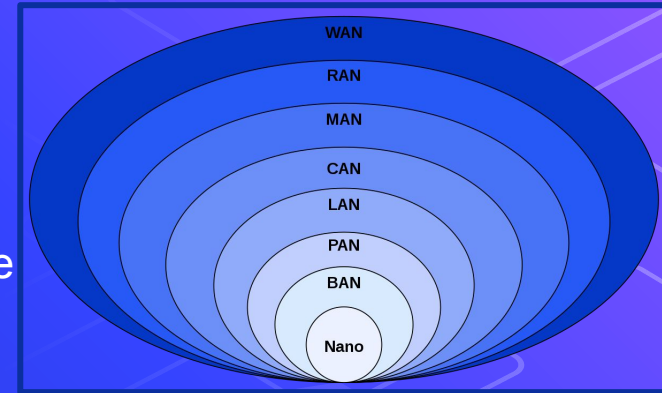
Summary

○ What is a router ?

○ What is a switch ?

○ What is a Firewall ?

○ Protocols - A set of rules or procedures for transmitting data between electronic devices, such as computers.

Homework

- Activity 1: **Use CLI** to migrate client VMs
  - Core Red (Gretzky) to Generic
  - Use finalized SysSec IP conventions
- Activity 2: Build topologies by scenario
  - Given a network description: build a topology.
- Update Topology

NetDef