

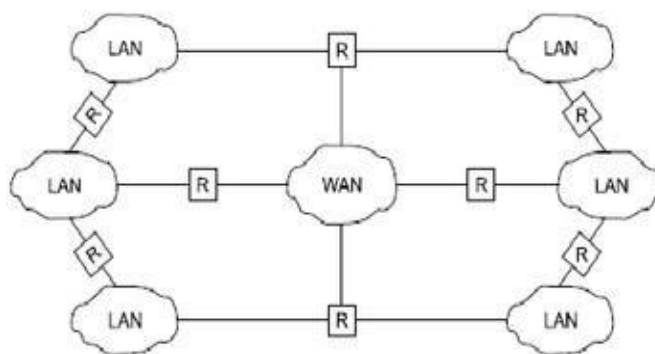
BCA-5003 Computer Networks

UNIT-IV

Devices: Repeaters, bridges, gateways, routers, The Network Layer; Design issues, Internetworking, Network-Layer in the internet.

INTERNETWORK

- An internetwork is defined as two or more computer network LANs or WAN.
- An Internetwork can be formed by joining two or more individual networks by means of various devices such as routers, gateways and bridges.
- An interconnection between public, private, commercial, industrial, or government computer networks can also be defined as **internetworking**.



Types of Internetwork

<u>Extranet</u>	<u>Intranet</u>
An extranet is used for information sharing. The access to the extranet is restricted to only those users who have login credentials. An extranet is the lowest level of internetworking. It can be categorized as MAN , WAN or other computer networks. An extranet cannot have a single LAN , atleast it must have one connection to the external network .	An intranet belongs to an organization which is only accessible by the organization's employee or members. The main aim of the intranet is to share the information and resources among the organization employees. An intranet provides the facility to work in groups and for teleconferences.

Switches in Computer Networks

- A **switch** is a networking device used to **connect multiple devices** within a **Local Area Network (LAN)**.
- It forwards data **only to the intended destination device**.
- A switch uses the **MAC address** of devices to determine where the data should be sent.
- It learns and maintains a **MAC address table** that maps MAC addresses to switch ports.



How Does a Switch Work?

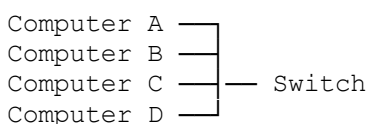
1. A device sends a **data frame** to the switch.
2. The switch checks the **destination MAC address** in the frame.
3. It looks for that MAC address in its **MAC address table**.
4. The switch forwards the frame through the **appropriate port**.
5. Thus, unnecessary transmission to other ports is avoided in normal known-unicast forwarding.

Switch vs Hub

- **Hub:**
 - Sends/broadcasts incoming data to **all connected devices**.
 - Does not use MAC addresses to selectively forward frames.
 - Creates more unnecessary traffic.
- **Switch:**
 - Uses **MAC addresses** to forward frames.
 - Sends a frame to the **appropriate port** when the destination is known.
 - Reduces unnecessary traffic.
 - Each switch port is normally its own **collision domain**, which helps reduce collisions compared with traditional shared-hub Ethernet.

Advantages of Switches

- **Efficient data forwarding**
- **Reduces unnecessary network traffic**
- **Improves network performance**
- **Reduces collisions**
- Allows **multiple devices** to communicate through the LAN.



If **Computer A** sends data to **Computer C**, the switch identifies **Computer C's MAC address** and forwards the frame through the port connected to **Computer C**.

Routers in Computer Networks

- A **router** is a networking device used to **connect two or more different networks**.
- It **forwards data packets** from one network to another.
- A router examines the **destination IP address** of a packet to determine where it should be sent.
- It uses a **routing table** and routing information to select an appropriate path for the packet.
- Routers are essential for **communication between different networks**, including communication over the Internet.
- A router can connect a **local network (LAN)** to an **external network**, such as an ISP network.

Functions of Routers

- **Connect Different Networks**
 - Connects two or more separate networks.
- **Determine the Best Path**
 - Selects an appropriate route for delivering packets to the destination.
- **Forward Data Packets**
 - Sends packets from one network/interface to the next toward their destination.
- **Enable Internet Connectivity**
 - Allows devices on a local network to communicate with networks outside the local network, including the Internet.

Example

LAN 1 Router Internet
Computers → [Router] → ISP/Internet

If a computer wants to access a website:

1. The computer creates a **data packet**.
2. The packet is sent to the **router**.
3. The router checks the **destination IP address**.
4. It determines the appropriate **next hop/path**.
5. The router forwards the packet toward the destination.

Switch vs Router

Switch	Router
Mainly connects devices within a LAN	Connects different networks
Uses MAC addresses for Layer-2 forwarding	Uses IP addresses for routing
Forwards frames	Forwards packets
Works primarily at Data Link Layer (Layer 2)	Works primarily at Network Layer (Layer 3)

Bridge in Computer Networks

- A **bridge** is a networking device used to **connect two or more LAN segments**.
- It operates mainly at the **Data Link Layer (Layer 2)** of the OSI model.
- A bridge uses **MAC addresses** to decide whether a frame should be forwarded to another network segment.
- It helps **reduce unnecessary network traffic** by filtering frames.
- It divides a LAN into separate **collision domains**, which can improve network performance.
- Bridges were commonly used to connect LAN segments; modern **switches largely perform and extend the same Layer-2 functions**.

Functions of a Bridge

- Connects **LAN segments**.
- Uses **MAC addresses** to forward or filter frames.
- Reduces unnecessary traffic between segments.
- Separates **collision domains**.
- Helps extend a LAN.

LAN Segment A

LAN Segment B

Computers — [Bridge] — Computers

In short: A bridge connects LAN segments and uses MAC addresses to control the forwarding of frames.

Repeater in Computer Networks

- A **repeater** is a networking device used to **regenerate and retransmit weakened signals**.
- It operates at the **Physical Layer (Layer 1)** of the OSI model.
- As a signal travels over a long distance, it can become **weak or distorted** due to attenuation.
- A repeater receives the weakened signal, **regenerates it**, and sends it forward again.
- It is mainly used to **extend the transmission distance** of a network.
- A repeater does **not examine MAC or IP addresses**.
- It does not filter network traffic; it works with the **physical signal**.

Functions of a Repeater

- Receives weakened signals.
- **Regenerates/reshapes** signals.
- Retransmits the regenerated signal.
- Extends the **distance or coverage** of a network.
- Helps overcome **signal attenuation**.

Device — Signal — [Repeater] — Regenerated Signal — Device
Weak Strong/Cleaner

In short: A repeater regenerates signals so that they can travel over a longer distance.

Bridge vs Repeater

Feature	Bridge	Repeater
OSI Layer	Layer 2 – Data Link	Layer 1 – Physical

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Feature	Bridge	Repeater
Main Purpose	Connect LAN segments	Extend signal distance
Uses MAC Address	Yes	No
Filters Traffic	Yes	No
Works With	Frames	Signals/Bits
Main Function	Forward/filter frames	Regenerate signals

Gateway in Computer Networks

- A **gateway** is a networking device or system that acts as an **entry and exit point between different networks**.
- It connects networks that may use **different protocols, architectures, or communication methods**.
- A gateway can **translate data or protocols** so that different types of networks can communicate.
- It can operate at **different layers of the OSI model**, depending on its purpose.
- In a typical home network, the **router often acts as the default gateway**, allowing local devices to communicate with external networks such as the Internet.

Network Layer

- The **Network Layer** is the **third layer (Layer 3)** of the OSI model.
- Its main purpose is to provide **delivery of packets from the source device to the destination device across one or more networks**.
- It is responsible for **logical addressing, routing, and packet forwarding**.

1. Design Issues of the Network Layer

The Network Layer has several important design issues:

1. Service Provided to the Transport Layer

- The Network Layer provides services to the **Transport Layer**.
- It determines how packets should be delivered from **source to destination**.
- The service may be:
 - **Connectionless**
 - **Connection-oriented**

2. Routing

- **Routing** is the process of determining the **best path** for a packet from source to destination.
- Routers use routing information to select an appropriate path.
- Routing can be:
 - **Static**
 - **Dynamic**

3. Packet Forwarding

- After a route is determined, the Network Layer must **forward packets** toward their destination.
- Routers examine the **destination IP address** and send the packet to the appropriate next hop.

4. Logical Addressing

- The Network Layer uses **logical addresses**, such as **IP addresses**, to identify devices/interfaces across networks.
- Example:

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- IPv4 → 192.168.1.10
- IPv6 → 2001:db8::1

5. Internetworking

- The Network Layer allows **different networks to communicate with each other**.
- It makes it possible to connect multiple networks into a larger **internetwork**, such as the Internet.

6. Congestion Control

- **Congestion** occurs when too much traffic is present in a network.
- Network Layer mechanisms and related protocols can help manage traffic and reduce congestion.

7. Quality of Service (QoS)

- QoS deals with providing appropriate network performance for different types of traffic.
- Important factors include:
 - **Delay**
 - **Bandwidth**
 - **Packet loss**
 - **Reliability**

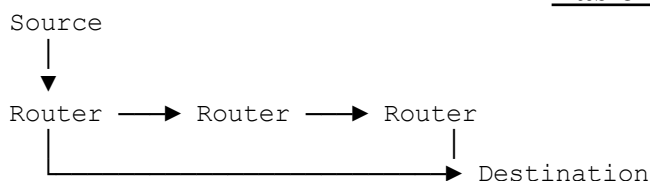
8. Fragmentation and Reassembly

- A packet may need to be divided into smaller pieces when it cannot fit into the maximum packet size supported by a link.
- This process is called **fragmentation**.
- The pieces may be **reassembled** at the destination, depending on the network protocol.

2. Network Layer in the Internet

- The Internet uses the **Internet Protocol (IP)** at the Network Layer.
- The two major versions are:
 - **IPv4**
 - **IPv6**
- IP provides **connectionless, best-effort packet delivery**.
- Data is divided into **packets (IP datagrams)** and forwarded through multiple routers.

Basic Working



Main Functions of the Internet Network Layer

- **Logical addressing**
 - Uses IPv4 or IPv6 addresses.
- **Routing**
 - Determines paths through interconnected networks.
- **Packet forwarding**
 - Routers forward IP packets toward their destinations.
- **Internetworking**
 - Connects different networks to form the Internet.

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- **Best-effort delivery**
 - IP does not guarantee that every packet will arrive, arrive in order, or arrive without duplication.
 - Reliability, when required, is provided by **higher-layer protocols such as TCP**.

Important Internet Protocols

- **IP (Internet Protocol)** → Provides addressing and packet delivery.
- **ICMP** → Used for network control, error reporting, and diagnostic messages.
- **Routing protocols** → Exchange routing information so routers can determine paths.
 - **RIP**
 - **OSPF**
 - **BGP**

Quick Revision

Topic	Main Point
Network Layer	OSI Layer 3
Main job	Packet delivery across networks
Addressing	IP address
Device	Router
Routing	Selects path
Forwarding	Sends packet to next hop
Internet Network Layer	Mainly based on IP
IP versions	IPv4 and IPv6
IP service	Connectionless, best-effort

In short: The Network Layer is responsible for logical addressing, routing, and forwarding packets across interconnected networks.