Computer Networks

Lab File

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Making an Ethernet

Tools needed –

Crimping tool

- A crimping tool is a device used to conjoin two pieces of metal by deforming one or both of them to hold each other. The result of the tool's work is called a crimp. An example of crimping is affixing a connector to the end of a cable.

Ethernet cable

- An Ethernet cable is a type of network cable used to connect devices like computers and routers to a local area network (LAN) or the internet. It provides a stable and faster internet connection compared to Wi-Fi by physically linking devices with a wired connection.

RJ45 connector

- RJ45 is a type of connector commonly used for Ethernet networking. It looks similar to a telephone jack, but is slightly wider.

Cable tester

- A cable tester is an electronic device used to verify the electrical connections in a signal cable or other wired assembly. Basic cable testers are continuity testers that verify the existence of a conductive path between ends of the cable, and verify the correct wiring of connectors on the cable.

Network switch

- A network switch is a device that connects multiple devices within a local area network (LAN) and forwards data packets between them based on their MAC addresses. It helps manage the flow of data, ensuring that information is sent only to the intended recipient, which improves network efficiency.

Punch down tool

- A punch down tool, is a small hand tool used by telecommunication and network technicians. It is used for inserting wire into insulation-displacement connectors on punch down blocks, patch panels, keystone modules, and surface mount boxes (also known as biscuit jacks).

Steps –

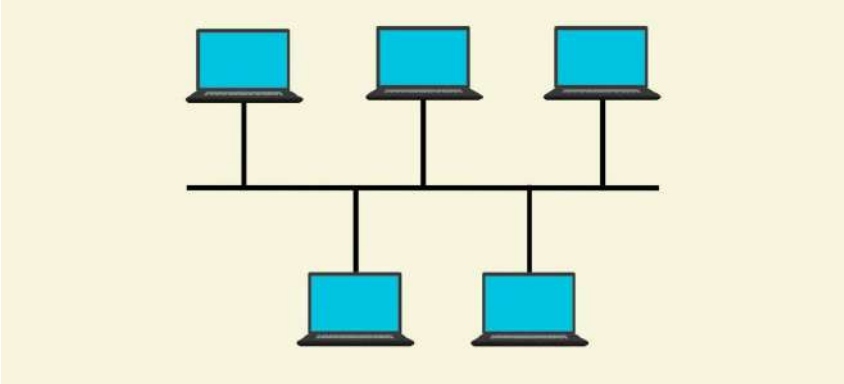
1. Using a crimping tool remove the shield of the ethernet cable
2. Separate and straighten out the 8 different coloured cables
3. Align them in the correct order given according to the given table

Pin	T568A Color Code	T568B Color Code
1	White-Green	White-Orange
2	Green	Orange
3	White-Orange	White-Green
4	Blue	Blue
5	White-Blue	White-Blue
6	Orange	Green
7	White-Brown	White-Brown
8	Brown	Brown

4. Using a crimping tool clip off the cables so that they align with each other perfectly
5. Put the cables in the RJ45 jack in the correct order and ensure that all the cables reach the end of the slot they are in
6. Using the crimping tool crimp the connectors of the RJ45 connector into the cables
7. Do the same for the other end of the ethernet cable
8. Check of the cable works using the cable tester

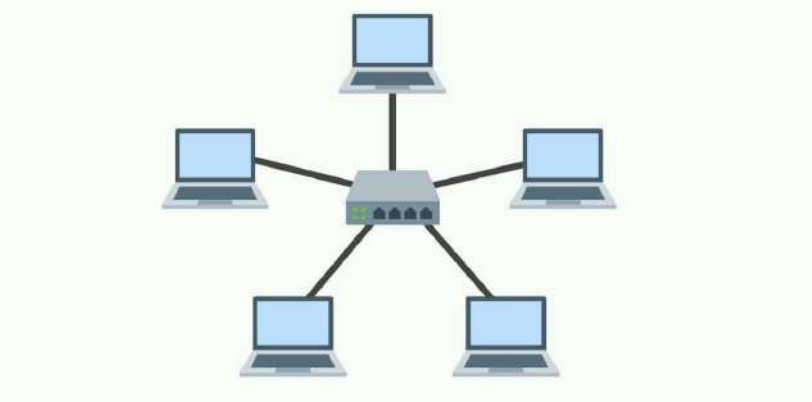
Topology

1. Bus Topology



- **Structure**: All devices are connected to a single central cable (bus).
- **Advantages**:
  - Cost-effective and easy to install.
  - Requires less cabling than other topologies.
  - Suitable for small networks.
- **Disadvantages**:
  - If the central cable fails, the entire network goes down.
  - Performance decreases with an increase in devices.
  - Limited cable length and number of devices.

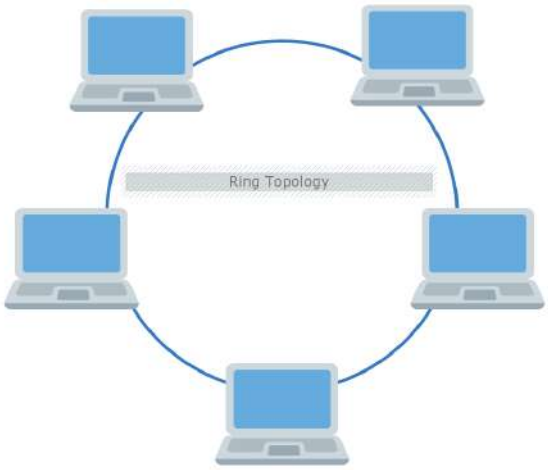
2. Star Topology



- **Structure**: All devices are connected to a central hub or switch.
- **Advantages**:
  - Easy to install and manage.
  - If one device fails, others remain unaffected.
  - Efficient data transmission with minimal collision.
- **Disadvantages**:
  - The entire network fails if the central hub/switch fails.

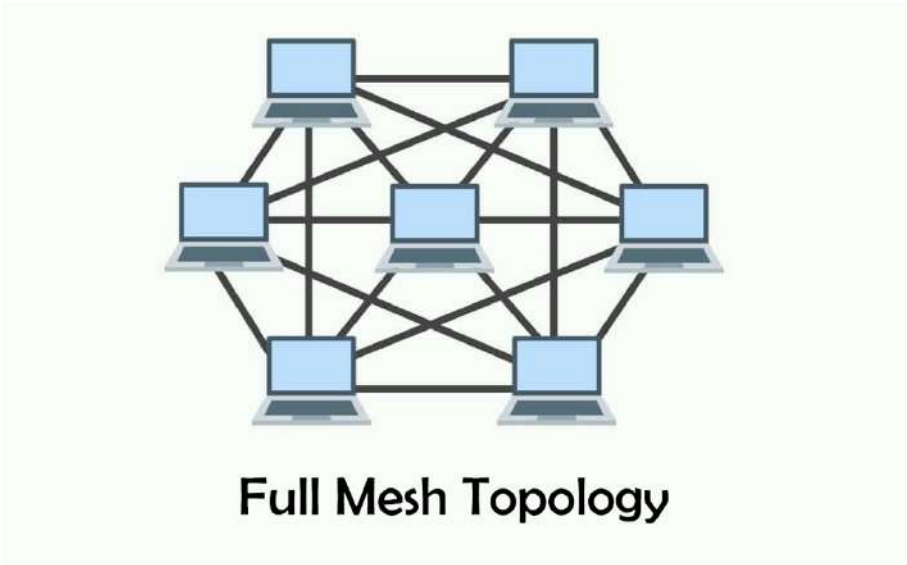
- More cabling required compared to bus topology.
- Can be expensive due to additional hardware requirements.

3. Ring Topology



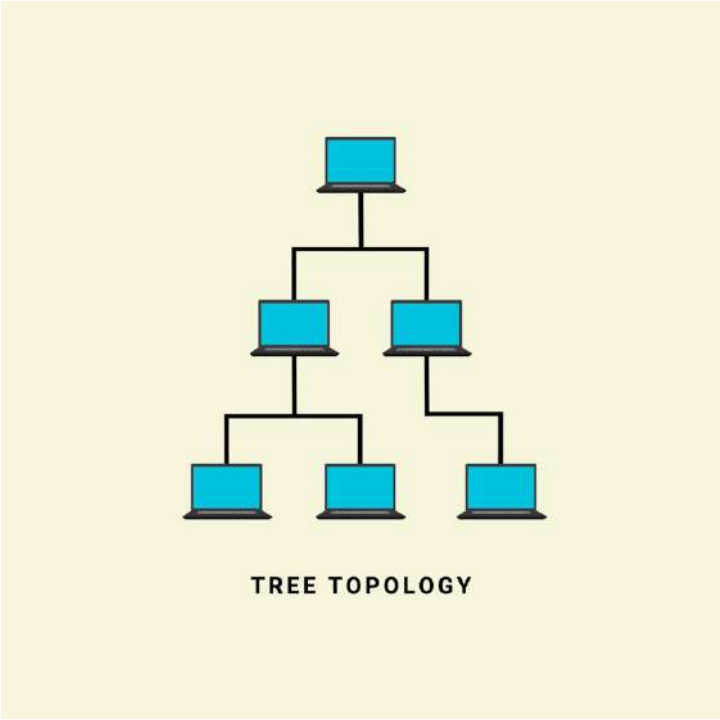
- **Structure**: Devices are connected in a circular manner, with each device connected to two others.
- **Advantages**:
  - Data flows in one direction, reducing data collision.
  - Equal access to network resources.
- **Disadvantages**:
  - A failure in one node can disrupt the entire network.
  - Adding or removing a device can affect network performance.
  - Troubleshooting is more complex compared to star topology.

4. Mesh Topology



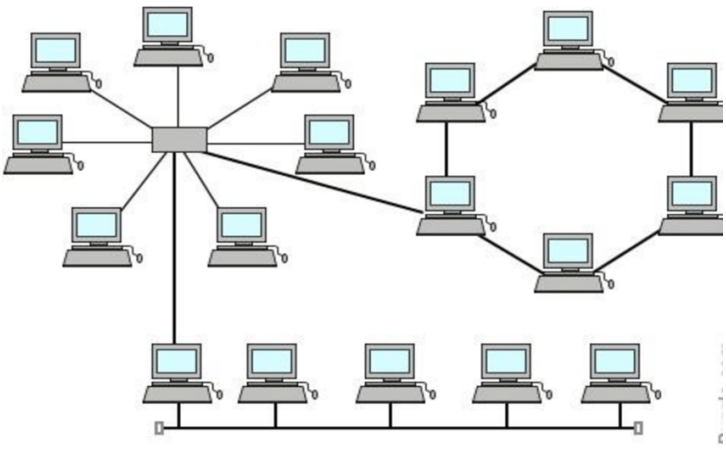
- **Structure**: Every device is connected to every other device in the network.
- **Advantages**:
  - Highly reliable (if one connection fails, others are available).
  - Supports high data traffic.
  - Ensures data security and privacy.
- **Disadvantages**:
  - Expensive due to extensive cabling and hardware.
  - Complex installation and maintenance.
  - Difficult to scale for large networks.

5. Tree(Hierarchal) Topology



- **Structure**: A tree like structure where one parent computer and multiple child computers connected to it. Usually depicted as a mix of bus and star topology
- **Advantages**:
  - Scalable and supports large networks.
  - Easy to troubleshoot and maintain.
- **Disadvantages**:
  - If the main backbone cable fails, the entire network is affected.
  - More expensive due to cabling and networking devices.

6. Hybrid Topology



- **Structure**: A combination of two or more different topologies.
- **Advantages**:
  - Flexible and scalable to meet network needs.
  - Can be optimized based on performance and cost.
- **Disadvantages**:
  - Complex design and maintenance.
  - Expensive due to additional networking hardware.

Switch, hub, connectors, cables(cabling standards) used in networks

Switch -

Definition -

A switch is a device in a computer network that connects multiple devices together and manages the flow of data between them by forwarding packets to the intended recipient based on their network addresses. It operates at the data link layer of the OSI model, allowing for efficient communication without data collisions.

Hub –

Definition –

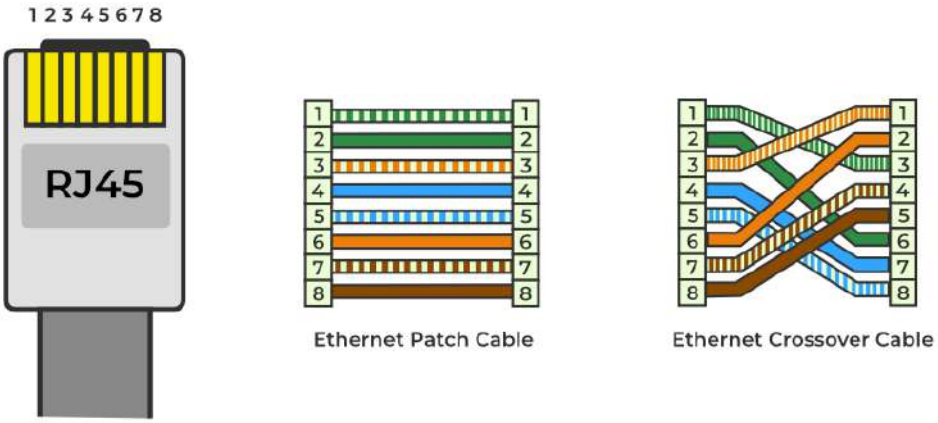
A hub is a hardware device used at the physical layer to connect multiple devices in the network. Hubs are widely used to connect LANs. A hub has multiple ports. Unlike a switch, a hub cannot filter the data, i.e. it cannot identify the destination of the packet, So it broadcasts or sends the message to each port

Connectors –

Definition –

Connectors are used to connect the guided (wired) transmission media to devices like the hub, server, workstations etc.

- RJ45 connector –
  - RJ45 stands for Registered Jack 45 and is the most commonly used connector in wired networks. The jacks are mainly used to connect to the Local Area Network (LAN).
  - RJ45 has a transparent plastic structure and is an 8-pin connector. It is an 8P8C connector and the number of wires that can be connected is 8. The jacks are mostly used with Shielded Twisted Pair cables or Unshielded Twisted Pair cables. If we take a close look at the end of the Ethernet cable connected to the RJ45 we can see the 8 wires out of which 4 wires are solid coloured and 4 are strip coloured

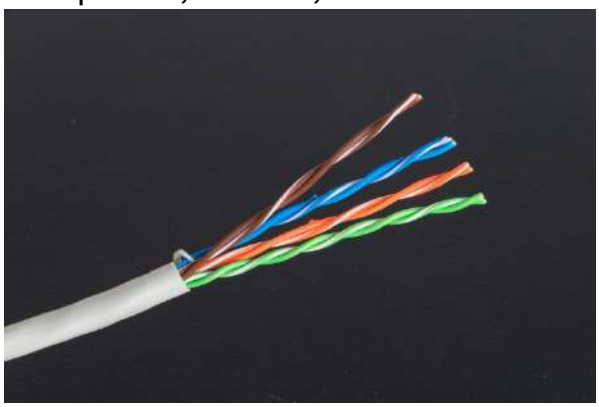


- Coaxial connector -
  - A coaxial connector has an inner conductor that is enveloped by a concentric conducting sleeve, with the conductor and shield separated by an insulating material; hence the term “coax” or “coaxial” connector. Coax connectors transmit analog signals while minimizing RF signal losses and work from DC to high-megahertz frequencies.

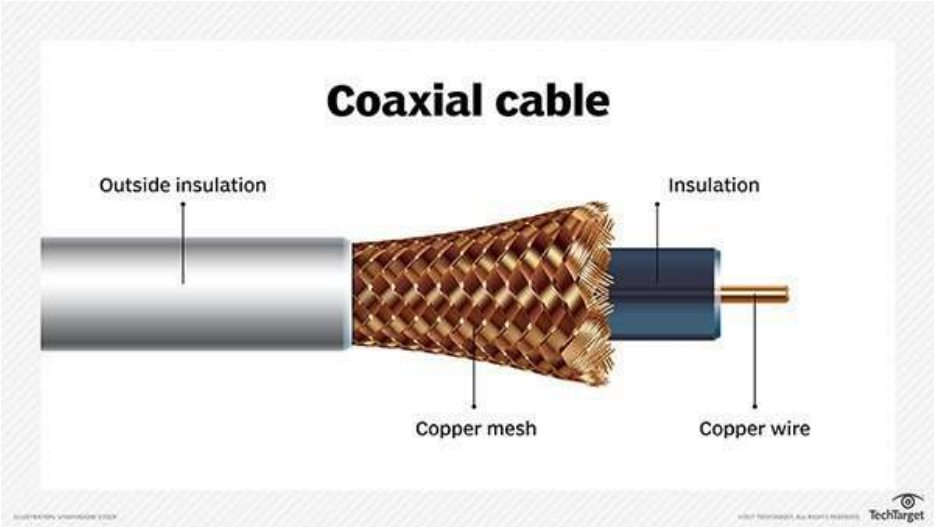
- Fiber optic connector –
    - An optical fiber connector is a device used to link optical fibers, facilitating the efficient transmission of light signals. An optical fiber connector enables quicker connection and disconnection than splicing.
    - Optical fiber connectors are categorized into single-mode and multimode types based on their distinct characteristics. Industry standards ensure compatibility among different connector types and manufacturers. These connectors find applications in telecommunications, data centers, and industrial settings

Cables –

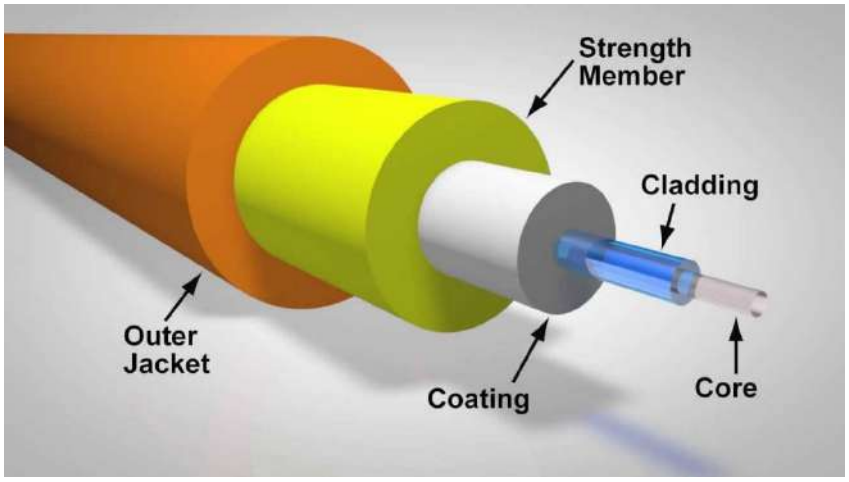
Twisted Pair - Twisted pair Ethernet cables are the most common type used in wired networks today. They consist of pairs of insulated copper wires twisted together to reduce electromagnetic interference and crosstalk. Each cable typically contains four pairs of wires, and depending on the category (like Cat5e, Cat6, or Cat6a), they support different speeds and bandwidths—up to 10 Gbps over distances of about 100 meters. They're flexible, affordable, and widely used for connecting devices like computers, routers, and switches in homes and offices.



Coaxial cable – A coaxial cable is used to carry high-frequency electrical signals with low losses. It uses 10Base2 and 10Base5 Ethernet variants. It has a copper conductor in the middle that is surrounded by a dielectric insulator generally made of PVC or Teflon. The dielectric insulator is surrounded by a plaited conducting metallic shield which reduces Electromagnetic Interference of the metal and outside interference and finally, the metallic shield is covered by a plastic covering called a sheath usually made of PVC or some other fire-resistant plastic material. Its maximum transmission speed is 10 Mbps.



Fiber optic cable – Fiber optic cables use optical fibers which are made of glass cores surrounded by several layers of covering material generally made of PVC or Teflon. It transmits data in the form of light signals due to which there are no interference issues in fiber optics. Fiber optics can transmit signals over a very long distance as compared to twisted pairs or coaxial cables



Routers and Bridges

Router -

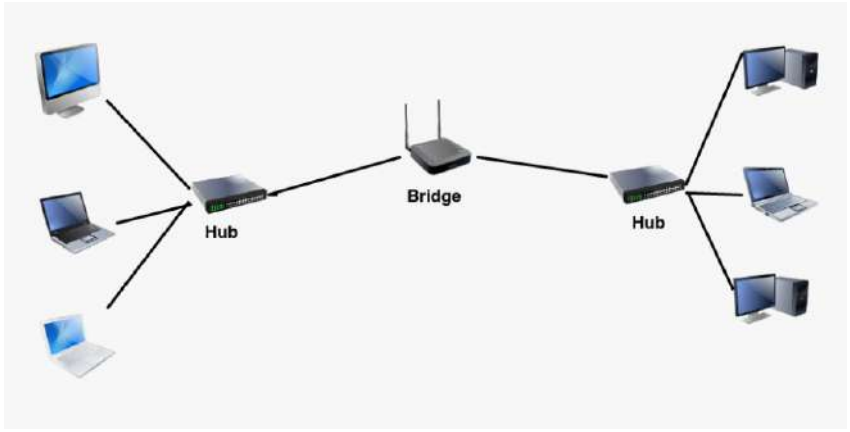
Definition -

A Router is a networking device that forwards data packets between computer networks. One or more packet-switched networks or subnetworks can be connected using a router. By sending data packets to their intended IP addresses, it manages traffic between different networks and permits several devices to share an Internet connection . Routers are the devices that are operated on the Network Layer of the OSI Model, these are the most common devices used in networking.

Bridges -

Definition -

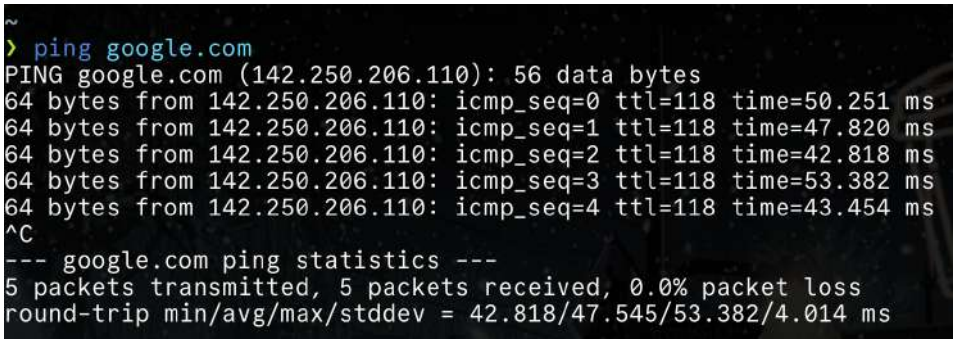
The bridge is a networking device in a computer network that is used to connect multiple LANs to a larger LAN. In computer networks, we have multiple networking devices such as bridges, hubs, routers, switches, etc, each device has its own specification and is used for a particular purpose. The bridge is a networking device that connects the larger LAN networks with the group of smaller LAN networks.



Bridge	Router
Bridge works in data link layer.	Router works in network layer.
Through bridge, data or information is not store and sent in the form of packet.	While through router, data or information is store and sent in the form of packet.
There are only two ports in bridge.	While there are more than two ports in router.
In bridge, routing table is not used.	While in routers, routing table is used.
Bridges are easy to configure.	While Routers are difficult to setup and configure.
Bridge focuses on MAC address .	While Router focuses on protocol address.
Bridge is comparatively inexpensive.	While Router is relatively expensive device.
Bridges are good for segment network and extends the existing network.	While Routers are good for joining remote networks.

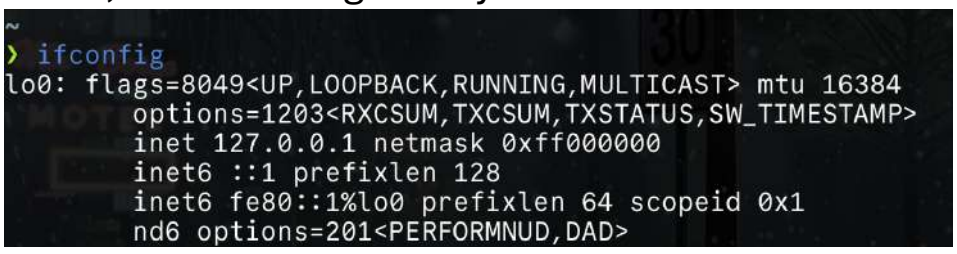
Basic networking commands

Ping - The ping command checks the connectivity between your device and another device or server by sending test packets and measuring the response time.



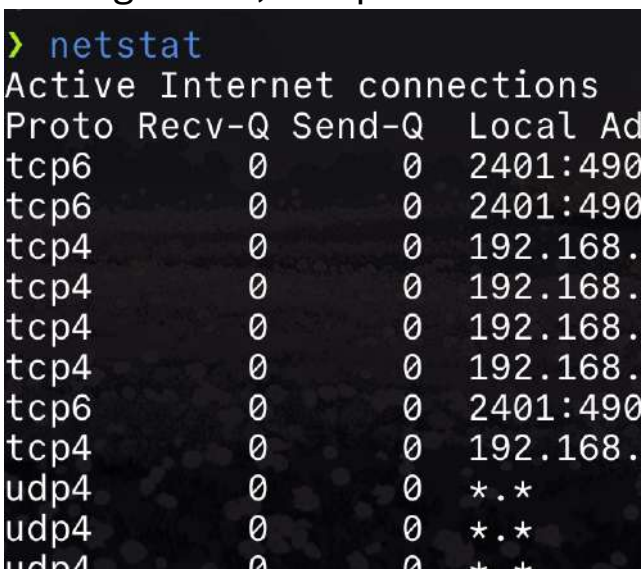
Traceroot - The traceroute command shows the path that data takes to reach a destination by listing all the network hops between your device and the target server.

Ipconfig/ifconfig - The ipconfig/ifconfig command displays your computer's network configuration details, like IP address, subnet mask, and default gateway.



nslookup - The nslookup command helps convert domain names into IP addresses.

netstat – The netstat command shows the network connections and the listening ports. It also shows current TCP/IP connections, routing tables, and protocol statistics.



Hamming Distance

Definition - Hamming distance is the number of positions at which two strings of equal length differ. In simpler terms, it counts how many characters you'd need to change to turn one string into the other.

Code –

```cpp
#include <iostream>
using namespace std;

int main() {
  int send, rec;
  cout << "Enter send number: ";
  cin >> send;
  cout << "Enter recived number: ";
  cin >> rec;

  int x = send ^ rec;
  int dis = 0;

  while (x > 0) {
    dis += x % 2;
    x = x / 2;
  }
  cout << "Hamming distance: " << dis;
  return 0;
}
```

```
Enter send number: 15
Enter recived number: 7
Hamming distance: 1
```

Checksum

Definition – Checksum is a Cyclic Redundancy Check (CRC) technique where extra n-1 bits added to the end of the data sent. A generator polynomial on n length is used to divide the data and the remainder of n-1 length is attached to the end. At the recover side if dividing by the generator polynomial does not give 0 as the remainder we can say that the data is not correct

Code –

```
#include <bitset>
#include <cstdlib>
#include <iostream>
#include <string>
using namespace std;

int int_to_bin(int a) {
  int temp = 0, m = 1;
  while (a > 0) {
    temp += (a % 10) * m;
    m *= 2;
    a = a / 10;
  }
  return temp;
}

string create_binary_no(int a) {
  string bina = bitset<32>(a).to_string();
  int cut = 0;
  for (int i = 0; i < bina.size(); i++) {
    if (bina[i] == '0') {
      cut = i;
    } else {
      break;
    }
  }
  bina = bina.substr(cut + 1, bina.size() - cut);
  return bina;
}

int binary_division(string bina, int polynomial, int l) {
  int i = 0;
  int bin = int_to_bin(stoi(bina.substr(i, l)));
  i += l;
  while (i < bina.size()) {
    bin = bin ^ polynomial;
    if (bitset<5>(bin).to_string()[0] == '1') {
      // i++;
    } else {
      bin = bin << 1;
      bin += bina[i] == '1' ? 1 : 0;
      i++;
    }
  }
  return bin;
}
```

```cpp
int string_to_binary(string a) {
  int bin = 0;
  int m = 1;
  for (int i = a.size() - 1; i >= 0; i--) {
    if (a[i] == '1') {
      bin += m;
    }
    m *= 2;
  }
  return bin;
}

int main() {
  // int polynomial = 0b11001;
  // int l = 5;
  string poly_string;
  cout << "Enter generating polynomial: ";
  cin >> poly_string;
  int l = poly_string.size();
  int polynomial = string_to_binary(poly_string);
  int a;
  cout << "Enter a number: ";
  cin >> a;

  string bina = create_binary_no(a << 4);
  int bin = binary_division(bina, polynomial, l);

  string a_str = create_binary_no(a);
  string final = a_str + bitset<4>(bin).to_string();
  cout << "Final number after Checksum of 4 length checksum: " << final << "\n";

  cout << (binary_division(final, polynomial, l) == 0 ? "Checksum verified"
                                                      : "Checksum failed")<<endl;

  return 0;
}
```

```
Enter generating polynomial: 10011
Enter a number: 127
Final number after Checksum of 4 length checksum: 11111111010
Checksum verified
```

Sliding Window

Definition - The sliding window is a flow control technique in networking where a sender can transmit multiple frames before needing an acknowledgment, allowing efficient and continuous data transfer.

Code –

```
#include <cstdlib>
#include <ctime>
#include <iostream>
using namespace std;

void send(int i, int *sent, int *rec) {
  sent[i] = 1;
  rec[i] = 1;
}

int main() {
  srand(time(NULL));
  int window_size, window_pos = 0, n_frames = rand() % 95 + 5;
  int sent[n_frames];
  int recived[n_frames];
  for (int i = 0; i < n_frames; i++) {
    sent[i] = 0;
    recived[i] = 0;
  }
  cout << "Frames = " << n_frames << "\n";
  cout << "Enter window size: ";
  cin >> window_size;
  int i;
  bool f;
  while (1) {
    i = window_pos;
    while (i < window_pos + window_size) {
      if (sent[i] == 0) {
        cout << "Sending " << i << "\n";
        send(i, sent, recived);
      }
      i++;
    }
```

```
    cout<<"\n";
    i = window_pos;
    while (i < window_size + window_pos) {
      if (recived[i] == 1) {
        cout << "Recived " << i << "\n";
        cout << "Window moved\n";
        window_pos++;
        i++;
      } else {
        break;
      }
    }
    cout<<"\n";
    f = true;
    for (int j = 0; j < n_frames; j++) {
      if (recived[j] == 0) {
        f = false;
        break;
      }
    }
    if (f) {
      cout << "Done all\n";
      break;
    }
  }
  return 0;
}
```

```
Frames = 10
Enter window size: 5
Sending 0
Sending 1
Sending 2
Sending 3
Sending 4

Recived 0
Window moved
Recived 1
Window moved
Recived 2
Window moved
Recived 3
Window moved
Recived 4
Window moved

Sending 5
Sending 6
Sending 7
Sending 8
Sending 9

Recived 5
Window moved
Recived 6
Window moved
Recived 7
Window moved
Recived 8
Window moved
Recived 9
Window moved

Done all
```