



Designing A Network Protocol

Jitish Kolanjery



Agenda

What is a network?

What are the types of network?

Standard Network Topologies

OSI 7-Layer Model

What is Protocol?

Protocol considerations

Case Study



What is a network?

*“A network is a system of interconnected devices, like computers, smartphones, or printers, that can communicate with each other and share resources, allowing for data exchange and collaboration between them, typically connected through cables or wireless signals; **essentially, it's a group of devices linked together to enable communication and information sharing.**”*

- Generative AI



Network Sizes

Personal-Area-Network: few personal devices.

Local-Area-Network: connects upto a few dozen devices local to an area

Metropolitan-Area-Network: devices in a metropolitan area (city wide)

Wide-Area-Network: spans several cities and campuses.

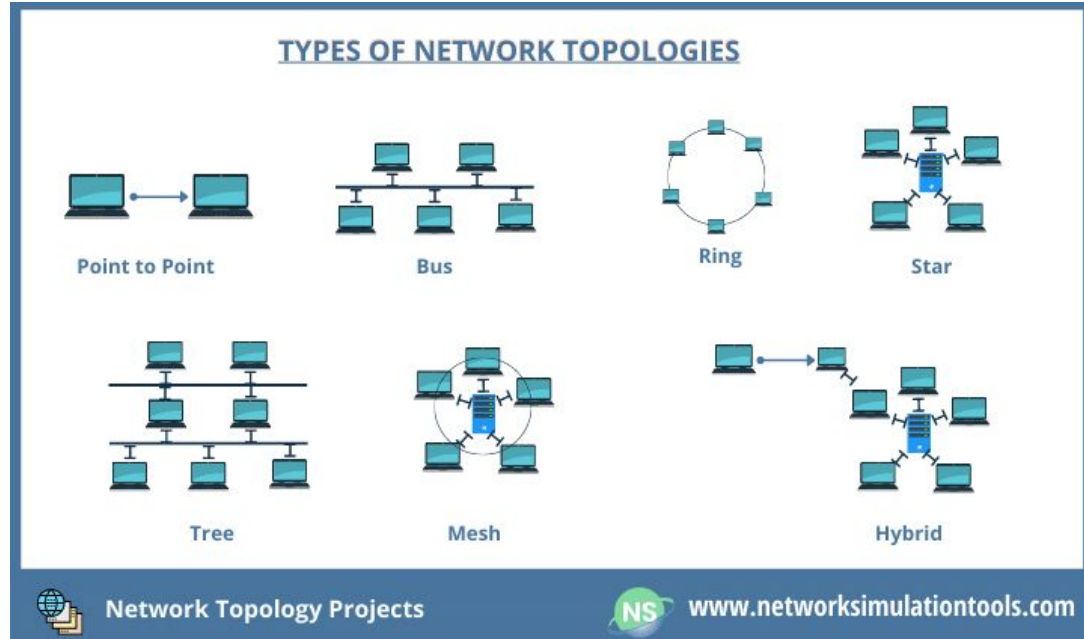
Network Topology

Topology specifies how the devices are connected to each other.

Basic topologies



They have different features and limitations. Can we identify some?





The 7 Layer Model

*“The OSI model breaks down network communication into distinct, manageable functions, allowing for easier troubleshooting, standardization across different network technologies, and a clear understanding of how data flows through a network by separating complex tasks into specific levels, each with its own defined responsibilities; **essentially, it provides a structured framework for analyzing and optimizing network communication at various stages**”*

- **Generative AI**

2 - Data Link Layer

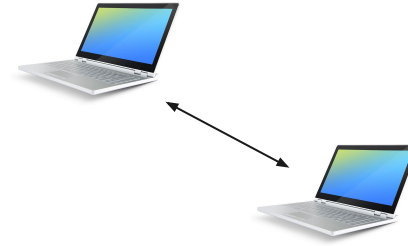
Defines direct Node-to-Node communication

Two sublayers:

- Media Access Control (MAC)

- Logical Link Layer

 - e.g. 802.3 Ethernet

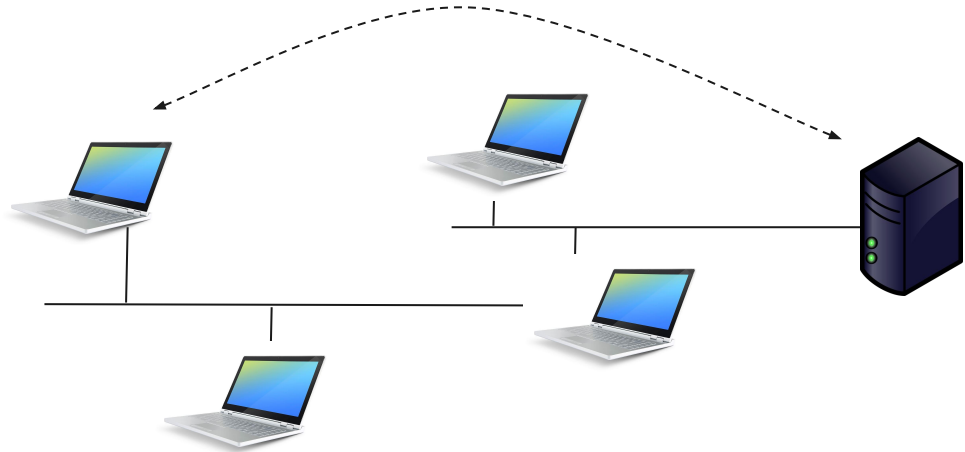


3 - Network Layer

Connects any two devices in a network (of any size and topology).

e.g.

Internet Protocol (IP)





4 - Transport Layer

Provides reliable and efficient communication between two devices.

e.g.

Transmission Control Protocol (TCP), User Datagram Protocol (UDP)



Layers 5,6 & 7

Session Layer

Maintains a “session” of communication between two devices.

Presentation Layer

Specifies format/presentation of data between the devices.

Application Layer

define communication between applications between the devices.



Network Protocol

“A network protocol is a set of established rules that govern how data is transmitted between devices on a network, essentially defining the format and procedures for communication between different devices so they can understand and exchange information effectively, regardless of their specific hardware or software configurations”

- **Generative AI**

Protocol Frames - Ethernet (Layer 2)

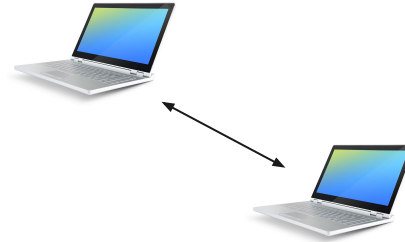
6	6	2	46-1500	4
DST MAC ADDR	SRC MAC ADDR	TYPE	PAYLOAD	FCS

6-byte (48 bits) MAC address

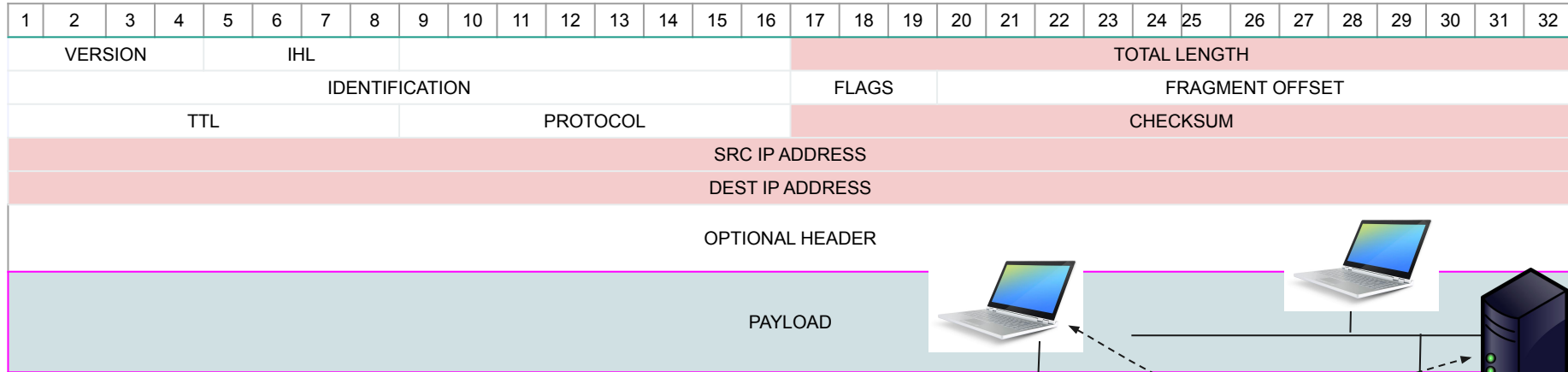
e.g: C8-E2-65-08-87-1B

Min. Throughput, $46/(18+46) = 71\%$

Max Throughput $1500/(8+1500) = 98.8\%$

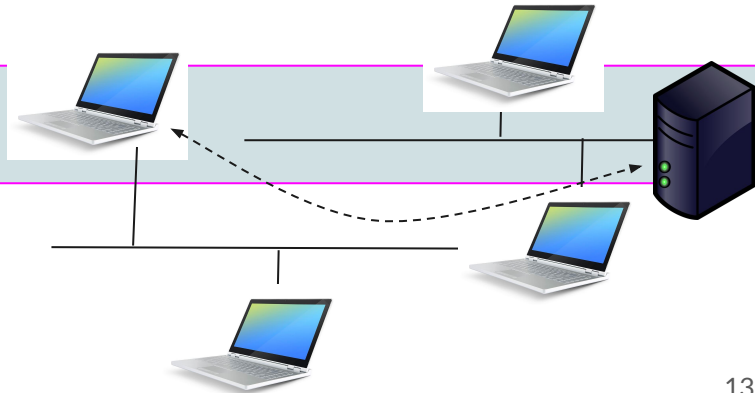


Protocol Frames - IPv4 (Layer 3)



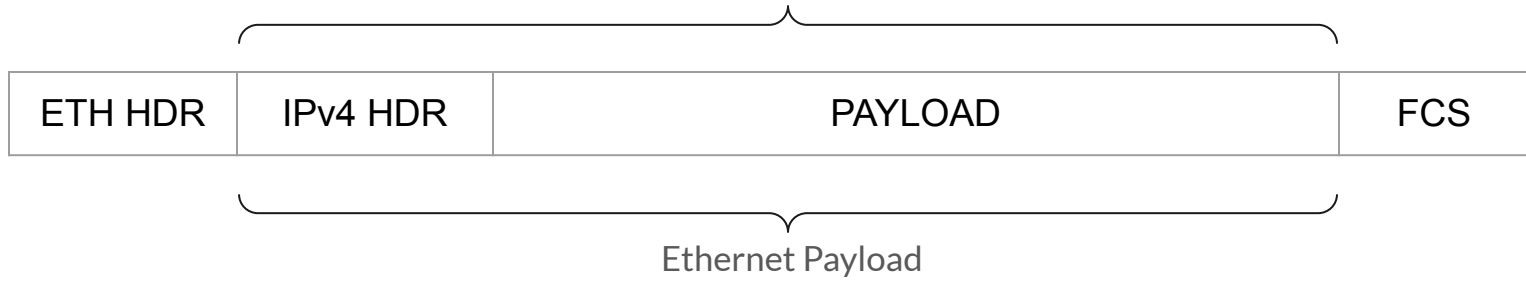
32 bit IPv4 address

e.g: 10.1.1.1





Packet





Case Study

point-to-point

No security requirement

jitter is ok

Reliability will be handled by higher layers

Secure against corruption

Bandwidth is low. Can only transfer 32 bits at a time

Data/Payload can be greater than 32 bits

Throughput, should be as much as possible



Case Study

First Packet

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	MSG TYPE							LENGTH							
LENGTH (Contd.)				HDR CRC				TOTAL CRC							

Subsequent Packet(s)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	PAYLOAD														
PAYLOAD															



Throughput

31 bits payload,

$$31/(32*2) = 48.4\%$$

12000 bits (1500 bytes) payload,

$$12000/(32* 389) = 96.4\%$$

where:

$$389 = 1 \text{ header packet} + 12000/31 \text{ subsequent packets}$$



Questions ?



Some Keywords

Ethernet

LAN/WAN/MAN

WiFi

BlueTooth

MAC

Protocol

TCP/IP

HotSpot

Topology

Internet

World Wide Web

HTTP

Cloud