**Lab Practical #02:**

Study of different network devices in detail.

**Practical Assignment #02:**

1. Give difference between below network devices.

* Hub and Switch
* Switch and Router
* Router and Gateway

1. Working of below network devices:
   * Repeater
   * Modem((DSL and ADSL)
   * Hub
   * Bridge
   * Switch
   * Router
   * Gateway

# Hub and Switch

|  |  |  |
| --- | --- | --- |
| No. | Hub | Switch |
| 1 | |  | | --- | | A basic device that connects multiple devices  and broadcasts data to all. | | |  | | --- | | A basic device that connects multiple devices  and broadcasts data to all. | |
| 2 | Broadcasts data to all devices in the network | Sends data only to the specific device (MAC address) |
| 3 | Physical Layer (Layer 1) | Data Link Layer (Layer 2) |
| 4 | Half-duplex i.e. data in one direction at a time | Full-duplex i.e. data can go both ways simultaneously |
| 5 | Outdated, used in older LANs. | Widely used in modern homes, offices, and enterprises. |

# Switch and Router

|  |  |  |
| --- | --- | --- |
| No. | Switch | Router |
| 1 | |  | | --- | |  |  |  | | --- | | A device that connects multiple devices  within a local network (LAN) and forwards  data based on MAC addresses. | | A device that connects different networks (e.g., LAN to Internet) and forwards data based on IP addresses. |
| 2 | Works at Layer 2 (Data Link Layer), some at Layer 3. | Works at Layer 3 (Network Layer). |
| 3 | Uses MAC addresses to forward data. | Uses IP addresses to forward data. |
| 4 | Forwards data within a single network (LAN). | Routes data between multiple networks. |
| 5 | Faster (1–10 Gbps or more). | Slightly slower due to complex routing tasks. |

# Router and Gateway

|  |  |  |
| --- | --- | --- |
| No. | Router | Gateway |
| 1 | Routes data packets between different networks using IP addresses. | Translates data between two networks that use different protocols (e.g., LAN to a legacy system). |
| 2 | A networking device that connects multiple networks, usually LAN to WAN or Internet. | A device (or software) that acts as an entry/exit point between two different networks using different protocols. |
| 3 | Home Wi-Fi router, enterprise router. | VoIP gateway, email gateway, or a gateway that connects IP network to an older protocol network. |
| 4 | Connects a home network to the Internet (both using IP). | Connects a corporate LAN to a legacy system that uses a different protocol. |
| 5 | Operates mostly at **Layer 3 (Network layer).** | Can operate at **multiple layers (Network to Application layer)** depending on protocol conversion. |

# Working of below network devices:

1. **Switch**

A switch is a networking device that connects multiple devices (like computers, printers, servers) within a Local Area Network (LAN) and helps them communicate efficiently.

It operates mainly at the Data Link Layer (Layer 2) of the OSI model, though some switches can work at Layer 3 (Network Layer) as well.

How Does A Switch Work?

1) Learning MAC addresses

* Every network device (computer, printer, etc.) has a unique MAC address (Media Access Control address).
* When a device sends data (a frame) through the switch, the switch notes down the MAC address and the port it came from, storing it in a MAC address table.

2) Forwarding / Filtering

* When the switch receives a frame, it checks the destination MAC address.
* If the destination MAC address is in its MAC address table, it forwards the frame only to the port where that device is connected.
* If the destination MAC address is unknown it floods the frame to all ports (except the one it came from) to find the destination.

3) Updating MAC table

* As communication continues, the switch keeps updating its MAC address table, mapping MAC addresses to ports dynamically.

4) Avoiding collisions

* Unlike hubs, switches create a dedicated path between the sender and receiver, reducing collisions and improving network efficiency.

1. **Router**

A router is a networking device that connects multiple networks together and forwards data packets between them.

it operates mainly at Layer 3 (Network Layer) of the OSI model.  
It uses IP addresses to determine the best path for data to travel.

Routers are used to connect:

* A home or office network to the internet
* Two or more LANs
* Different network segments

How does a Router work?

1) Receives the packet

* The router receives a data packet on one of its interfaces.
* The packet contains the source IP address and destination IP address.

2) Checks routing table

* The router looks at the destination IP address of the packet.
* It searches its routing table (a list of known networks and how to reach them) to determine the best next hop or interface.

3) Forwards the packet

* Based on the routing table, the router forwards the packet out through the appropriate interface towards its destination.

4) Path determination

* Routers use routing protocols (like OSPF, BGP, RIP) or static routes to build and update their routing tables.
* These protocols help routers choose the most efficient path.

1. **Gateway**

A gateway is a networking device that acts as a bridge between two different networks using different communication protocols. It enables devices from one network to communicate with devices in another network that would otherwise be incompatible.

It can operate across multiple OSI layers (3–7) depending on the type of protocol conversion required.

Gateways are often used to connect:  
• A private LAN to the Internet (default gateway)  
• Two networks using different protocols  
• Legacy systems with modern networks

How does a Gateway work?

1. Receives the data  
   • The gateway receives data from one network that may use a different protocol.  
   • It identifies the source and destination network requirements.
2. Performs protocol conversion  
   • The gateway translates data from one protocol to another (for example, from IPv4 to IPv6, or from TCP/IP to another protocol).  
   • This ensures compatibility between the two networks.
3. Checks policies/rules  
   • Gateways may apply security rules, filtering, or address translation during data conversion.
4. Forwards the data  
   • After conversion, the gateway forwards the data to the destination network or device using the appropriate format.
5. **Repeater**

A repeater is a networking device used to extend the range of a network by strengthening and retransmitting signals. It is mainly used when data signals become weak or distorted over long distances.

It operates at Layer 1 (Physical Layer) of the OSI model.

Repeaters are commonly used in:  
• Extending wired Ethernet connections over long distances  
• Boosting Wi-Fi signals to increase wireless coverage

How does a Repeater work?

1. Receives the signal  
   • The repeater receives a weak or degraded signal from one segment of the network.
2. Regenerates the signal  
   • It cleans and amplifies the signal, restoring it to its original quality.
3. Transmits the signal  
   • The refreshed signal is retransmitted to the next segment, extending the network’s reach.
4. **Modem (DSL and ADSL)**

A modem (modulator-demodulator) is a device that converts digital signals from a computer into analogue signals for transmission over telephone lines and vice versa. This allows computers to communicate over traditional phone lines for Internet access.

DSL (Digital Subscriber Line) and ADSL (Asymmetric DSL) modems are widely used for broadband Internet connections.

• DSL provides digital data transmission over telephone lines.  
• ADSL offers higher download speeds than upload speeds (asymmetric), making it suitable for home and office use.

Modems are used to:  
• Connect a home or office network to an Internet Service Provider (ISP)  
• Provide broadband Internet over telephone lines without interfering with voice calls

How does a Modem work?

1. Modulation  
   • Converts digital data from a computer into analogue signals for transmission over phone lines.
2. Demodulation  
   • Converts incoming analogue signals from the ISP back into digital signals for the computer.
3. Maintains Internet connection  
   • Establishes and manages the connection between the user’s network and the ISP.
4. **Hub**

A hub is a simple networking device that connects multiple devices in a network and forwards any incoming data to all connected devices. It does not filter or direct traffic, meaning every device receives the same data, which can cause network congestion.

It operates at Layer 1 (Physical Layer) of the OSI model.

Hubs are mainly used in:  
• Small and simple Local Area Networks (LANs)  
• Situations where low cost is more important than efficiency

How does a Hub work?

1. Receives the signal  
   • The hub receives a data signal from one of its connected devices.
2. Broadcasts the signal  
   • It broadcasts the same signal to all other connected devices, regardless of the destination.
3. No learning or filtering  
   • A hub does not learn device addresses or filter traffic, leading to collisions and slower network performance.
4. **Bridge**

A bridge is a networking device that connects two or more network segments and helps control traffic between them. It filters data based on MAC addresses, reducing unnecessary traffic and improving overall network performance.

It operates at Layer 2 (Data Link Layer) of the OSI model.  
Bridges are used to:  
• Divide large networks into smaller, more manageable segments  
• Reduce collisions by controlling traffic between segments  
• Improve performance in busy networks

How does a Bridge work?

1. Receives the frame  
   • The bridge receives a data frame from one network segment.
2. Learns MAC addresses  
   • It examines the source and destination MAC addresses to learn which devices are connected to each segment.
3. Forwards or filters  
   • If the destination is on the same segment, the frame is dropped.  
   • If the destination is on a different segment, the frame is forwarded to that segment.