Taxonomy of Communication Networks
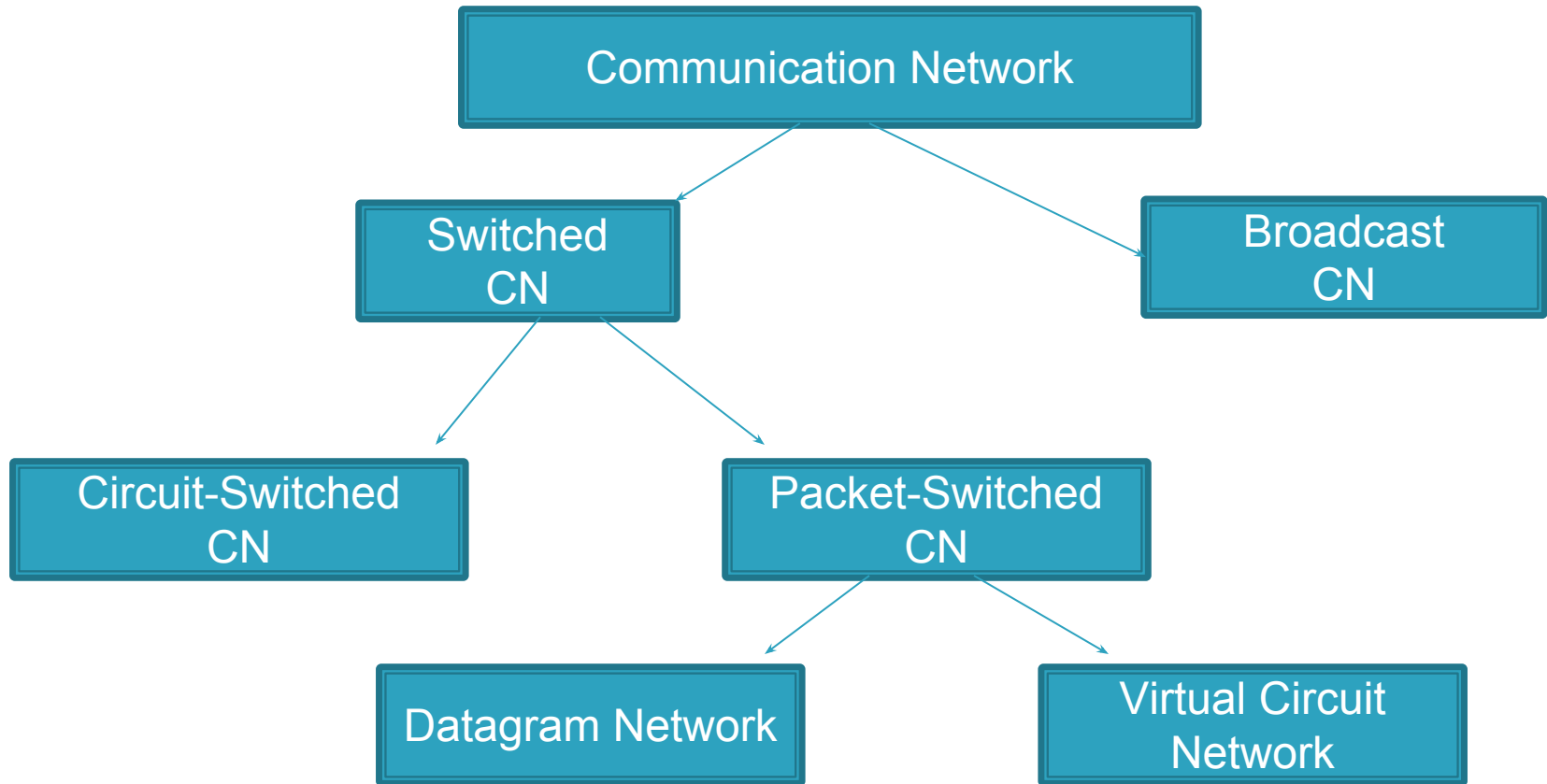
Communication Network (CN) can be classified based on the way in which the nodes exchange information

```
              Communication Network
                /              \
         Switched CN         Broadcast CN
          /        \
  Circuit-Switched   Packet-Switched CN
        CN              /        \
             Datagram Network   Virtual Circuit
                                    Network
```
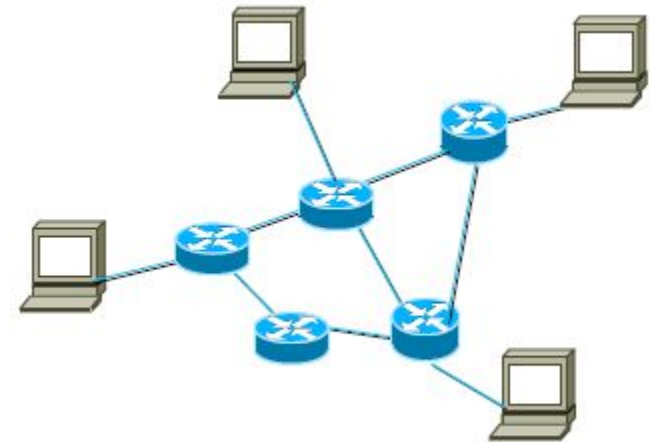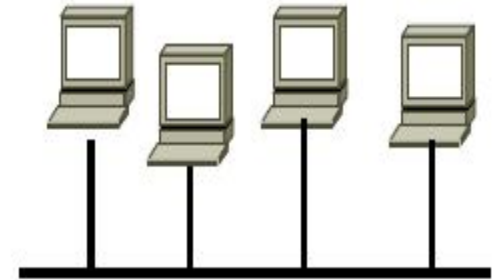
Broadcast Vs Switched Network

Broadcast networks

- Information transmitted by any node is received by every node in the network
- Ex: Broadcast Ethernet, wireless LANs
- Need to coordinate the access to the shared medium
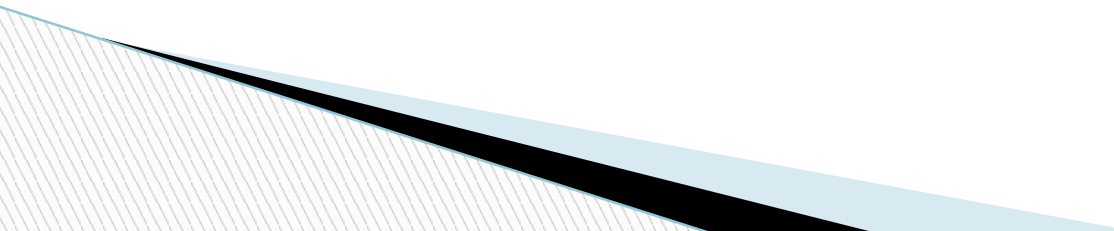 - ❖ MAC

Switched networks

- Links are point-to-point
- Ex: WANs (Telephony Network, Internet)
- Routing becomes harder

Switched Network

- **Switched Network** is a series of interlinked nodes which are called switches
- In a switched network, some switching nodes are connected to the **end systems** (like computers, telephones), others are used only for **routing**

Switching: Methods

- Circuit switching
- Packet switching
  - ❖ Datagram approach
  - ❖ Virtual circuit switched approach

Circuit Switched Network

- Three phases in circuit switching
  - Establish
  - Transfer
  - Disconnect
- The telephone message is not broken
  - It is sent all together
- The message arrives in the same order as it was sent originally
- Electronic signals pass through many switches before a connection is established (**In modern circuit-switched networks**)

Circuit Switched Network

- During a call (**transfer phase**), switches can not be used by any other network traffic
  - ❖ Hence, the resources remain **dedicated** to the circuit during the entire transfer of data and the entire message follows the **same path**

- A circuit-switched network is excellent for data that needs a **constant link from end-to-end**, for example, real-time video

Packet Switched Network

- Packets are sent as soon as they are available
  - ❖ the message is broken into small data packets

Packet Switched network Approaches

- Datagram Network Approach
- Virtual Circuit Network Approach

Packet Switched Network

Datagram approach of packet switching

- **no need to set up a dedicated path in advance**
- It is up to routers to use store-and-forward transmission to send each packet on its way to the destination on its own
- Packets seek out the most efficient route to travel as circuits become available
  - not necessarily the shortest route
- **There is no fixed path**
  - Different packets can follow different paths
  - Packets may arrive out of order
- It places a tight upper limit on the size of packets
  - This ensures that no user can monopolize any transmission line for very long (e.g., many milliseconds)
  - Thus, **it can handle interactive traffic**

A comparison of circuit switched and Datagram packet switched networks

Item	Circuit switched	Packet switched
Call setup	Required	Not needed
Dedicated physical path	Yes	No
Each packet follows the same route	Yes	No
Packets arrive in order	Yes	No
Is a switch crash fatal	Yes	No
Bandwidth available	Fixed	Dynamic
Time of possible congestion	At setup time	On every packet
Potentially wasted bandwidth	Yes	No
Store-and-forward transmission	No	Yes
Charging	Per minute	Per packet

In Circuit and Packet Switched Network

- The trade-off is between guaranteed service and wasting resources versus not guaranteeing service and not wasting resources

Virtual Circuit Network

A cross between a circuit-switched network and a datagram network

- **As in a circuit-switched network**
  - ❖ It has setup and teardown phases in addition to the data transfer phase
  - ❖ A virtual circuit is made before actual data is transmitted **but** it is different from circuit switching in a sense that
    - ❖ **in circuit switching** the **call accept** signal comes only from the final destination to the source
    - ❖ **while** in case of **virtual-packet switching** this **call accept** signal is transmitted between each adjacent intermediate node.
  - ❖ all packets follow the same path established during the connection

Virtual Circuit Network

In virtual-circuit packet switching

- An initial setup phase is used to set up a route between the intermediate nodes for all the packets passed during the session between the two end nodes.

- In each intermediate node, an entry is registered in a table to indicate the route for the connection that has been set up.

- Thus, packets passed through this route, can have short headers, containing only a *virtual circuit identifier (VCI), and not their destination.*

- This approach is **slower than Circuit Switching**, since **different virtual circuits** may **compete** over the same resources, and an initial setup phase is needed to initiate the circuit.

Virtual Circuits guarantees that all packets in a flow follow one path
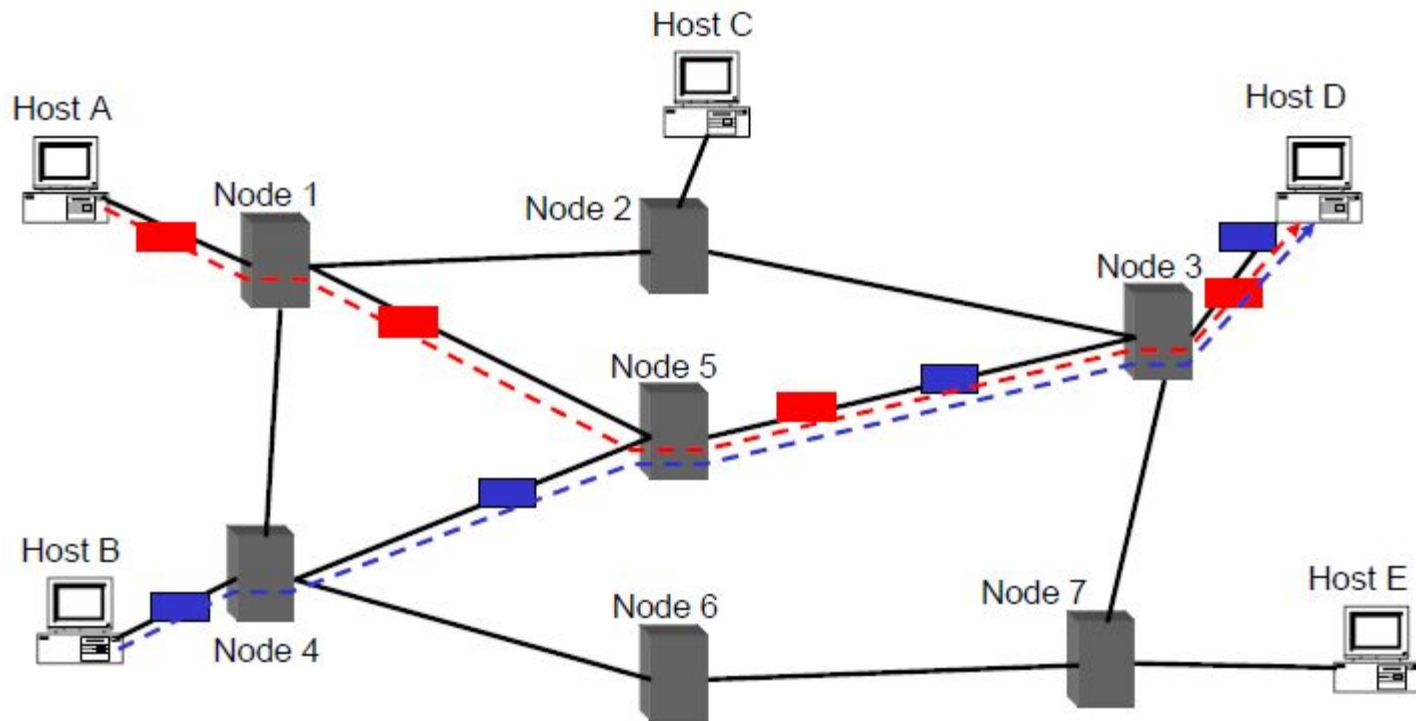
INTERNET (in reality)

- is a datagram network

- BUT part of the Internet uses circuit-switching (Phone links) or virtual circuit (ATM)