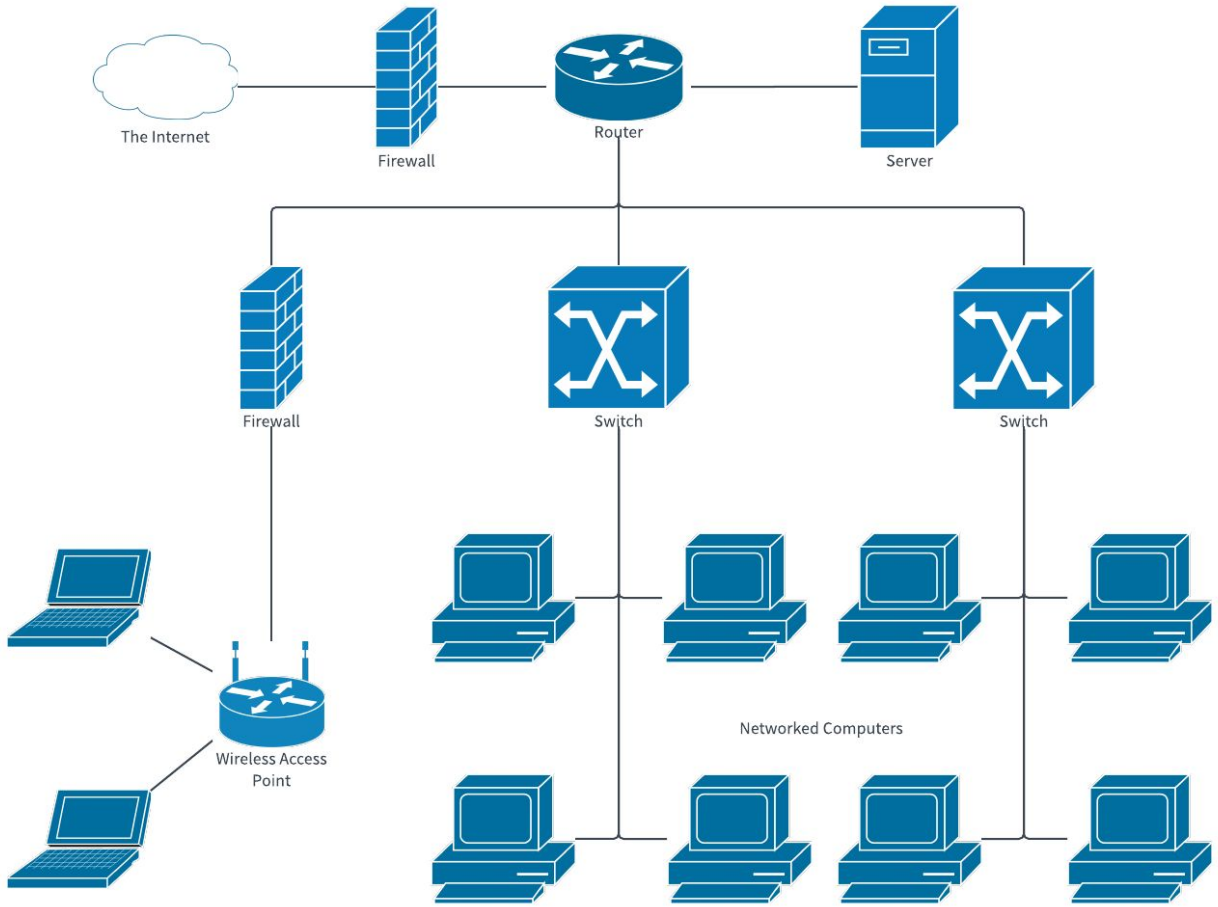
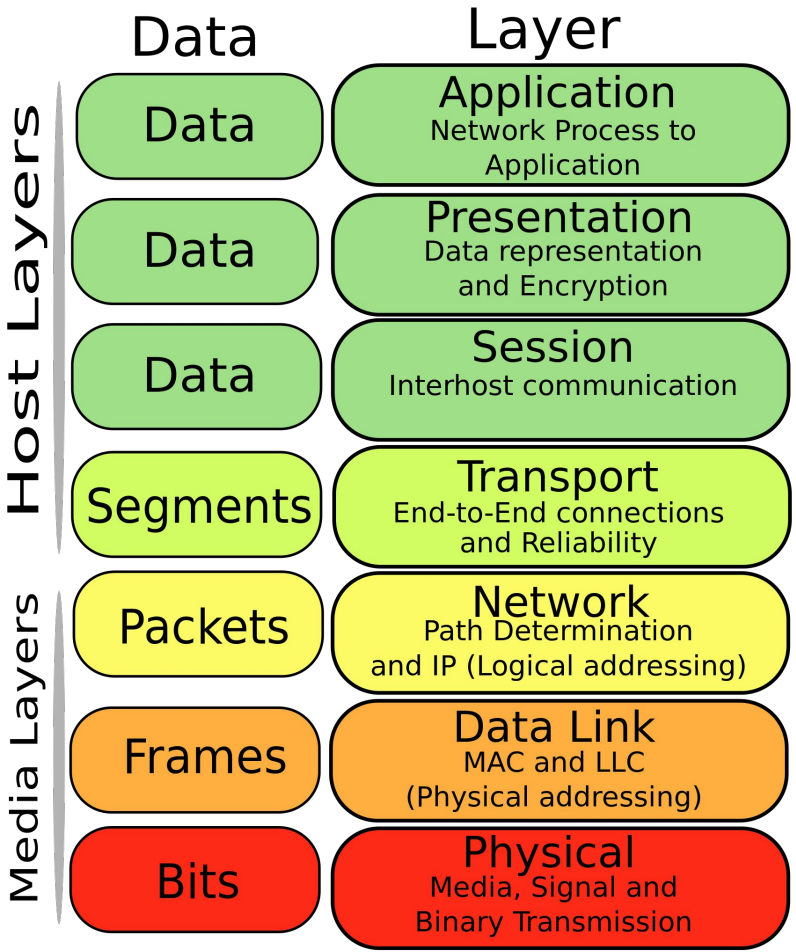
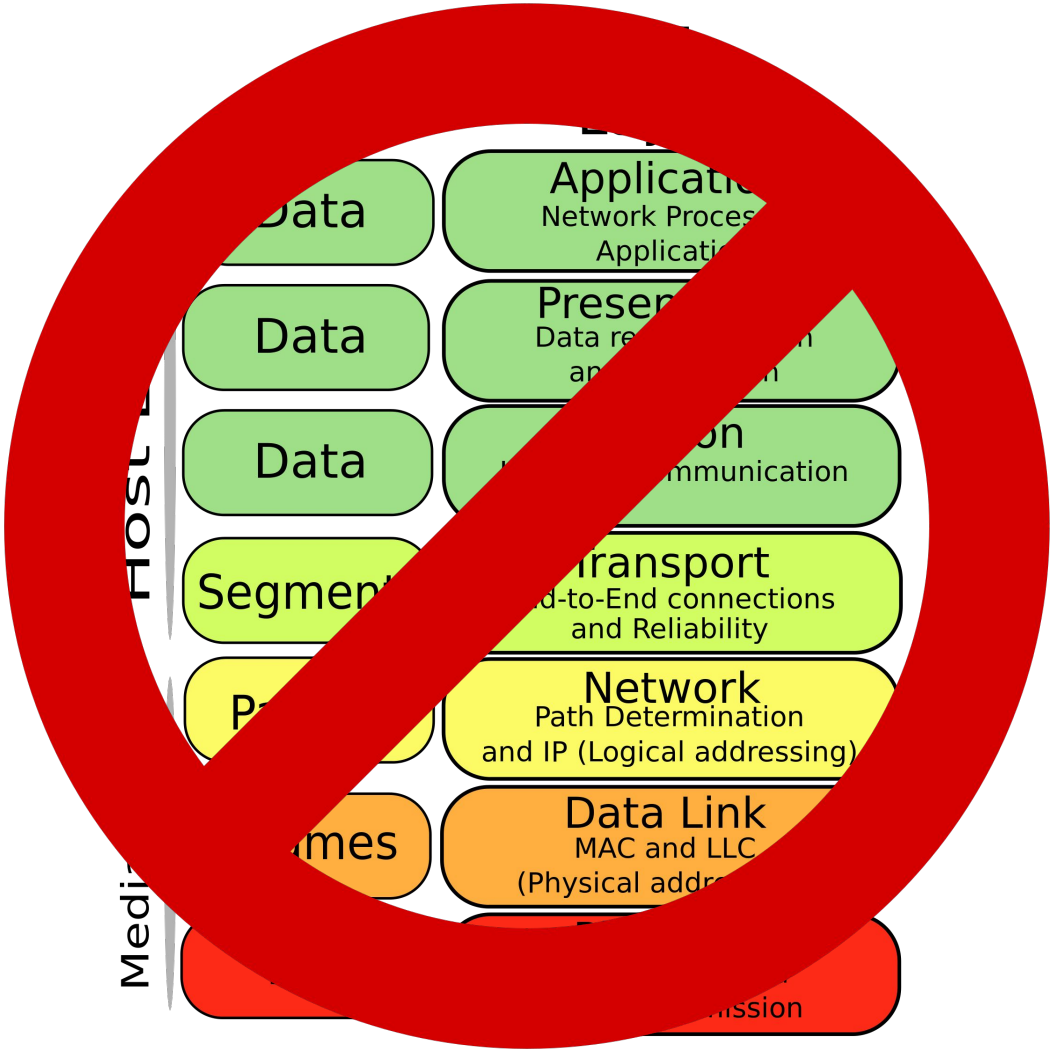
Introduction to Networking!

The parts I think will be useful to you, anyway. I’m glossing over a lot, but this will give you a general sense of how stuff works


The Internet
Firewall
Router
Server
Firewall
Switch
Switch
Wireless Access Point
Networked Computers

OSI Model


Data
Layer
Host Layers
Media Layers
Data
Application
Network Process to Application
Data
Presentation
Data representation and Encryption
Data
Session
Interhost communication
Segments
Transport
End-to-End connections and Reliability
Packets
Network
Path Determination and IP (Logical addressing)
Frames
Data Link
MAC and LLC (Physical addressing)
Bits
Physical
Media, Signal and Binary Transmission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The Three Layers that Matter

- Transport
  - Handles data reliability and flow control
  - Address: Port number
    - Identifies a specific program on a device
    - Example: 80
- Network
  - Gets data from point A to point B across different networks
  - Address: IP Address
    - Identifies a computer between networks
      - (Except for private addresses...)
    - Example: `159.89.147.177`
- Data Link
  - Gets data from point A to point B within a network
  - Address: MAC Address
    - Identifies a computer within a network
    - Example: `6c:40:08:bd:2a:d0`

Transport Layer Protocols

- TCP
  - Most common
  - Reliable
  - Order guaranteed
- UDP
  - Unreliable (though in practice it’s pretty reliable tbh)
  - Order not guaranteed
- ICMP
  - Used for control messages between routers, mostly
  - Also used for pings

Port Numbers

- Every program that’s listening for connections has a port number
- Common ports:
  - 80 - HTTP
  - 443 - HTTPS
  - 22 - SSH
  - 53 - DNS
  - 3389 - RDP
- The connection initiator uses a random high port as the source

IP and Routing

- This was a lot simpler before 1996
- Every device had a public IP address and could easily talk to any other device in the world
- The general process:
  - Is the computer I want to talk to part of my network?
    - If yes: send the data directly
    - If not: send the data to your router
      - Your router will send the data on to another router
      - The data will keep being passed through routers until it reaches its destination

DNS

- Remembering the IP address of every website would be a pain, fortunately DNS exists

The Problem with IPv4

- There are only 4,294,967,296 IPv4 addresses
- There are ~7,661,105,082 people alive right now
- A lot of them own more than one internet-connected device
- The solution? Private addressing

Private Addressing

- There are 3 blocks of private addresses
  - 10.0.0.0 – 10.255.255.255
  - 172.16.0.0 – 172.31.255.255
  - 192.168.0.0 – 192.168.255.255
- Not publicly routable

Private Addressing Example

Open up a terminal and type “`ipconfig`” (or “`ifconfig`” if you’re not on Windows).

Then Google “ip address”.

They’re different!

Private Addressing

- The translation between public and private addresses is called network address translation (NAT)
- You don’t need to understand how it works, just remember that it exists

How IP Addresses Work

- 32-bit integers that we split into 4 octets to make things easier
- Separated into a network address and a host address by bitwise AND with a subnet mask
- Example:
  - Address: 1.2.3.4
  - Subnet mask: 255.255.255.0
  - Network address = Address & subnet mask = 1.2.3.0
- Oh, also, the last address in a subnet is the broadcast address
- Let’s try some more examples

A Note About IPv6

- There’s a newer version of IP that uses 128-bit addresses, but adoption has been slow
- It works similarly to IP in most other ways
- I finished my networking classes the year before IPv6 was introduced to the curriculum, so I honestly don’t know as much about it as I should

MAC Addresses

- Significant only within your local subnet
- 48-bit integers expressed as 6 hexadecimal octets
- Example: `6c:40:08:bd:2a:d0`
- Globally unique
  - The first 3 octets define the manufacturing organization
  - The last 3 define the specific network interface
  - In the above example:
    - `6c:40:08` is one of Apple's vendor prefixes
    - `bd:2a:d0` is my laptop's wifi card specifically
- Broadcast address: `ff:ff:ff:ff:ff:ff`

Let’s try making a human network

Hopefully this works and makes sense