Intro to Networking

October 27, 2025

Before we get started...

Nerdy definition of network

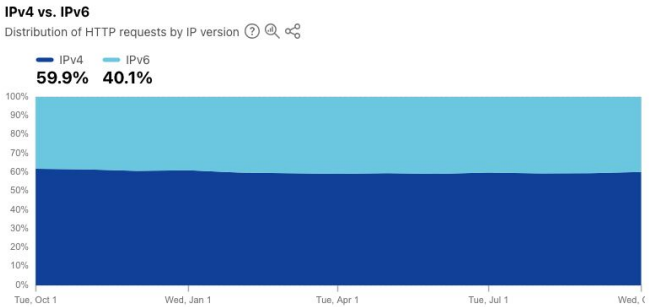
- A tool that lets two or more **nodes** (or **devices** or **endpoints**) communicate via a **protocol**
- Nodes exchange data using **packets**

Ref: https://xkcd.com/thing-explainer/

internet or Internet?

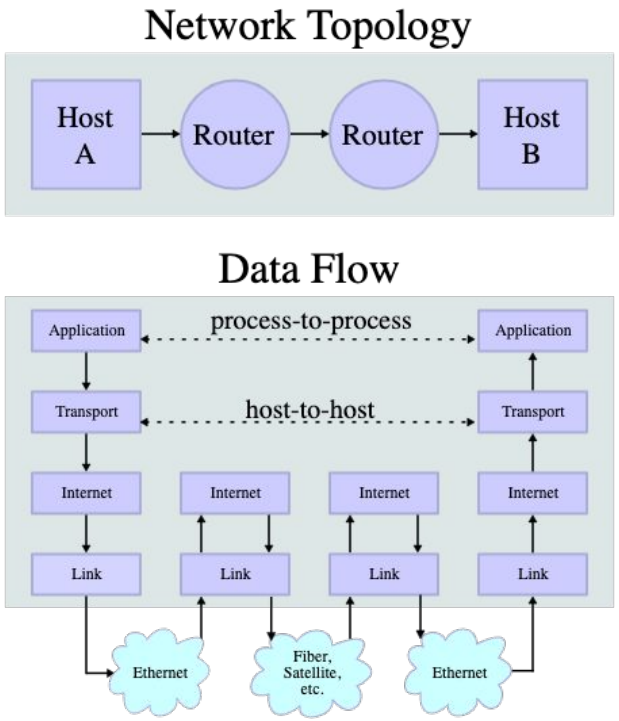
- internet = interconnected network
- Internet = global (for now) internet that uses TCP/IP protocol

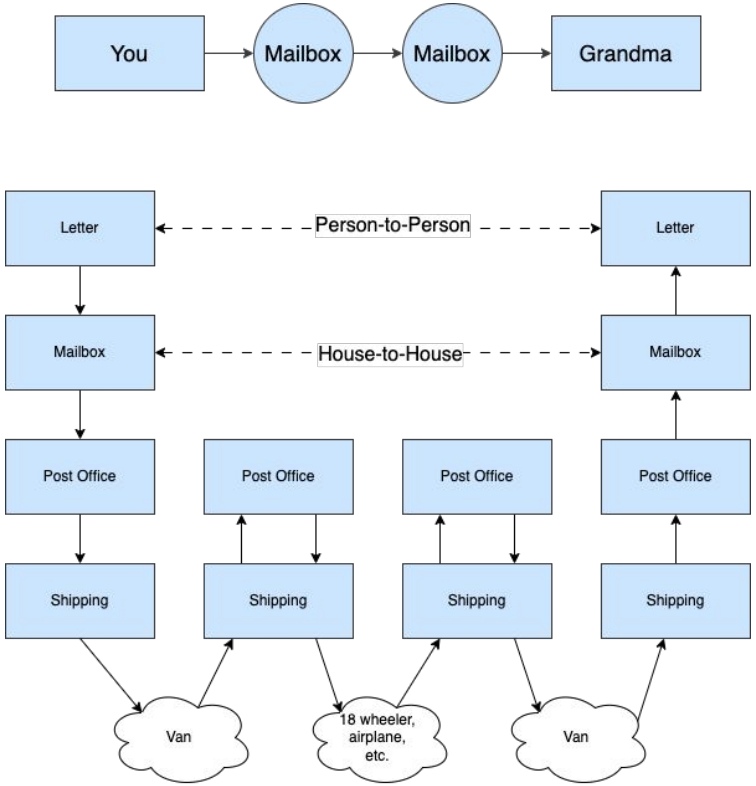
TCP/IP



- Transmission Control Protocol/Internet Protocol suite
- Developed in 1970s by Vint Cerf & Robert Kahn
- Every node on a network requires at least one address, every service has a port number
- IPv4 (1983): very-widely deployed, showing its age, supports 4 billion addresses (4,294,967,296)
- IPv6 (2017): usage increasing, path to the future, supports 340 undecillion addresses (340,282,366,920,938,463,463,374,607,431,768,211,456)
- Up to 65K ports per node

TCP/IP “Stack”


Network Topology
Host A
Router
Router
Host B
Data Flow
Application
process-to-process
Application
Transport
host-to-host
Transport
Internet
Internet
Internet
Internet
Link
Link
Link
Link
Ethernet
Fiber, Satellite, etc.
Ethernet

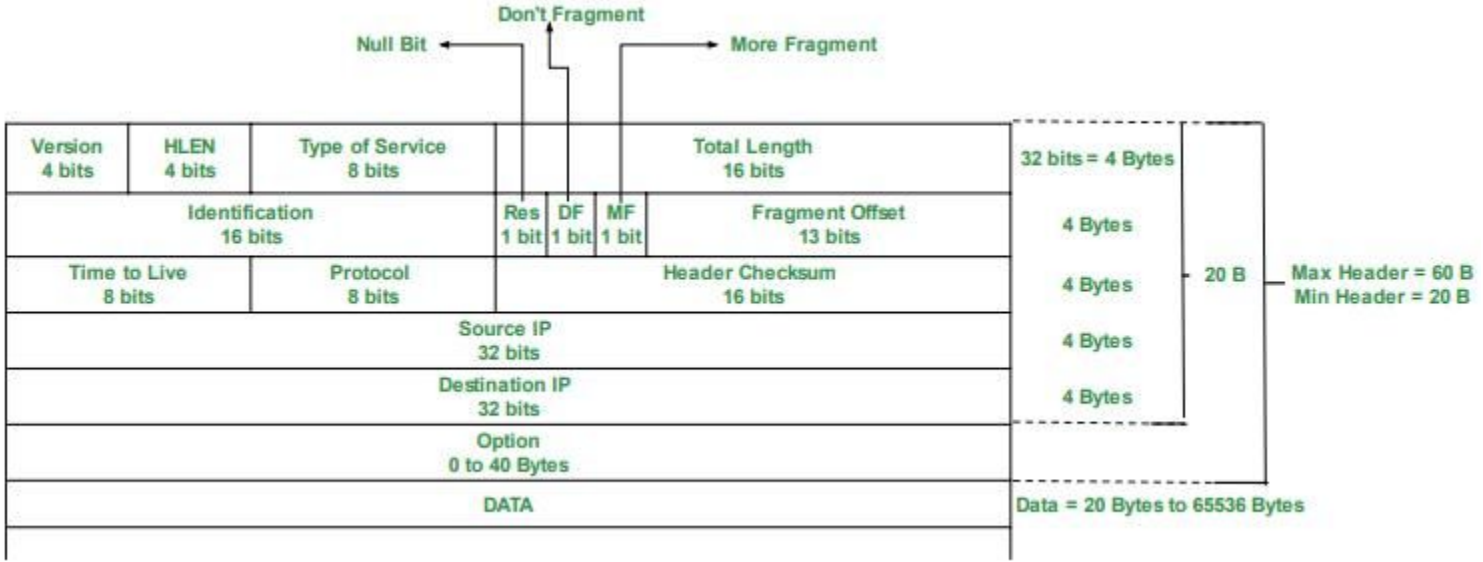

You
Mailbox
Mailbox
Grandma
Letter
Person-to-Person
Letter
Mailbox
House-to-House
Mailbox
Post Office
Post Office
Post Office
Post Office
Shipping
Shipping
Shipping
Shipping
Van
18 wheeler, airplane, etc.
Van

Ethernet Frame

802.3 Ethernet packet and frame structure

Layer	Preamble	Start frame delimiter (SFD)	MAC destination	MAC source	802.1Q tag (optional)	Ethertype (Ethernet II) or length (IEEE 802.3)	Payload	Frame check sequence (32-bit CRC)	Interpacket gap (IPG)
Length (octets)	7	1	6	6	(4)	2	42–1500[c]	4	12
Layer 2 Ethernet frame	(not part of the frame)		← 64–1522 octets →						(not part of the frame)
Layer 1 Ethernet packet & IPG	← 72–1530 octets →								← 12 octets →

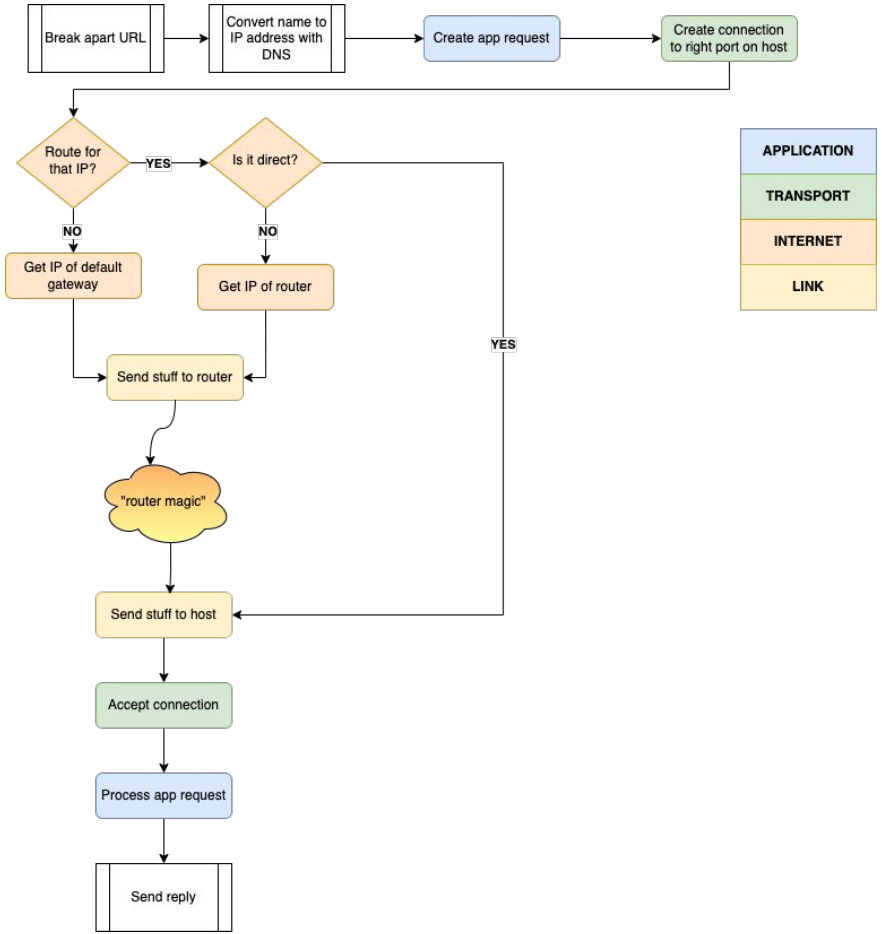
IP Datagram


Don't Fragment
Null Bit
More Fragment
Version
4 bits
HLEN
4 bits
Type of Service
8 bits
Total Length
16 bits
32 bits = 4 Bytes
Identification
16 bits
Res
1 bit
DF
1 bit
MF
1 bit
Fragment Offset
13 bits
4 Bytes
Time to Live
8 bits
Protocol
8 bits
Header Checksum
16 bits
4 Bytes
20 B
Max Header = 60 B
Min Header = 20 B
Source IP
32 bits
4 Bytes
Destination IP
32 bits
4 Bytes
Option
0 to 40 Bytes
DATA
Data = 20 Bytes to 65536 Bytes

Prepare to look behind the curtain

- Uniform Resource Locator (URL): protocol://host/path
- Domain Name System (DNS)
- IP address v4: 10.9.8.7
- IP address v6: 2001:0db8:85a3::8a2e:0370:7334
- Port: like a room in a building

Peek behind the curtain



NAT & Private Network Numbers

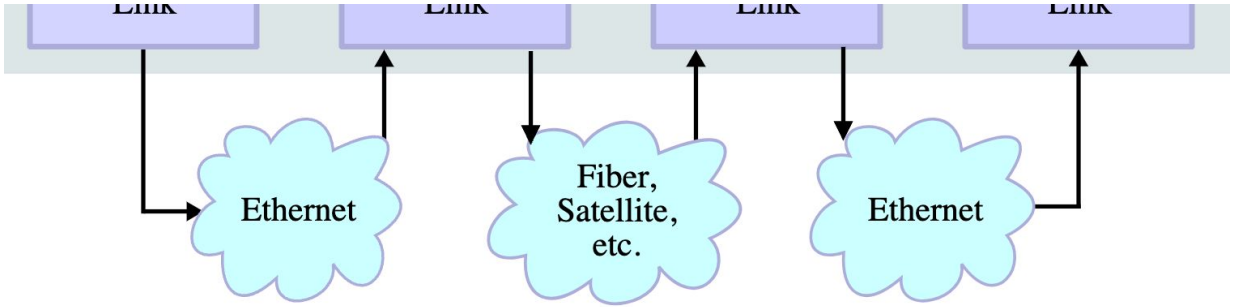
- Network Address Translation (NAT)
  - Originally not a part of TCP/IP
  - Created to deal with IP address exhaustion
  - Concept “violates” the ethos of TCP/IP
  - Frowned upon in IPv6, but NPTv6 exists
- IPv4 RFC 1918 blocks
  - 10.0.0.0/8 (10.0.0.0-10.255.255.255): 16 million addresses
  - 172.16.0.0/12 (172.16.0.0-172.31.255.255): 1 million addresses
  - 192.168.0.0/16 (192.168.0.0-192.168.255.255): 65K addresses
- IPv6 Unique Local Addresses (ULA), RFC 4193
  - fd00::/8, fdxx:xxxx:xxxx:xxxx:yyyy:yyyy:yyyy:yyyy

Address Autoconfiguration

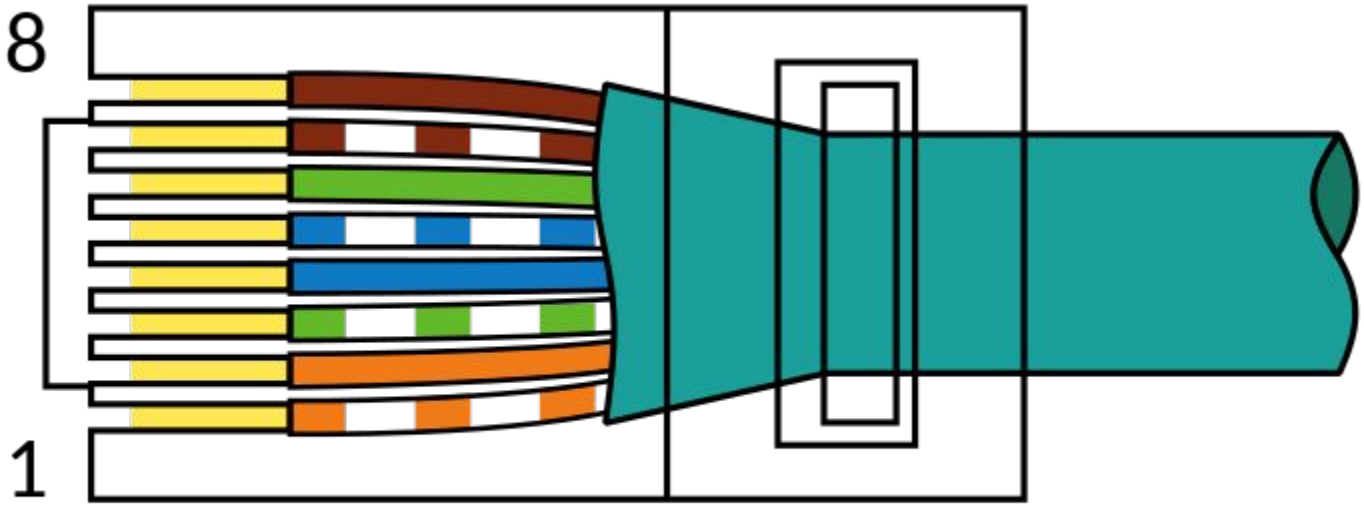
- Dynamic Host Configuration Protocol (DHCP)
- Link local address IPv4/Zeroconf: 169.254.0.0/16
- IPv6 is more advanced
  - Link local address IPv6: fe80::/10
  - Stateless address autoconfiguration (SLAAC)
  - Neighbor Discovery Protocol

More about the physical layer

- Cables: Coaxial, Unshielded Twisted Pair (UTP), Shielded Twisted Pair (STP)
- Fiber: Multi-mode (orange, aqua, violet, lime green), single-mode (yellow)
- Wireless: Wi-Fi (2.4, 5, 6, or 60 GHz), LTE & 5G, satellite



Crimping UTP cable (TIA-568B standard)



T568B