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Principles of Internet Technologies

Lecture 2:

Network Components

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NETWORK COMPONENTS
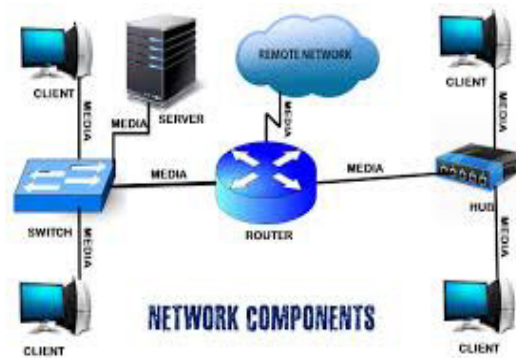
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Network Components

1. **The Network Hardware Devices:** *(NIC Card, Repeater, Hub, Switch, Bridge, Router, Gateway).*

2. **Network Media:**

   1. **Wired:** *Twisted Pair (UTP), Co-axial, fiber Optic*

   2. **Wireless:** *Microwave, Satellite*

3. **Network categories:** *(LAN, MAN, WAN)*

4. **Types of Networks (Physical Topologies):** *(Bus, Ring, Star, Mesh, Hybrid Topologies)*

5. **Network Architecture:** *(Peer-to-Peer Architecture, Client/Server Architecture)*

6. **Network Protocols:** *(TCP/IP).*

7. **Applications of Networks.**

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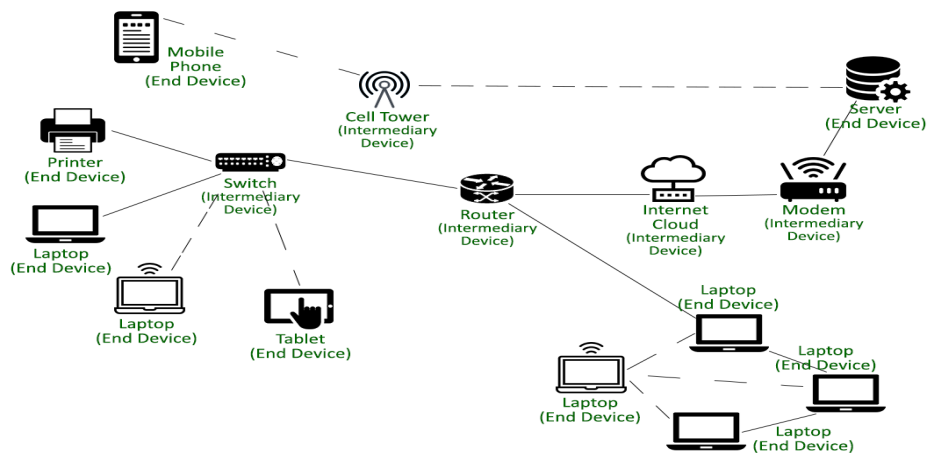
The Networking Devices(Nodes)

- *Networking Devices:* *refer to the components used to connect computers as well as other electrical devices together by communication links known as **transmission media** for the exchange of information and resource sharing.*

- *Networking Devices* *is any device that is capable of sending or receiving data. In the basis of functionality and usage, the Networking devices can be classified into*

1. *End Devices:*
2. *Intermediary Devices:*

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The Networking Devices(Nodes)

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The Networking Devices(Nodes)

1. ***End Devices:*** *are the devices that serve as a source point (known as a **server**) or a destination point (known as a **client**), or both in the communication that occurs on a computer network.*

- *Functions of End Devices :*
  - A. ***They serve as the originator of the data or information that flows through the network (i.e. server).***
  - B. ***Act as an interface between end-users (humans) and the communication network having several node devices (i.e. computer).***

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The Networking Devices(Nodes)

1. ***Intermediary Devices:*** *are devices that are designed to forward the data from one side to another side in a computer network.*

- *To manage the data flowing through the intermediary devices we use various addressing systems such as **IP Address**, **MAC Address**, and **Port Numbers** (or Port Address) along with the information about the network interconnections.*

- *Examples of the intermediary devices : **Network Interface Card (NIC), Hubs, Switches**, **Routers**, **Network bridges**. **Gateways**, **Firewalls**, **Wireless AP (Access Points),** etc.,*

Network Interface Card (NIC)

- *NIC also called **interface controller**, **network adapter** or **LAN adapter**. it is used to physically connect **host devices** to the **network media**.*

- *A NIC is a printed circuit board that fits into the expansion slot of a bus on a computer motherboard and allows both **wired** and wireless communications.*

- *Each NIC is identified by a unique code called a **Media Access Control (MAC)** address that used to control data communication for the host on the network.*

Network Interface Card

Ethernet cable

Ethernet Port
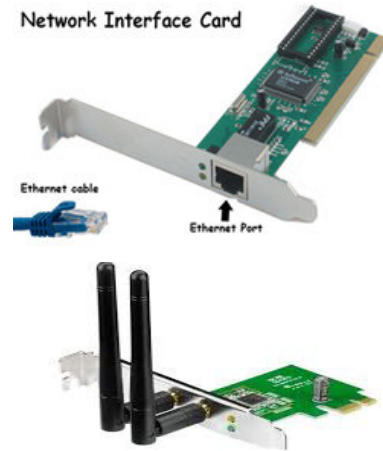
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Repeaters

- ***A repeater is** a network device used to regenerate a signal between two cable segments or wireless access points. **Repeaters regenerate analog or digital signals that are distorted by transmission loss due to attenuation.***

- *Repeaters require a **small amount of time to regenerate the signal**. **Many network architectures limit the number of repeaters that can be used in a network row.***

Wireless Router or Access Point   Repeater   Desktop/ Laptop

Hubs

- **Hub** allow computers and devices to plug into their ports in order to connect to each other and share files, data and resources. Typically HUBs are available with 4,8,12,24,48 ports.

- **Hubs** are **non-intelligent** devices and the do not manage any of the data that flows through them. The hub simply sends the data onto every computer/device on the network.

- This lack of data management makes network that are connected by hubs **very slow** because there is a lot of unnecessary data flowing around.

- **Hubs** are old technology and have been replaced by **switches** which manage data more effectively and operate much faster.

Hubs

- Based on functionality, there are two types of HUB:

  1. **Passive HUB:** It forwards the data signal from all ports except the port on which signal arrived. It doesn't interfere in data signal.

  2. **Active HUB:** It also forwards the data signal from all ports except the port on which signal arrived. But before forwarding, it improves quality of data signal by amplifying it. Due to this added features active HUB is also known as **repeaters**.
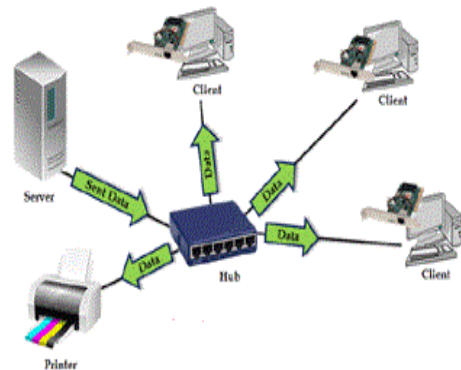
Bridges

- **Bridge**: *A hardware device used to create a connection between two separate computer networks or to divide one network into two.*

- *Bridges improve network* ***throughput*** *by separate* ***collision domain***, *, so the number of collisions on the network is reduced and each collision domain has its own separate bandwidth for this reason a bridge operate at a more intelligent level than hubs.*

- **Bridge** *forward data depending on the Hardware (****MAC****) address and checks data to determine if it should cross the bridge or not. This makes each part of the network more efficient.*

Bridges

- *Abridge can connect two different types of media or* ***network architecture*** *but it cannot connect two different types of* ***network layer protocol***. ***Bridge requires same network layer protocol in all segments.***

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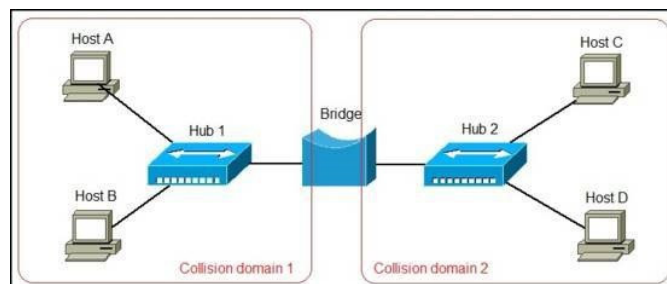
Switches

- *Switches work as the same way of the hubs. Unlike hubs,* **switches can identify the destination of a packet and send information only to the computer that is suppose to receive the information.**

- *Switches helps to reduce the* **possibility of collision and increasing network performance**, *however, collision can only occurs when two devices try to get access to one channel and that can be solved by buffering one of them for later access.*

- *Switches are a better option than hubs for larger networks or home networks with 4 or more connected computers.*

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Switches

- *How switches manage data is summarized below:*

1. *Each network device has a* **Media Access Control (MAC)** *address which uniquely identifies it.*

2. *Data sent to the switch contains the* **MAC address of the sending device and the MAC address of the receiving device**.

3. *The switch will check these addresses and only send the data to the relevant device rather than to all devices as hub do.*

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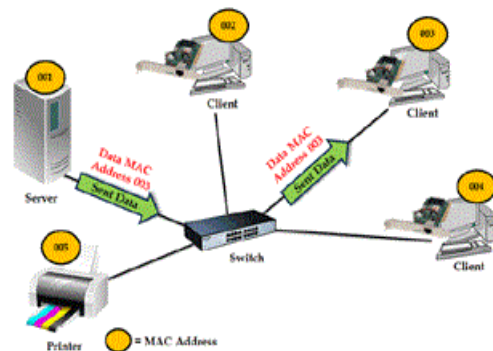
Routers

- *A router is a device like a switch that routes data packets based on their **IP addresses**. The router is mainly a **Network Layer device**. Routers normally used to connect networks to the outside world via the Internet.*

- *It transfers data in the form of **IP packets**. In order to transmit data, it uses **IP address** mentioned in the destination field of the IP packet.*

- *Routers have a **routing table** in it that is refreshed periodically according to the changes in the network. In order to transmit data packets, it consults the table and uses a routing protocol. In order to prepare or refresh the routing table, routers share information among each other.*

Types of Routers

- *A variety of routers are available depending upon their usages. The main types of routers are.*

1. ***Wireless router:** A wireless router uses an **Ethernet cable** to connect to a modem. It distributes data by converting packets from binary code into radio signals, then wirelessly broadcasts them using antennae.*

2. ***Wired router: A** wired router also uses an Ethernet cable to connect to a modem. It then uses separate cables to connect to one or more devices within the network, create a LAN, and link the devices within that network to the Internet.*

Types of Routers

- *In addition to wireless and wired routers for small LANs, there are many specialized types of routers that serve specific functions such as **Core router, Edge router and Brouters**.*
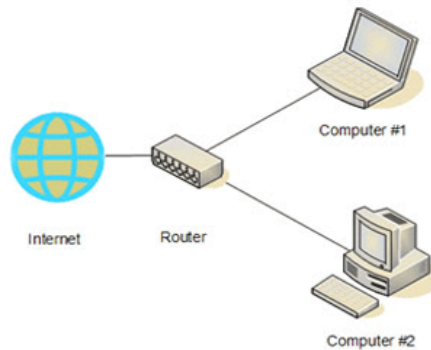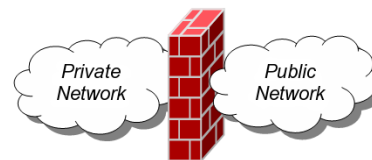
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Firewall

- ***A firewall is a network device or software that protects a computer network from unauthorized access.***

- *Firewalls are inserted in connections between **secure internal networks** and potentially **insecure external networks** such as the Internet.*

- *Firewalls are typically configured to **reject access requests from unrecognized sources** while allowing actions from **recognized ones**.*

- *The vital role firewalls play in network **security grows** in parallel with the constant increase in **cyber attacks**.*

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Network Media

- *Networking media can be defined simply as the means by which signals (data) are sent from one computer to another (either by cable or wireless means).*

  1. *Wired (Guided): widely adopted family that uses copper and fiber media in local area network (LAN) technology are collectively known as Ethernet*

     1. *Copper Cable*
        1. *Coaxial Cables*
        2. *Twisted Pair cables:*
           - A. *Shielded Twisted Pair(STP)*
           - B. *Unshielded Twisted Pair(UTP)*
     2. *Fiber Optic Cable*

  2. *Wireless (Unguided): Microwave, Satellite*
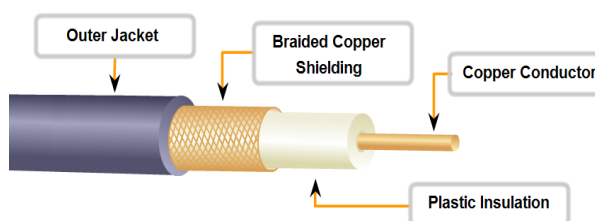
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Wired Network Media: Copper Cable

- *Copper Cable A type of network media that transfers **electrical** signals via copper medium.*

- *The disadvantage of sending data over copper wire is that the further the signal travels, the weaker it becomes.*

1. *Coaxial Cables: It can be run **longer** distances than Twisted pair Cables. Two types of coaxial cable: **Thick coaxial** and **Thin Coaxial**.*

   1. *Speed: 10-100Mbps*
   2. *Cost: Inexpensive*
   3. *Media and connector size: Medium*
   4. *Maximum cable length: 500m*

Outer Jacket | Braided Copper Shielding | Copper Conductor | Plastic Insulation

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Copper Cable: Twisted Pair cables
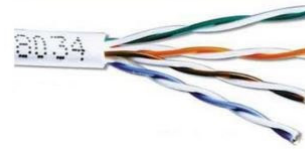
1. **Shielded Twisted Pair(STP):**
    1. **Speed**: *0-100Mbps*
    2. **Cost**: *Moderate*
    3. **Media and connector size**: *Medium to large*
    4. **Maximum cable length**: *100m*

2. **Unshielded Twisted Pair (UTP)**
    1. **Speed**: *10-100-1000 Mbps*
    2. **Cost**: *Least Expensive than STP*
    3. **Media and connector size**: *Small*
   4. **Maximum cable length:** *100m * (Depending on the quality/category of cable)*

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Twisted Pair cables: Implementation

- **Twisted Pairs Cables are:**
- **Pair 1:** *White/blue, Blue*   **Pair 2:** *White/Orange, Orange*
- **Pair 3:** *White/Green, Green*   **Pair 4:** *White/Brown, Brown*
- **RJ45 Connector:** *The letters RJ stand for registered jack. A RJ45 connector is a modular 8 position,*
  *8 pin connector used for terminating **Twisted Pairs Cables** .*
- **Twisted Pairs Cables Categories are:**
    1. **CAT 1:** *Maximum Data Rate Less than **1 Mbps***
    2. **CAT 2:** *Maximum Data Rate **4 Mbps***
    3. **CAT 3:** *Maximum Data Rate **16 Mbps***
    4. **CAT 4:** *Maximum Data Rate **20 Mbps***
    5. **CAT 5, 5E:** *Maximum Data Rate **100 Mbps***
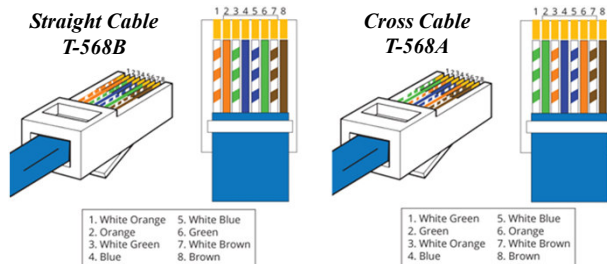   6. **CAT 6:** *Maximum Data Rate **100-250 MHz***

RJ45
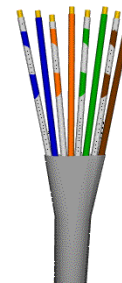
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UTP Implementation

- *Two types of UTP Implementation: Straight-through and **crossover**. Straight-through cables are mainly used for **connecting non-similar devices** while crossover cables are mostly used for **connecting similar devices**.*

Straight Cable T-568B

Cross Cable T-568A

1. White Orange 5. White Blue
2. Orange 6. Green
3. White Green 7. White Brown
4. Blue 8. Brown

1. White Green 5. White Blue
2. Green 6. Orange
3. White Orange 7. White Brown
4. Blue 8. Brown

CABLE CRIMPING AND TESTING

CRIMPER CABLE STRIPPER RJ45 CONNECTOR

CABLE TESTER UTP CABLE

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Wired Network Media: Fiber Optic Cable

2. **Fiber Optic Cable:** *A data transmission technology that encodes data using light and sends the light down a very long strand of thin glass or plastic. Fiber optic connections are fast and can cover very long distances.*

- *Signal transmitted by **photos** rather than **electrons**, dramatically higher bandwidth. Fiber Optic mostly used for backbone communication connections.*

- *Fiber optic cabling can support **too high bandwidths** in the range from **100 Mbps to 2 gigabytes** because light has a much greater frequency than electricity.*

- *The disadvantage of optical fiber are:*
  1. **High Cost,**
  2. **Unidirectional light propagation and**
  3. **Installation and Maintenance .**

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Wireless (Unguided) Network Media

- *Wireless :* In this type of media, the signal propagates in the form of **electromagnetic waves** without using a physical medium, i.e., in the air. There are also called **Unbounded media**.

- *Propagation Methods:* The unguided signals can travel from the transmitter to the receiver in many different ways. The three most important methods are:

  1. *Ground Wave Propagation.*

  2. *SKY Propagation.*

  3. *Space propagation.*

- *Transmission Methods:* There are 3 types of unguided/wireless transmission media which are *Radio Waves, Microwaves, Infrared.*

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Wireless (Unguided) Network Media

- *Types of Wireless (Unguided) Network Media devices:*

*Omni Antenna*   *Sector Antenna*   *Grid Antenna*   *PowerBeam Antenna*   *Dish Antenna*

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Wireless Internet Service Provider (WISP)

- *WISP used **to provide Internet access on a point-to-point and point-to-multipoint basis**, for companies, governmental organizations, schools, universities and other institutions having Local Area Networks (LAN).*
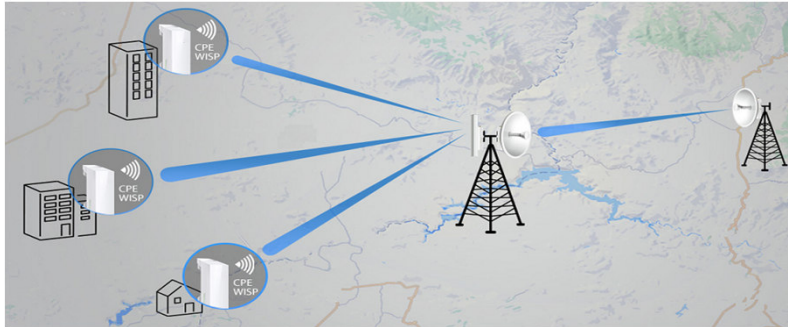
Cisco Network Topology Icons

Small hub   Router   Workgroup switch   Repeater   Bridge

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Assignment (1)

- *Write a short overview (**Three Papers at most**)about one of the following Wireless (Unguided) Network Media devices, and this overview should covers: **(1) properties of the device and its type, (2) advantage and disadvantage of the device and (3) What are used for?**.*

  1. *Omni Antenna*

  2. *Sector Antenna*

  3. *Power-Beam Antenna*

  4. *Dish Antenna*

  5. *Gateway networking hardware*

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The End

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