Network

Physics 129AL

Zihang Wang
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Network types

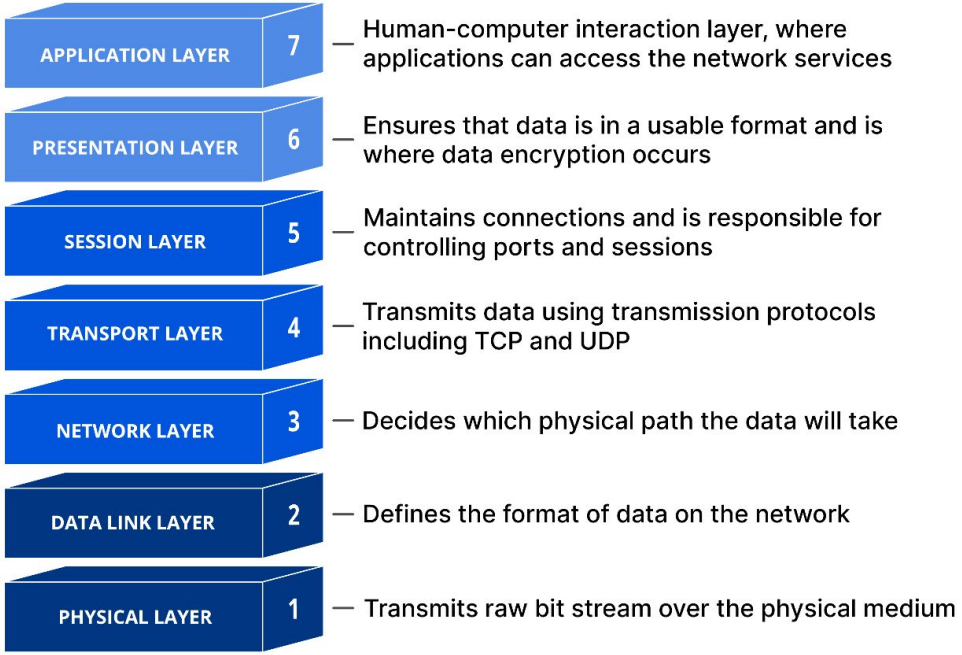
Computer networks can be classified into various types based on their scale, purpose, and geographic coverage.

Local Area Network (**LAN**): small-scale networks within a local area.

Wide Area Network (**WAN**): large-scale networks (for example, internet).

Network Protocols

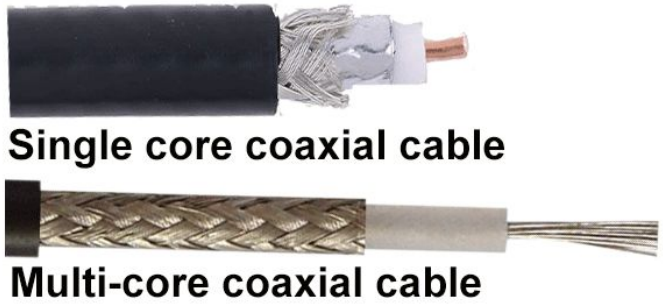
Open systems interconnection (OSI) model contains network protocols that govern the communication and data exchange between devices and systems over a network.



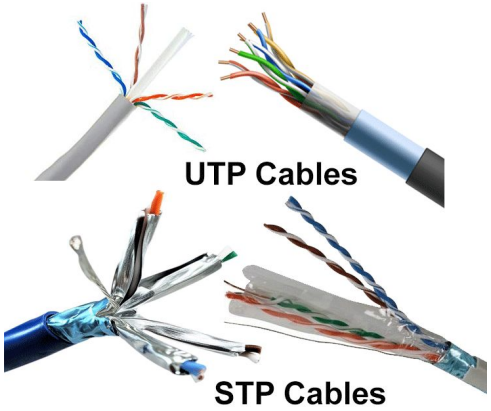
https://www.cloudflare.com/learning/ddos/glossary/open-systems-interconnection-model-osi/

Layer 1: Physical Layer

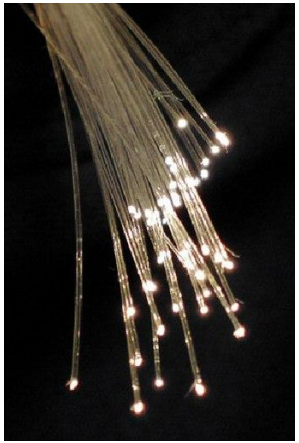
Physical layer is the foundation of network communication, responsible for managing the physical infrastructure and transmission of raw binary data over the network medium.



Coaxial Cable (retired)



Ethernet cable



Optical Fibers

https://www.computernetworkingnotes.com/networking-tutorials/network-cable-types-and-specifications.html

https://en.wikipedia.org/wiki/Optical_fiber

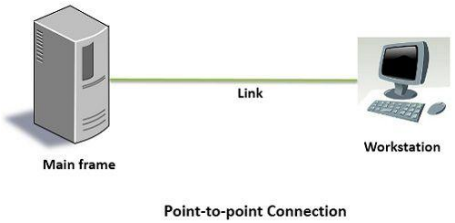
Layer 2: Data Link Layer

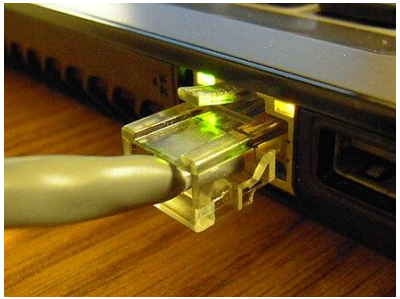
The data link layer provides for the transfer of data frames between devices connected to the physical link. This layer is communication between devices on the same local network (LAN) segment, e.g. via Ethernet protocol, Wi-Fi 802.11 (802.11a/b: Operates in the 5/2.4 GHz frequency)**.The protocol is limited by device-device communication.**

Data Framing

Physical Addressing: Media Access Control (MAC) address

Flow Control and Error Detection and Correction

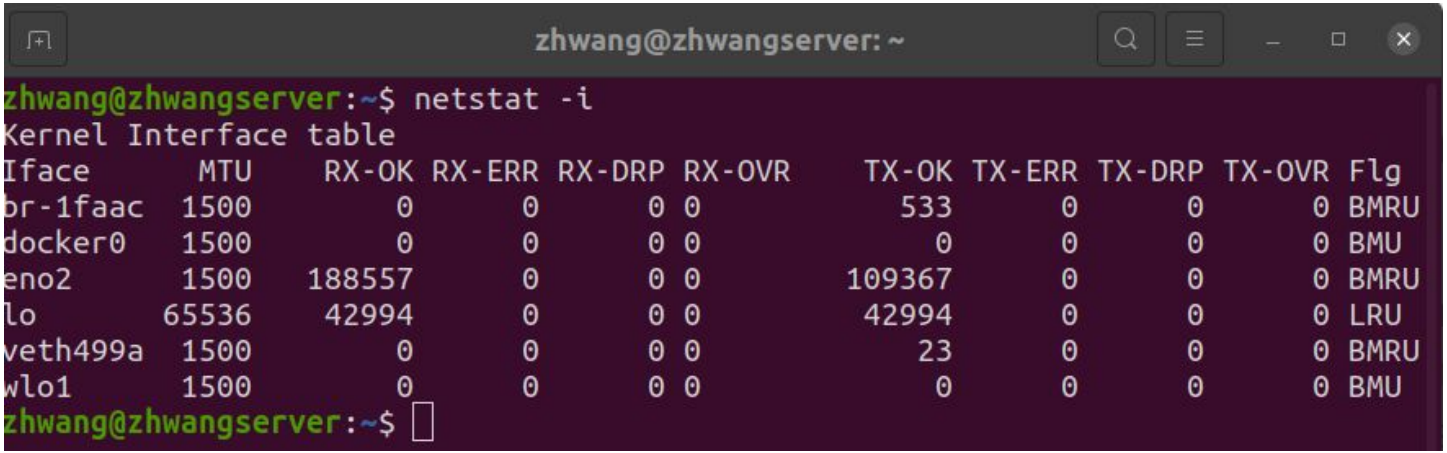




https://en.wikipedia.org/wiki/Ethernet
https://techdifferences.com/difference-between-point-to-point-and-multipoint-connection.html

Layer 3: Network layer

The network layer is responsible for routing data packets between devices in different networks or local subnets.The protocol is determining the best path for data packets to travel from the source to the destination across a network (Including Firewalls and Tunnelling). Internet Protocol (IP): Devices in a network are assigned unique logical addresses.



Local: Layer 1-3

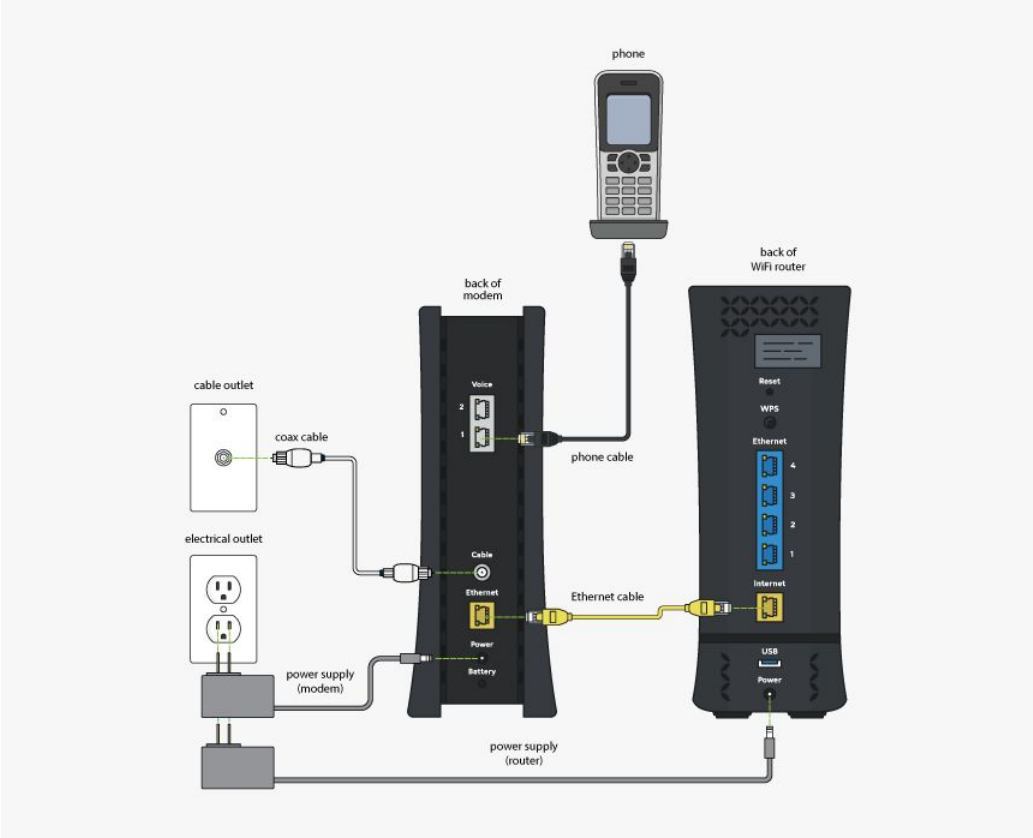
Modem and router are two distinct devices that play essential roles in networking.

Modem (Modulator-Demodulator)

(Layer 1-2) A device that modulates and demodulates digital data into analog signals for transmission over a specific medium and then converts incoming analog signals back into digital data.

Router:

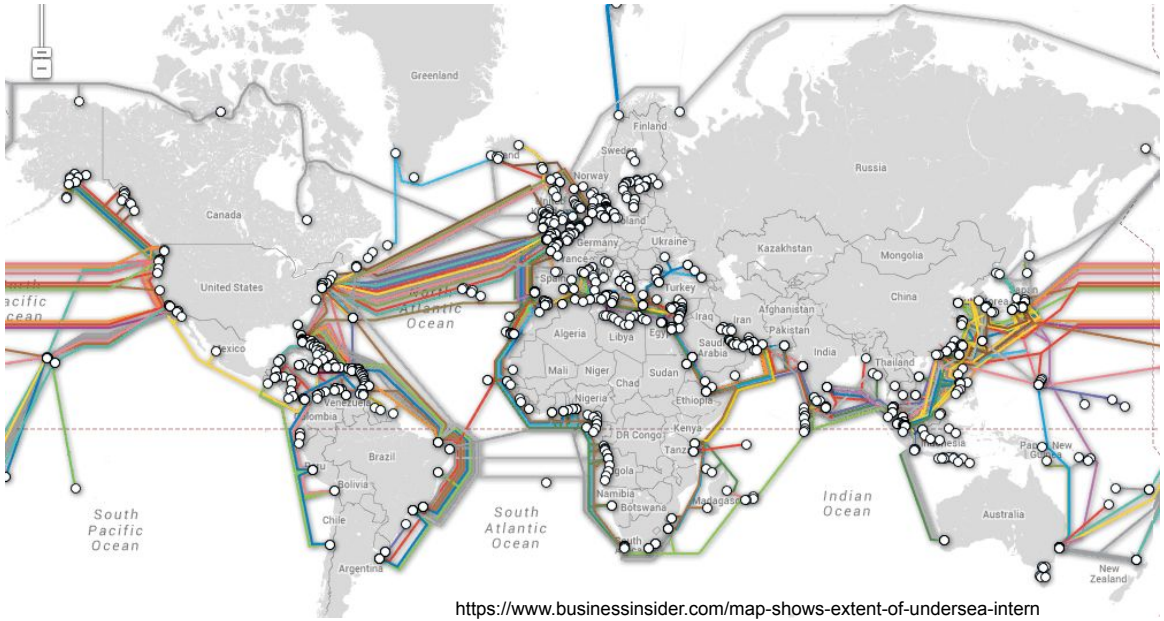
(Layer 2-3) A router is a networking device that connects multiple devices within your local network and routes data packets between them.



https://www.pngitem.com/middle/xbwwoR_setting-up-spectrum-wifi-spectrum-modem-and-router/

Global: Layer 1-3

Network nodes (e.g. data centers) are critical for global data and communication connectivity, allowing data to travel between continents and regions through the extensive undersea cable network.



https://www.businessinsider.com/map-shows-extent-of-undersea-internet-cables-that-russians-could-cut-2017-12

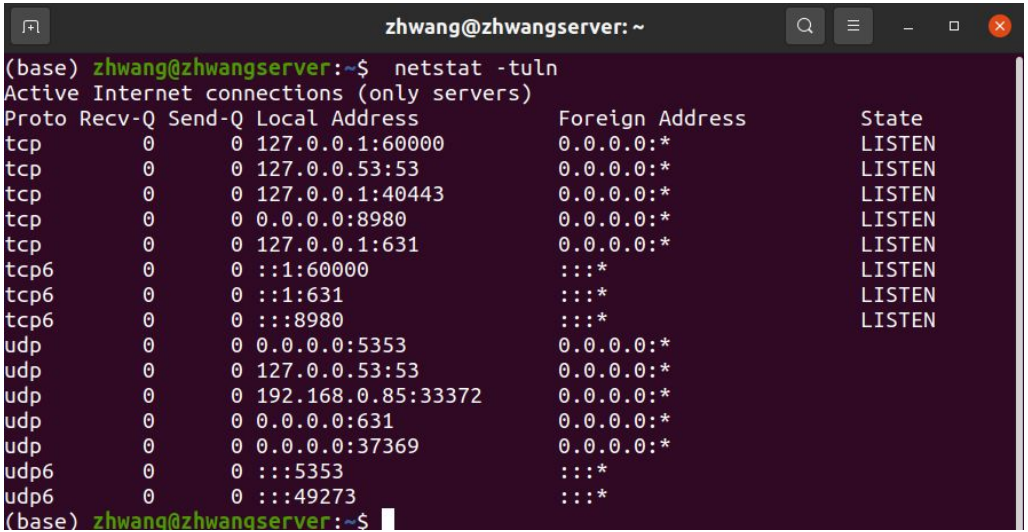
https://www.windsystemsmag.com/the-latest-advancements-in-submarine-cables-protection/

Layer 4: Transport Layer

The transport layer is responsible for ensuring end-to-end communication between devices across a network, namely the **sockets**.Two common protocols are TCP (Transmission Control Protocol) and UDP (User Datagram Protocol).

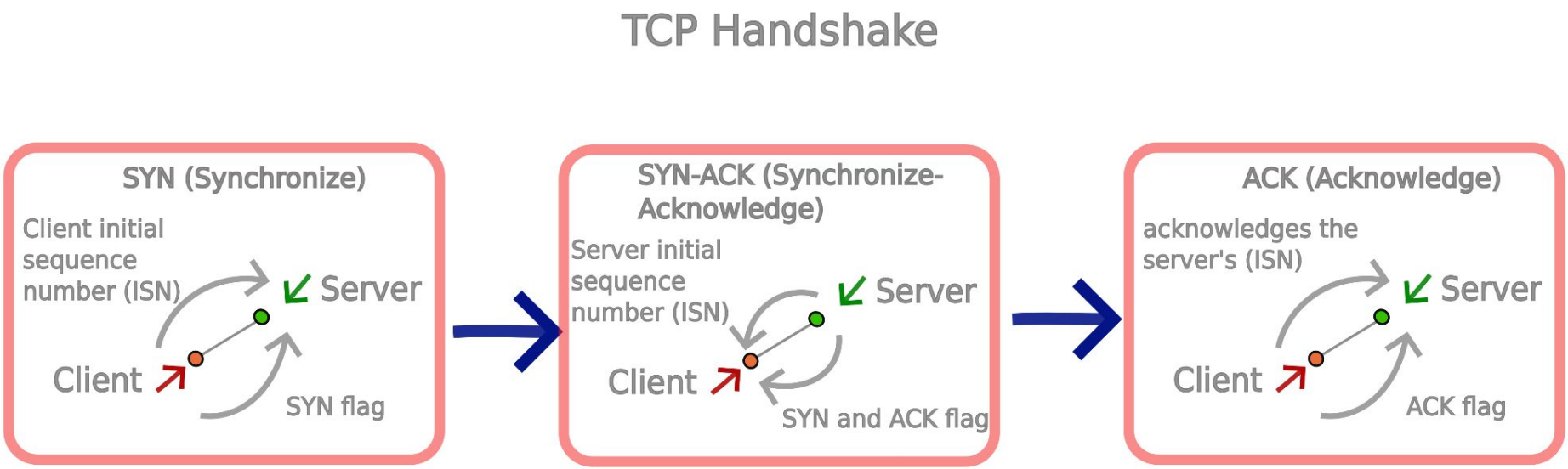
TCP:preserve data integrity, connection-oriented communication.

UDP: prioritize speed over data integrity, connectionless communication.



TCP Handshake

TCP handshake is designed to ensure that both devices agree to establish a reliable communication channel before exchanging data.



Port binding and Reserved IP Address

When a device wants to provide a service over TCP, it binds to a specific port number and listens for incoming connections on that port. Some ports are reserved for specific purposes, such as HTTP (port 80), HTTPS (443), and SSH (22).

Private IP Address

Private IP addresses are used within local networks, such as home or corporate networks, to allow multiple devices to communicate with each other.

10.0.0.0 to 10.255.255.255

172.16.0.0 to 172.31.255.255

192.168.0.0 to 192.168.255.255

Loopback IP Address

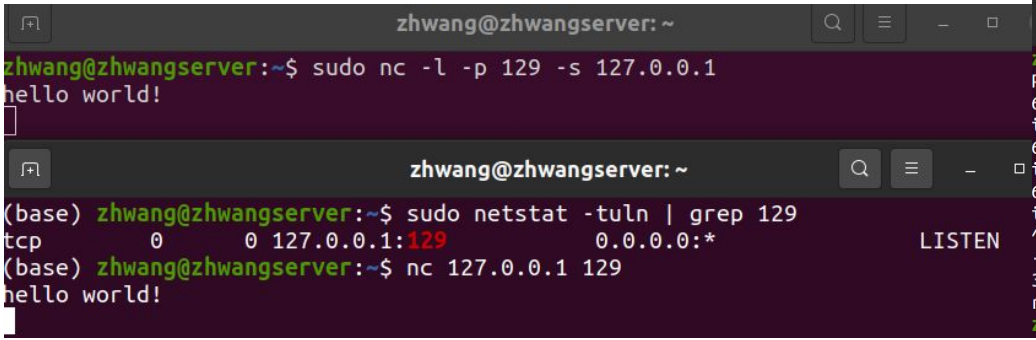
It is used for local network communication within a device itself, and it always refers to the local host,

127.0.0.0 to 127.255.255.255

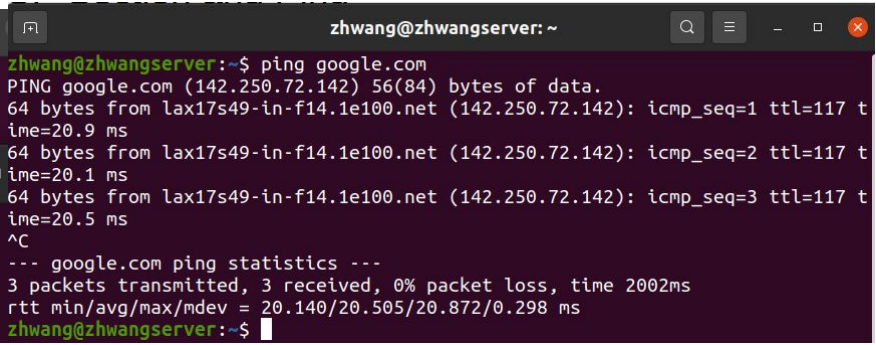
TCP Sessions and Ping

We can create TCP sessions with **netcat** in a local network. The option -s gives local address.

TCP sessions on a local network



Ping an IP address



Check Network Configuration

We can check network configuration using the command, **ifconfig**

```
eno2: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.0.85  netmask 255.255.255.0  broadcast 192.168.0.255
        inet6 fe80::5e3d:5eae:2785:656b  prefixlen 64  scopeid 0x20<link>
        ether 00:d8:61:34:de:5f  txqueuelen 1000  (Ethernet)
        RX packets 390992  bytes 327740646 (327.7 MB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 237951  bytes 75474925 (75.4 MB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
        device interrupt 16  memory 0xa4300000-a4320000
```

```
lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 57626  bytes 3703927 (3.7 MB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 57626  bytes 3703927 (3.7 MB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

```
tun0: flags=4305<UP,POINTOPOINT,RUNNING,NOARP,MULTICAST>  mtu 1400
        inet 128.111.237.46  netmask 255.255.255.255  destination 128.111.237.4
6
        inet6 fe80::6686:1568:18c2:35f2  prefixlen 64  scopeid 0x20<link>
        unspec 00-00-00-00-00-00-00-00-00-00-00-00-00-00-00-00  txqueuelen 500
 (UNSPEC)
        RX packets 67829  bytes 53849086 (53.8 MB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 51273  bytes 17367846 (17.3 MB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

```
wlo1: flags=4099<UP,BROADCAST,MULTICAST>  mtu 1500
        ether f4:d1:08:a7:9c:89  txqueuelen 1000  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

eno2, physical Ethernet network interface: main internet access from the service provider.

lo, loopback interface: It is used for communication within the local device itself, and any data sent to this interface is looped back and delivered internally.

tun0, tunneling interface: it allows network traffic to be encrypted and routed through a remote VPN server.

wlo1, wireless network interface: it allows the computer to connect to and communicate with wireless networks, such as Wi-Fi networks.

Layer 5: Session Layer

The transport layer is responsible for establishing, maintaining, and terminating communication sessions, ensuring that data is properly synchronized and organized for transmission.

Layer 6: Presentation Layer

The transport layer is responsible for data compression, data Encryption and Graphics. It also checks data integrity receiving from layer 7 or layer 5.

Layer 7: Application Layer

The application layer defines protocols that control the communication and data exchange between different applications and devices. The protocols includ HTTP (Hypertext Transfer Protocol), SMTP (Simple Mail Transfer Protocol), DNS (Domain Name System)