% Network A
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Definition

We consider a network as a graph of connected entities created to allow exchange informations through nodes

Unicast, Broadcast Multicast

Cast is the packet data stream.

1. `Unicast` will send data to an unique address, recipient
2. `Broadcast` send data to all recipients of a network
3. `Multicast` send data to a group of recipients

Network Topology

Network Topology refers to the physical and logical arrangement of devices on a network. There are several different types of Network Topologies, including Bus, Star, Ring, Mesh, and Tree.
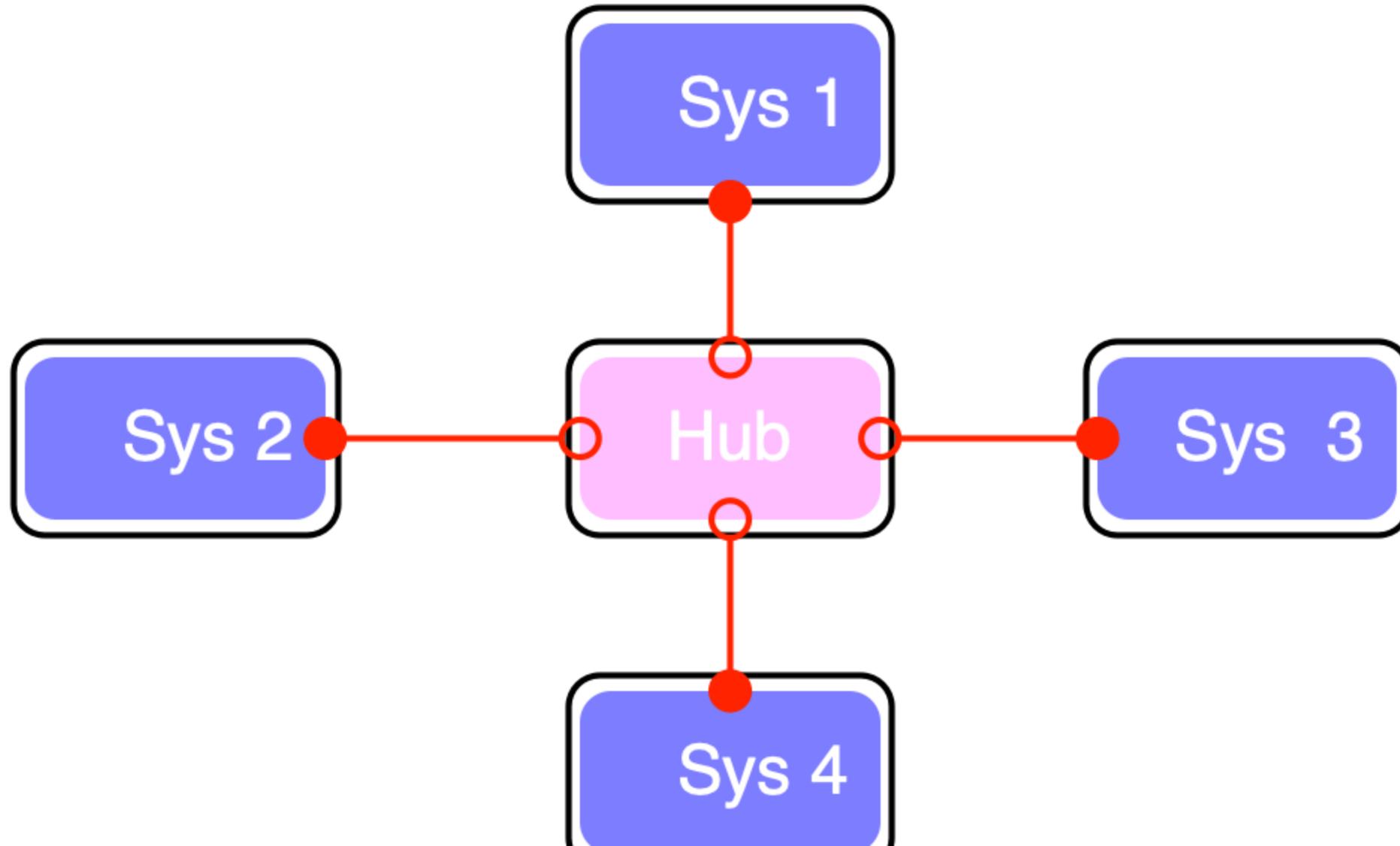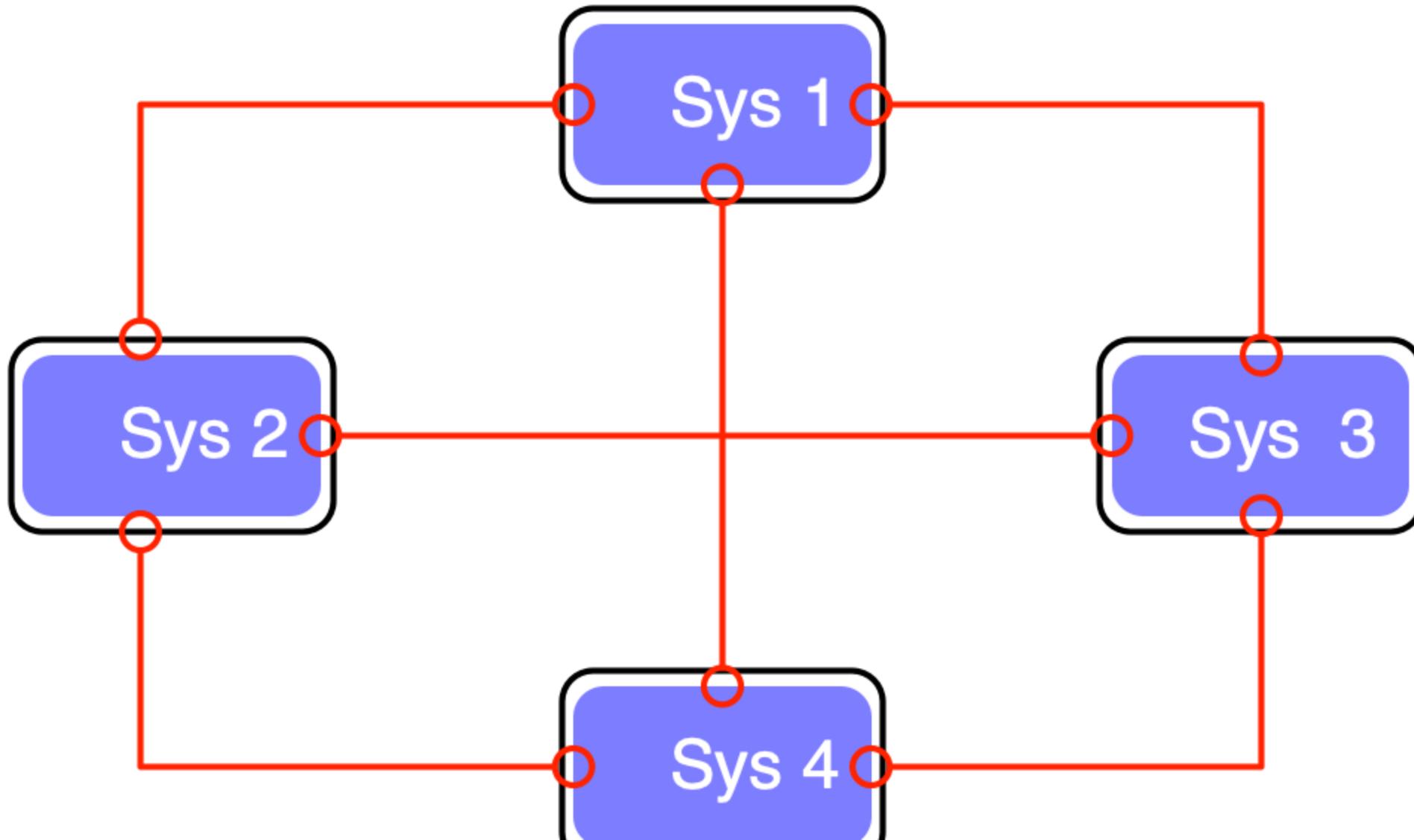
Bus Topology
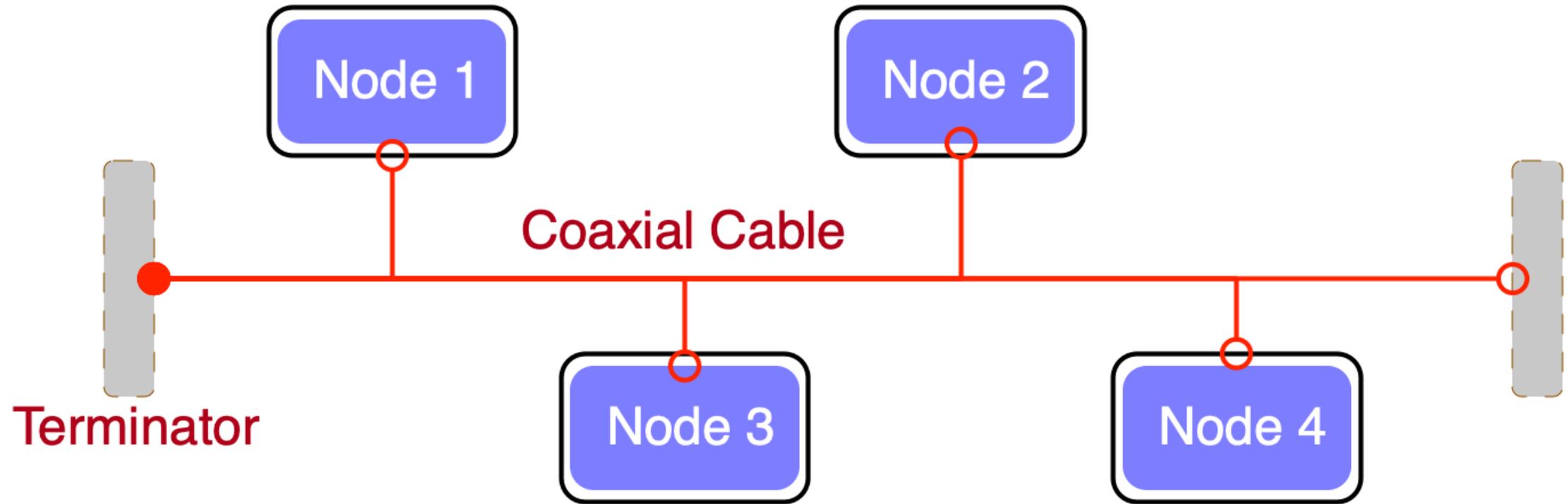
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This type of topology is easy to set up and manage, but it can be vulnerable to failure if the backbone cable or bus is damaged

Star Topology

Star Topology

Tree Topology
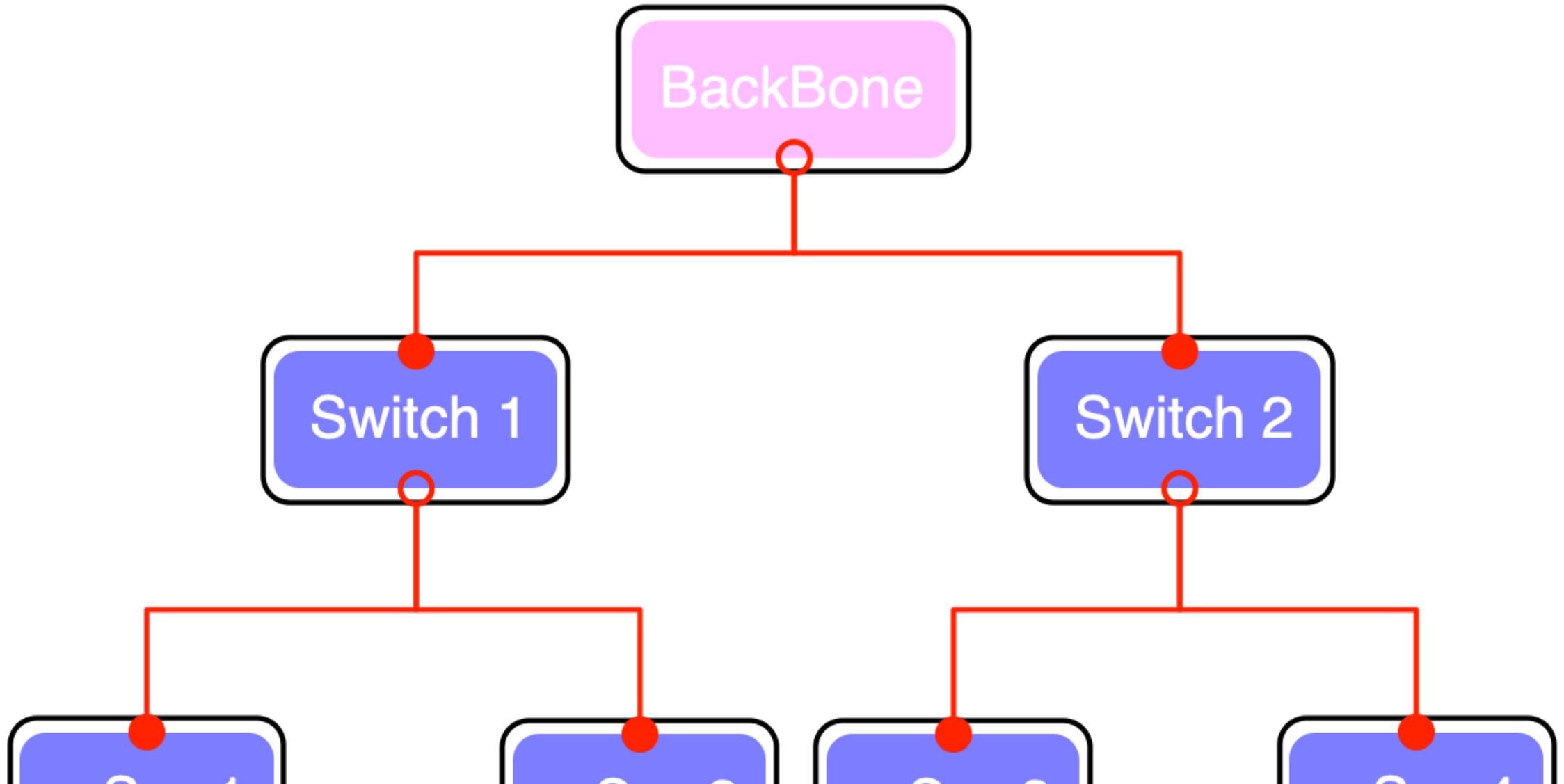
Types of Networks

Main Types are

1. `LAN` (local Area Network)
2. `MAN` (Metropolitan Area Network)
3. `WAN` (Wide Area Network)

Other networks:

`PAN` (Personal Area Network), `SAN` (Storage Area Network), `EPN` (Enterprise Private Network), `VPN` (Virtual Private Network)

PAN

a personal area network having an interconnection of personal technology devices to communicate over a short distance. It covers only less than 10 meters.
Usually is a `bluethoot` network

LAN

Connects network devices in such a way that personal computers and workstations can share data, tools, and programs. The group of computers and devices are connected together by a switch, or stack of switches, using a private addressing scheme as defined by the TCP/IP protocol.

MAN

Covers a larger area than that covered by a LAN and a smaller area as compared to WAN. MAN has a range of 5-50km. It connects two or more computers that are apart but reside in the same or different cities. It covers a large geographical area and may serve as an ISP (Internet Service Provider).(FastWeb)

WAN
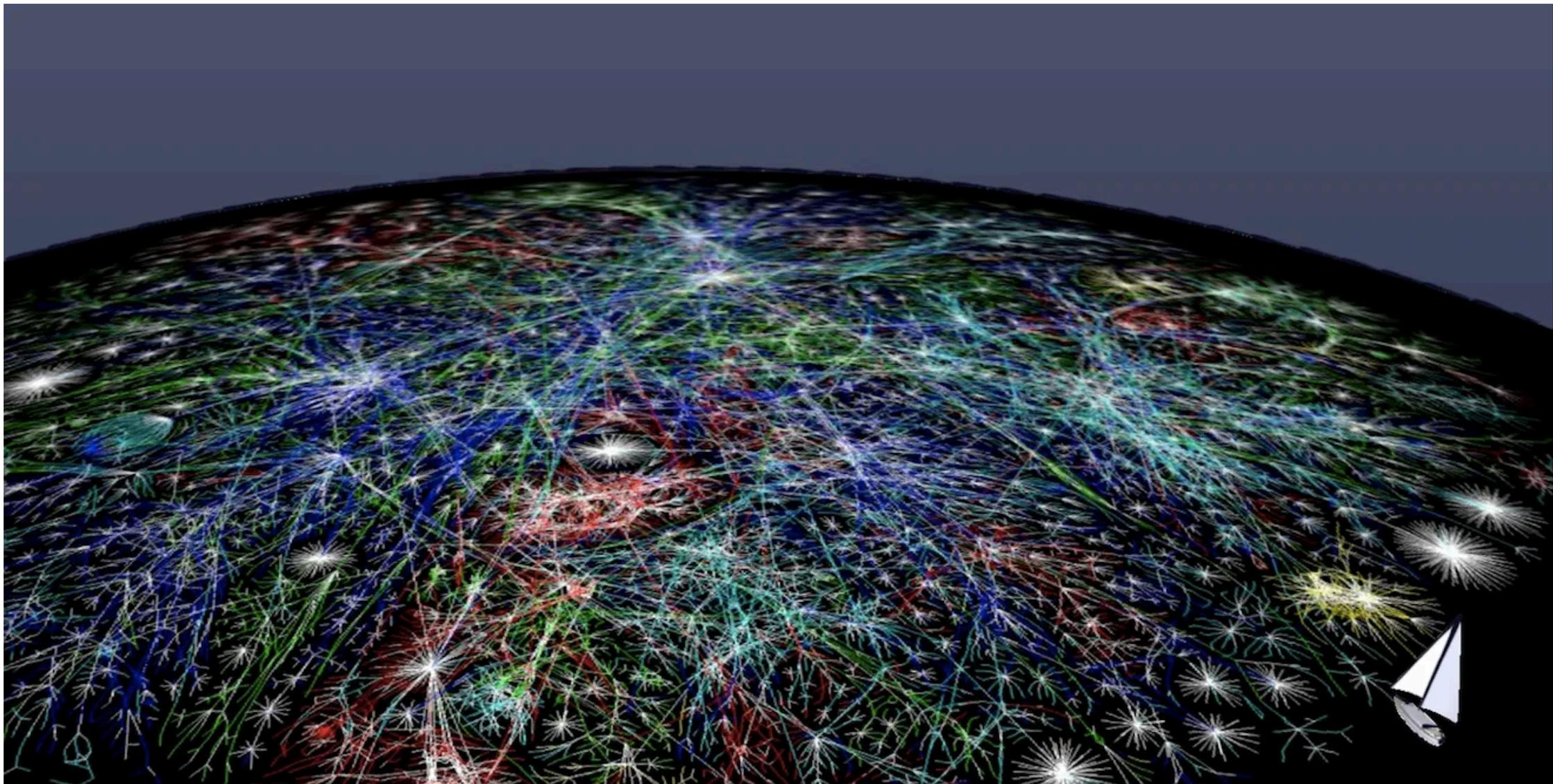
OSI Layers

7	Application	Protocol definition (http, ssh) data formatting, emulation
6	Presentation	Encryption, Compression, encode translations
5	Session	Start/terminate network comunications
4	Transport	Data Segment, error correction
3	Network	Logical Addressing, Packet, routing

Layer 1

Physical Layer

- `Telephone network modems`.
- `IrDA` physical layer.
- `USB` physical layer.
- `EIA RS-232, EIA-422`....
- `Ethernet cables and plugs` 10BASE-T, 10BASE ...
- Varieties of `802.11 Wi-Fi` physical layers.
- `DSL`.
- `ISDN`.

Layer 1 devices

Modems
Hubs

Layer 2

Data Link Protocols

- `ARP` Address Resolution Protocol
- `Ethernet`
- `FDDI` Fiber Distributed Data Interface
- `IEEE 802.2` MAC layers
- `IEEE 802.11` wireless LAN
- `I²C`
- `PPP` Point-to-Point Protocol
- `Spanning Tree Protocol`
- `Token ring`

Layer 2 devices

```
Switches
WAP (wireless access point)
```

Layer 3

Network Layer Protocols

- `ICMP` Internet Control Message Protocol
- `IPsec` Internet Protocol Security
- `IPv4/IPv6` Internet Protocol
- `IPX` Internetwork Packet Exchange
- `RSMLT` Routing Information Protocol

Layer 4

Transport Layer

- ATP AppleTalk Transaction Protocol
- IL Fibre Channel Protocol
- TCP Transmission Control Protocol
- UDP User Datagram Protocol

Layer 5

Session Layer Protocol

- `ADSP` AppleTalk Data Stream Protocol
- `H.245` Call Control Protocol for Multimedia Communication
- `NetBIOS` Network Basic Input Output System
- `PAP` Password Authentication Protocol
- `PPTP` Point-to-Point Tunneling Protocol
- `RPC` Remote Procedure Call Protocol
- `SMPP` Short Message Peer-to-Peer
- `SOCKS` the SOCKS internet protocol

Layer 6

Presentation Layer

> Is the lower layer for an application layer can usually manage

- Data conversion
- Character code translation
- Compression
- Encryption and Decryption

Layer 7

Application Layer

- `Atom` (rss) Publishing Protocol
- `HTTP` HyperText Transfer Protocol
- `LDAP` Lightweight Directory Access Protocol
- `NFS` Network File System
- `RPC` Remote Procedure Call
- `SMB` Server Message Block
- `SMTP` Simple Mail Transfer Protocol
- `SSH` Secure Shell
- `Tor` anonymity network

TCP/IP Model

DoD model

designed and developed by the Department of Defense (DoD) in the 1960s and is based on standard protocols. It stands for Transmission Control Protocol/Internet Protocol.

TCP/IP Layers

5 Application		Protocol definition (http, ssh) data formatting, emulation
6 Presentation		Encryption, Compression, encode translations
5 Session		Start/terminate network comunications
4 Transport		TCP,UDP
3 Network/internet		IP,ICMP,ARP
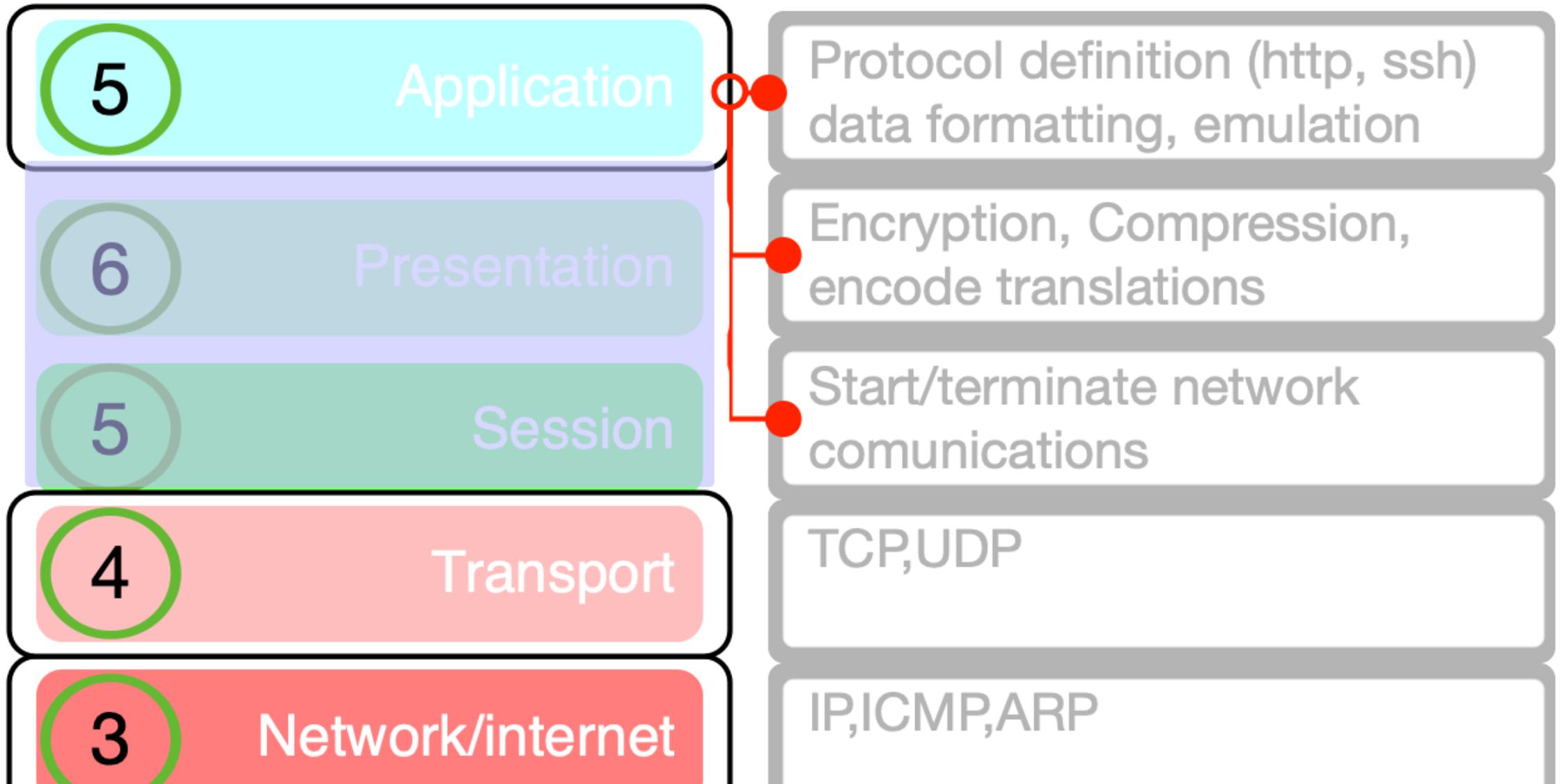
Layer 3

Internet Layer

- `IP` Will deliver packets from the source to the destination using the IP addresses in the packet headers. IP has 2 versions: IPv4 and IPv6.
- `ICMP` Internet Control Message Protocol. It is encapsulated within IP datagrams.Provide information about network.
- `ARP` Address Resolution Protocol. Its job is to find the hardware address of a host from a known IP address.

Layer 4

Transport Layer

- `TCP` Character-by-character transmission rather than separate packets. A starting point that establishes the connection, the whole transmission in byte order, and an ending point that closes the connection.
- `UDP` Connections between receiving and sending hosts are not verified by UDP. Applications that transport little amounts of data use UDP

Layer 5

Application Layer

- `HTTP` and `HTTPS`
- `SSH`
- `FTP` and `sftp`
- `ldap` and `ldaps`
- etc

differences I

TCP/IP	OSI
TCP refers to Transmission Control Protocol.	OSI refers to Open Systems Interconnection.
TCP/IP has 5 layers.	OSI has 7 layers.

differences II

TCP/IP	OSI
TCP/IP is more reliable	OSI is less reliable
TCP/IP does not have very strict boundaries.	OSI has strict boundaries

differences III

| TCP/IP	OSI
TCP/IP follows connection-less a horizontal approach.	OSI follows a vertical approach.
TCP/IP uses both session and presentation layer in the application layer itself.	OSI uses different session and presentation layers.

differences IV

TCP/IP	OSI
TCP/IP developed protocols then model.	OSI developed model then protocol.
Transport layer in TCP/IP does not provide assurance delivery of packets.	In OSI model, transport layer provides assurance delivery of packets.

differences V

TCP/IP	OSI
TCP/IP model network layer only provides connection less services.	Connection less and connection-oriented both services are provided by the network layer in the OSI model.
Protocols cannot be replaced easily in TCP/IP model.	Protocols are better covered and is easy to replace with the change in technology.

IP addressing

IP Addressing

1010101 11101110 10100100 00101010

85.239.164.42
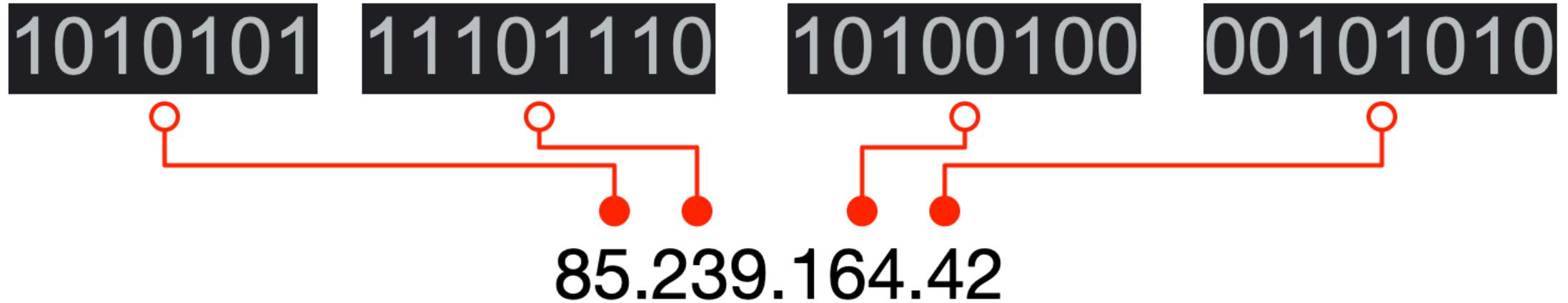
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IP address is an address having information about how to reach a specific host, especially outside the LAN. An IP address is a 32 bit unique address having an address space of 2^32.

Classfull IP

	Byte 1	Byte 2	Byte 3	Byte 4
Class A	Net Id			Host ID
Class B	Net Id			Host ID
Class C	Net Id			Host ID
Class D	Multicast Address			
Class E	Reserved			

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CLassfull IP II

Class	Leading bits	Size of *network number* bit field	Size of *rest* bit field	Number of networks	Addresses per network	Total addresses in class	Start address	End address	Default subnet mask in dot-decimal notation	CIDR notation
Class A	0	8	24	128 (2^7)	16,777,216 (2^{24})	2,147,483,648 (2^{31})	0.0.0.0	127.255.255.255[a]	255.0.0.0	/8
Class B	10	16	16	16,384 (2^{14})	65,536 (2^{16})	1,073,741,824 (2^{30})	128.0.0.0	191.255.255.255	255.255.0.0	/16
Class C	110	24	8	2,097,152 (2^{21})	256 (2^8)	536,870,912 (2^{29})	192.0.0.0	223.255.255.255	255.255.255.0	/24
Class D (multicast)	1110	not defined	not defined	not defined	not defined	268,435,456 (2^{28})	224.0.0.0	239.255.255.255	not defined	/4[7]
Class E (reserved)	1111	not defined	not defined	not defined	not defined	268,435,456 (2^{28})	240.0.0.0	255.255.255.255[b]	not defined	not defined

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Classless Routing

Classless Inter-Domain Routing (CIDR)
is a method for allocating IP addresses and for IP routing. The Internet
Engineering Task Force introduced CIDR in 1993 to replace the previous
classful network addressing architecture on the Internet

CIDR notation

CIDR notation is a compact representation of an IP address and its associated network mask. The notation was invented by Phil Karn in the 1980 CIDR notation specifies an `IP address`, a slash (`'/'`) character, and a decimal number.

> The decimal number is the count of consecutive leading 1-bits (from left to right) in the network mask. The number can also be thought of as the width (in bits) of the network prefix.

Example

For example:

198.51.100.14/24 represents the IPv4 address 198.51.100.14 and its associated network prefix 198.51.100.0, or equivalently, its `subnet mask 255.255.255.0`, which has `24 leading 1-bits`.

subnet Mask

A subnet mask is a `bitmask` that encodes the prefix length associated with an IPv4 address or network in quad-dotted notation: 32 bits, starting with a number of 1-bits equal to the prefix length, ending with 0-bits, and encoded in four-part dotted-decimal format: `255.255.255.0`.

IANA

The Internet Assigned Numbers Authority (IANA) issues to regional Internet registries (RIRs) large, short-prefix CIDR blocks. However, a /8 (with over sixteen million addresses) is the largest block IANA will allocate

CIDR Blocks

| Address format	Difference to last address	Mask	Addresses		Relative to class A, B, C	Restrictions on *a*, *b*, *c* and *d* (0..255 unless noted)	Typical use
			Decimal	2^n			
a.b.c.d/32	+0.0.0.0	255.255.255.255	1	2^0	$\frac{1}{256}$ C		Host route
a.b.c.d/31	+0.0.0.1	255.255.255.254	2	2^1	$\frac{1}{128}$ C	$d = 0 ... (2n) ... 254$	Point-to-point links (RFC 3021 ↗)
a.b.c.d/30	+0.0.0.3	255.255.255.252	4	2^2	$\frac{1}{64}$ C	$d = 0 ... (4n) ... 252$	Point-to-point links (glue network)
a.b.c.d/29	+0.0.0.7	255.255.255.248	8	2^3	$\frac{1}{32}$ C	$d = 0 ... (8n) ... 248$	Smallest multi-host network
a.b.c.d/28	+0.0.0.15	255.255.255.240	16	2^4	$\frac{1}{16}$ C	$d = 0 ... (16n) ... 240$	
a.b.c.d/27	+0.0.0.31	255.255.255.224	32	2^5	$\frac{1}{8}$ C	$d = 0 ... (32n) ... 224$	Small LAN
a.b.c.d/26	+0.0.0.63	255.255.255.192	64	2^6	$\frac{1}{4}$ C	$d = 0, 64, 128, 192$	
a.b.c.d/25	+0.0.0.127	255.255.255.128	128	2^7	$\frac{1}{2}$ C	$d = 0, 128$	
a.b.c.0/24	+0.0.0.255	255.255.255.0	256	2^8	1 C		Large LAN
a.b.c.0/23	+0.0.1.255	255.255.254.0	512	2^9	2 C	$c = 0 ... (2n) ... 254$	
a.b.c.0/22	+0.0.3.255	255.255.252.0	1,024	2^{10}	4 C	$c = 0 ... (4n) ... 252$	Small business
a.b.c.0/21	+0.0.7.255	255.255.248.0	2,048	2^{11}	8 C	$c = 0 ... (8n) ... 248$	Small ISP/ large business
a.b.c.0/20	+0.0.15.255	255.255.240.0	4,096	2^{12}	16 C	$c = 0 ... (16n) ... 240$	
a.b.c.0/19	+0.0.31.255	255.255.224.0	8,192	2^{13}	32 C	$c = 0 ... (32n) ... 224$	
a.b.c.0/18	+0.0.63.255	255.255.192.0	16,384	2^{14}	64 C	$c = 0, 64, 128, 192$	ISP/ large business
a.b.c.0/17	+0.0.127.255	255.255.128.0	32,768	2^{15}	128 C	$c = 0, 128$	

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Private Network Blocks

| RFC 1918 name	IP address range	Number of addresses	Largest CIDR block (subnet mask)	Host ID size	Mask bits	Classful description[Note 1]
24-bit block	10.0.0.0 – 10.255.255.255	16 777 216	10.0.0.0/8 (255.0.0.0)	24 bits	8 bits	single class A network
20-bit block	172.16.0.0 – 172.31.255.255	1 048 576	172.16.0.0/12 (255.240.0.0)	20 bits	12 bits	16 contiguous class B networks
16-bit block	192.168.0.0 – 192.168.255.255	65 536	192.168.0.0/16 (255.255.0.0)	16 bits	16 bits	256 contiguous class C networks

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TCP/IP

IP header

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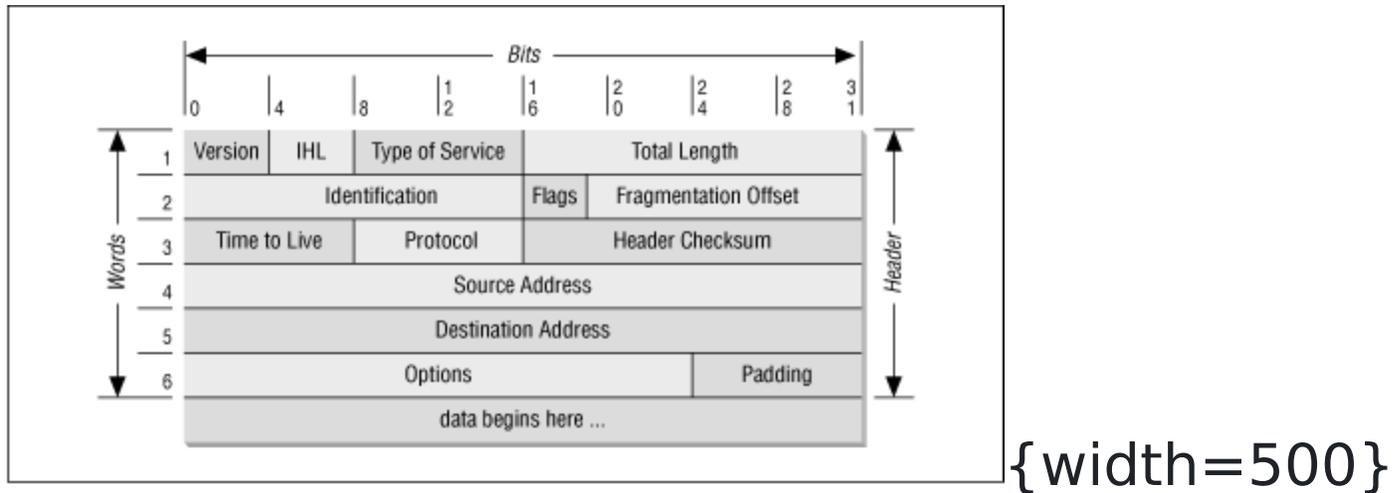
The ip header has an header checksum that will ensure that the packet header is correctly formed.
This will avoid for example "spoofing" pratices(different IP adress of the sender)
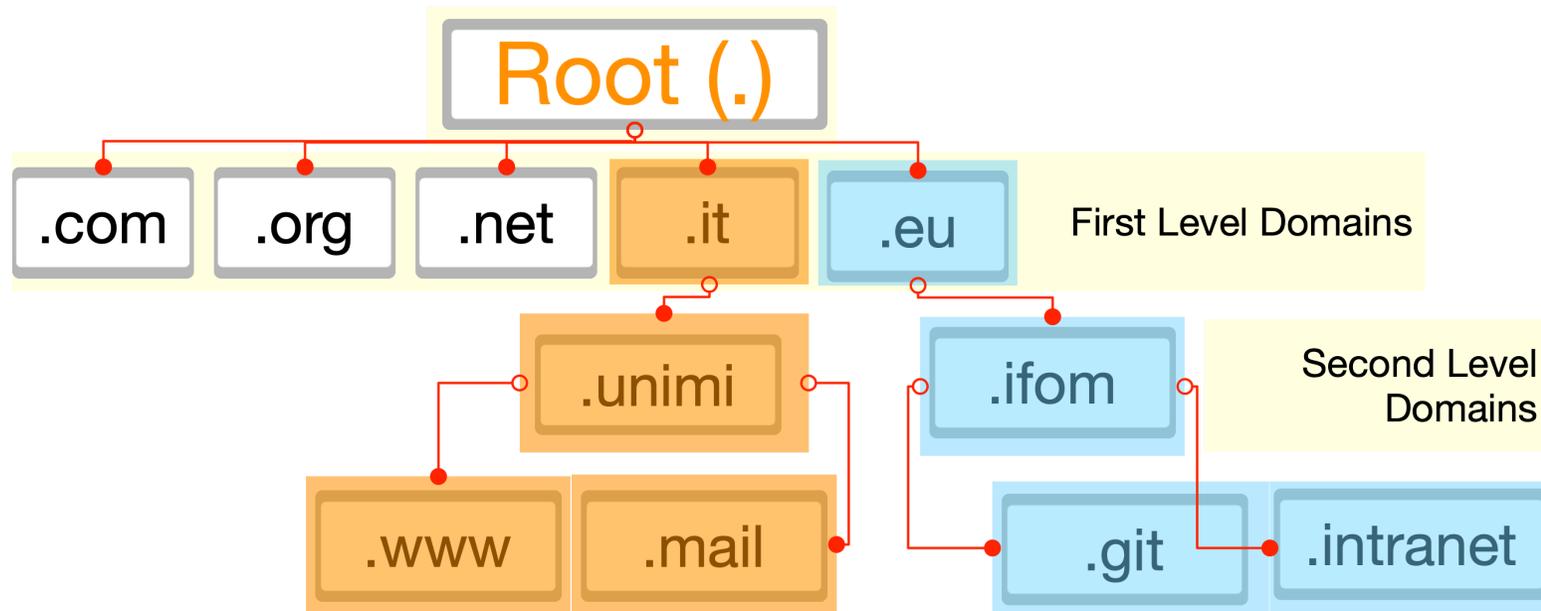
Protocol Handshake
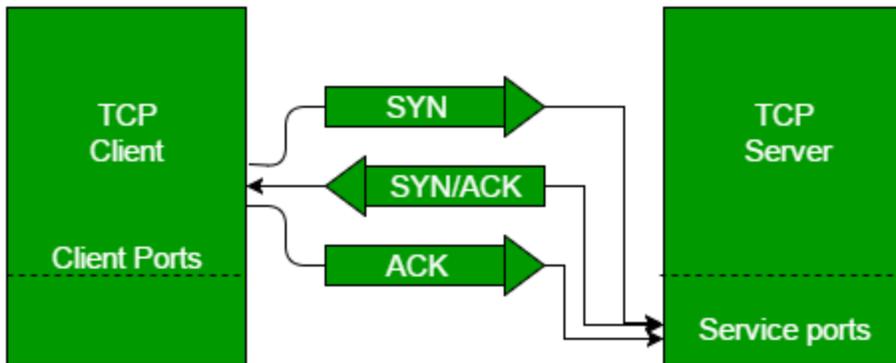
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The ending of the handshake will result in a properly crafted connection on a server designed port.

DNS

DNS

The Domain Name System (DNS) is the phonebook of the Internet. Humans access information online through domain names, like ifom.eu or unimi.it. Web browsers interact through Internet Protocol (IP) addresses. DNS translates domain names to IP addresses so browsers can load Internet resources.

Domain Tree

Root (.)

.com .org .net .it .eu

First Level Domains

.unimi .ifom

Second Level Domains

.www .mail .git .intranet

How dns server hierarchy work

Tell me the ip of **git.ifom.eu**

Ask dns server root **(.)** for **.EU**

Ask dns server **.eu** for **.ifom**

Ask dns server **.ifom** for **.git**

host git.ifom.eu has address 85.239.163.68

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