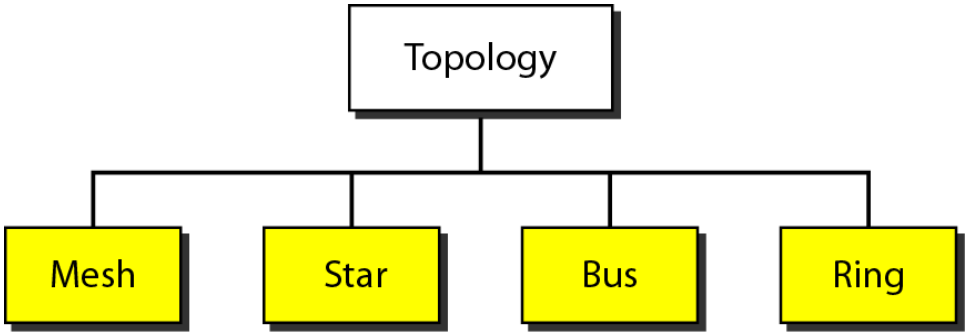
Networks

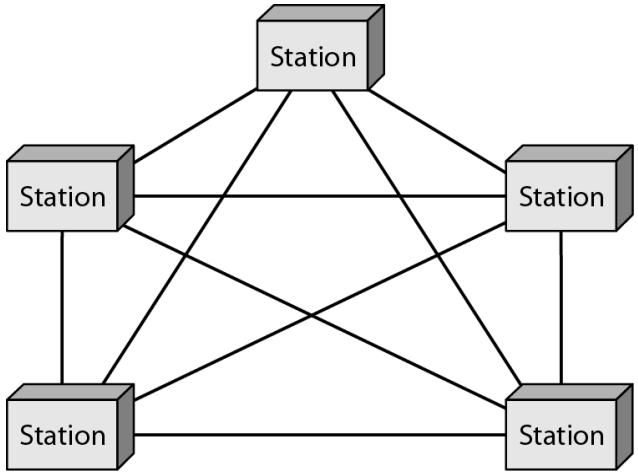
- Physical Topology
  - The way a network is laid out physically
  - Two or more links form a topology
  - The topology of a network is the geometric representation of the relationship of all the links and linking devices (nodes) to one another.
  - Four topologies : Mesh, Star, Bus, and Ring

Physical Topology



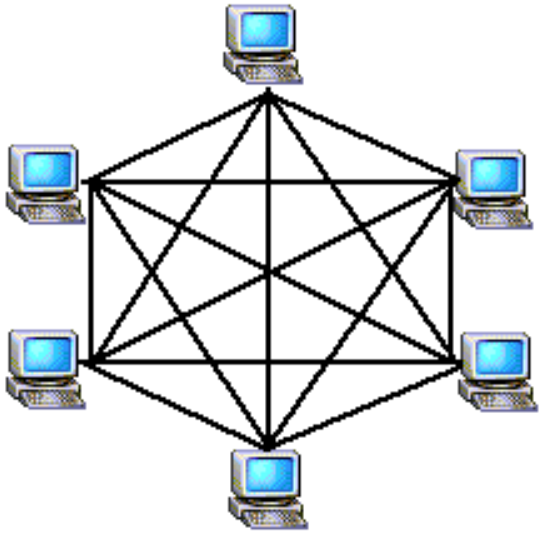
Physical Topology

- Mesh
  - Every link is dedicated point-to-point link
  - The term dedicated means that the link carries traffic only between the two devices it connects



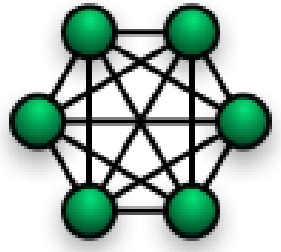
Physical Topology

- Mesh
  - To link ***n*** devices fully connected mesh has:
    n (n - 1) / 2 physical channels (Full-Duplex)
  - Every Device on the network must have
    n - 1 ports



Physical Topology

- Mesh
  - Example:



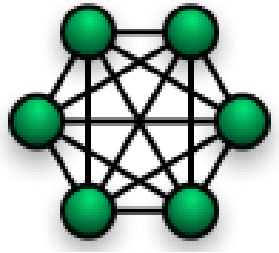
8 devices in mesh has links: n(n-1) / 2

number of links = 8 (8-1)/2 = **28**

number of ports per device = n – 1 = 8 –1 = **7**

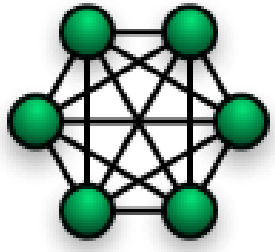
Physical Topology

- Mesh
  - Advantages
    - Each connection carry its own data load (no traffic problems)
    - A mesh topology is robust
    - Privacy or security
    - Fault identification and fault isolation



Physical Topology

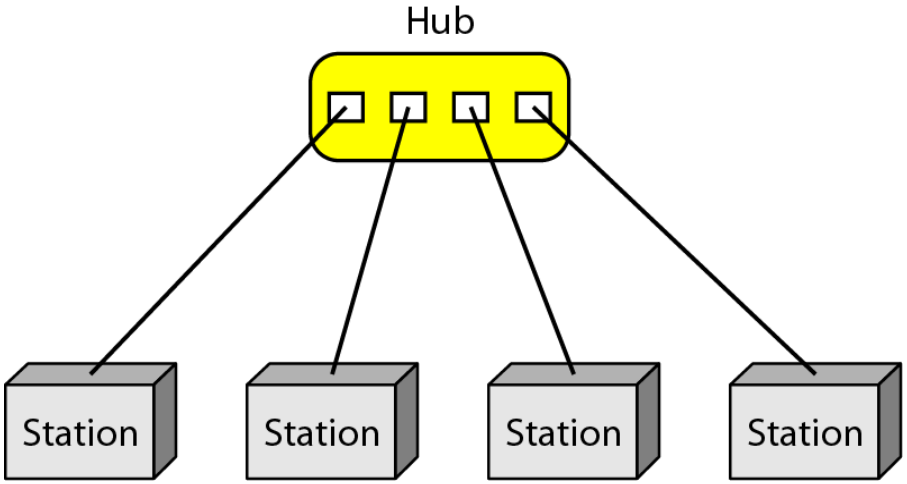
- Mesh:
  - Disadvantages
    - Big amount of cabling
    - Big number of I/O ports
    - Installation and reconnection are difficult
    - Sheer bulk of the wiring can be greater than the available space
    - Hardware connect to each I/O could be expensive



- Mesh topology is implemented in a limited fashion;

Physical Topology

- Star:
  - Dedicated point-to-point to a central controller (Hub)
  - No direct traffic between devices
  - The control acts as an exchange



Physical Topology

- Star
  - Advantages
    - Less expensive than mesh (1 Link + 1 port per device)
    - Easy to install and reconfigure
    - Less cabling
    - Additions, moves, and deletions required one connection
    - Robustness : one fail does not affect others
    - Easy fault identification and fault isolation

Physical Topology

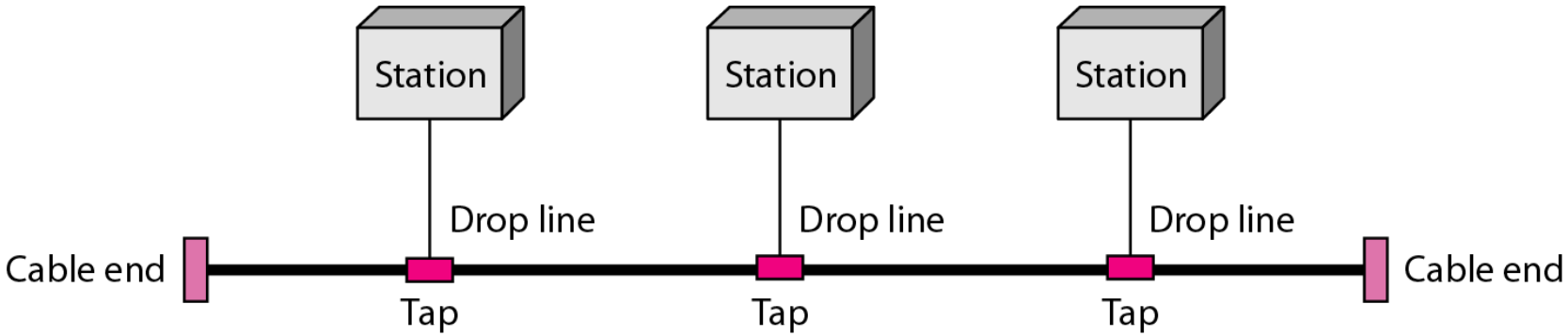
- Star
  - Disadvantages
    - Dependency of the whole topology on one single point (hub)
    - More cabling than other topologies (ring or bus)
- Used in LAN

Physical Topology

- Bus
  - It is multipoint
  - One long cable acts as a backbone
  - Used in the design of early LANS, and Ethernet LANs

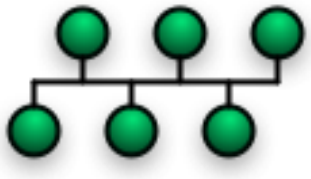
Physical Topology

- Bus
  - Nodes connect to cable by drop lines and taps
  - Signal travels along the backbone and some of its energy is transformed to heat
  - Limit of number of taps and the distance between taps



Physical Topology

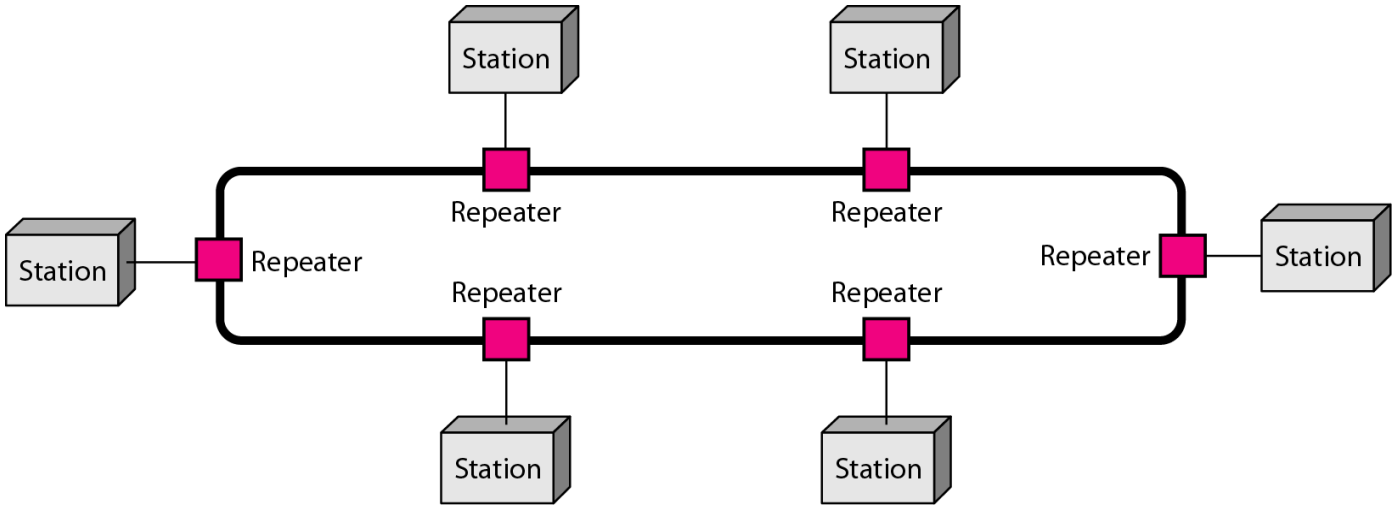
- Bus



  - Advantages
    - Ease of installation
    - Less cables than mesh, star topologies
  - Disadvantages
    - Difficult reconnection and fault isolation (limit of taps)
    - Adding new device requires modification of backbone
    - Fault or break stops all transmission
    - The damaged area reflects signals back in the direction of the origin, creating noise in both directions

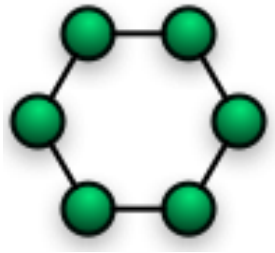
Physical Topology

- Ring
  - Each device has dedicated point-to-point connection with only the two devices on either side of it
  - A signal is passed along the ring in one direction from device to device until it reaches its destination
  - Each devices incorporates a Repeater



Physical Topology

- Ring
  - Advantages
    - Easy of install and reconfigure
    - Connect to immediate neighbors
    - Move two connections for any moving (Add/Delete)
    - Easy of fault isolation
  - Disadvantage
    - Unidirectional
    - One broken device can disable the entire network. This weakness can be solved by using a dual ring or a switch capable of closing off the break



Physical Topology

- Hybrid Topology
  - Example: having a main star topology with each branch connecting several stations in a bus topology

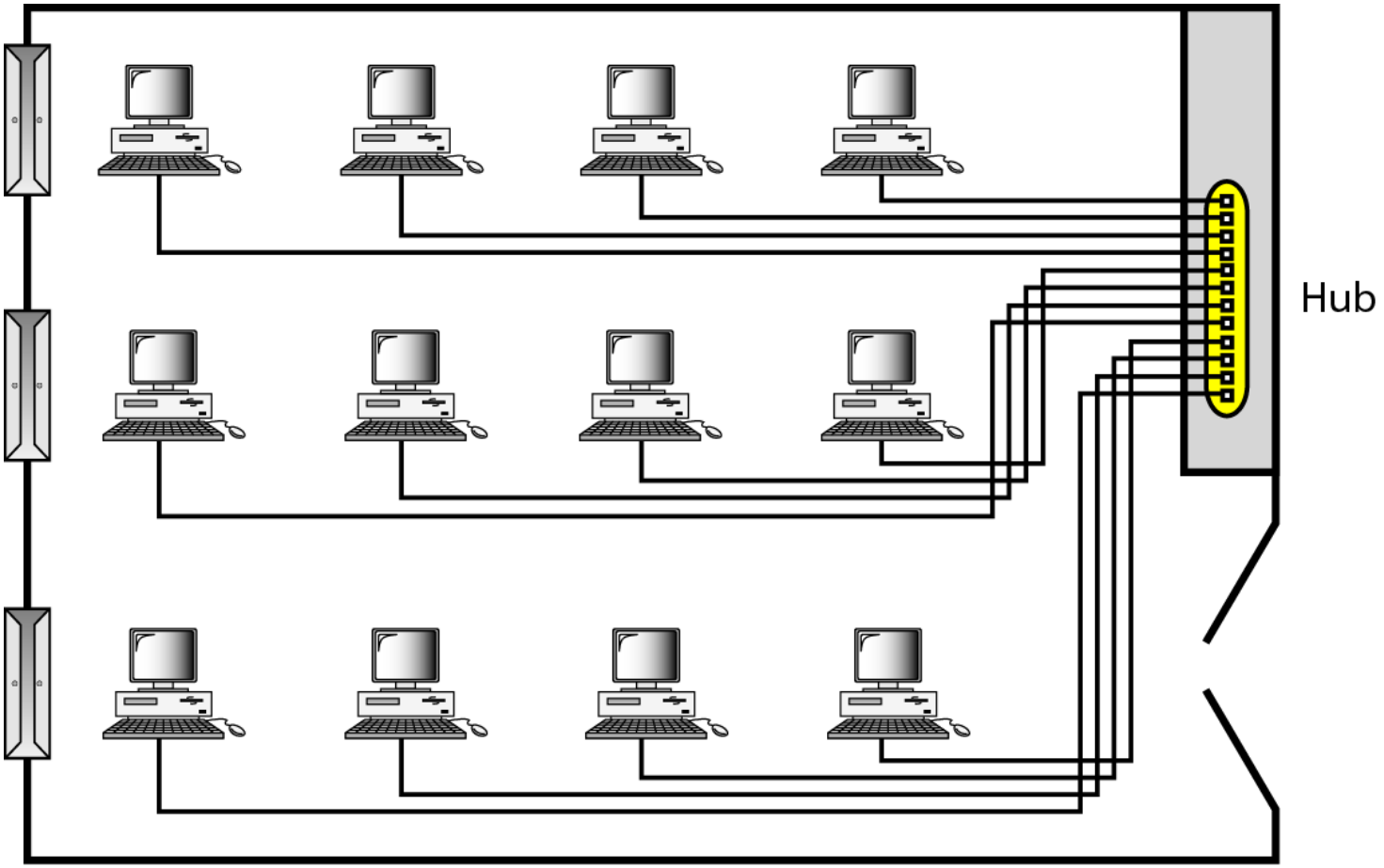
Categories of Networks

- Network Category depends on its size
- Two primary categories
  - **LAN (Local Area Network)**: Covers area < 2miles
  - **WAN (Wide Area Network)**: Can be worldwide
  - **MAN (Metropolitan Area Network)**: Between LAN & WAN, span 10s of miles

Local Area Network (LAN)

- Privately owned
- Links devices in the same office, building, or campus
- Simple LAN: 2 PCs & 1 printer in home or office
- Size is limited to a few kilometers
- Allow resources to be shared (hardware, software, or data)

Local Area Network (LAN)

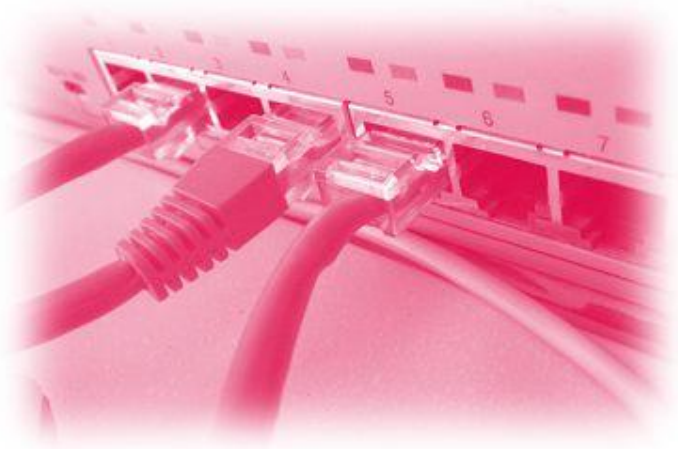


An isolated LAN connecting 12 computers to a hub in a closet

Local Area Network (LAN)

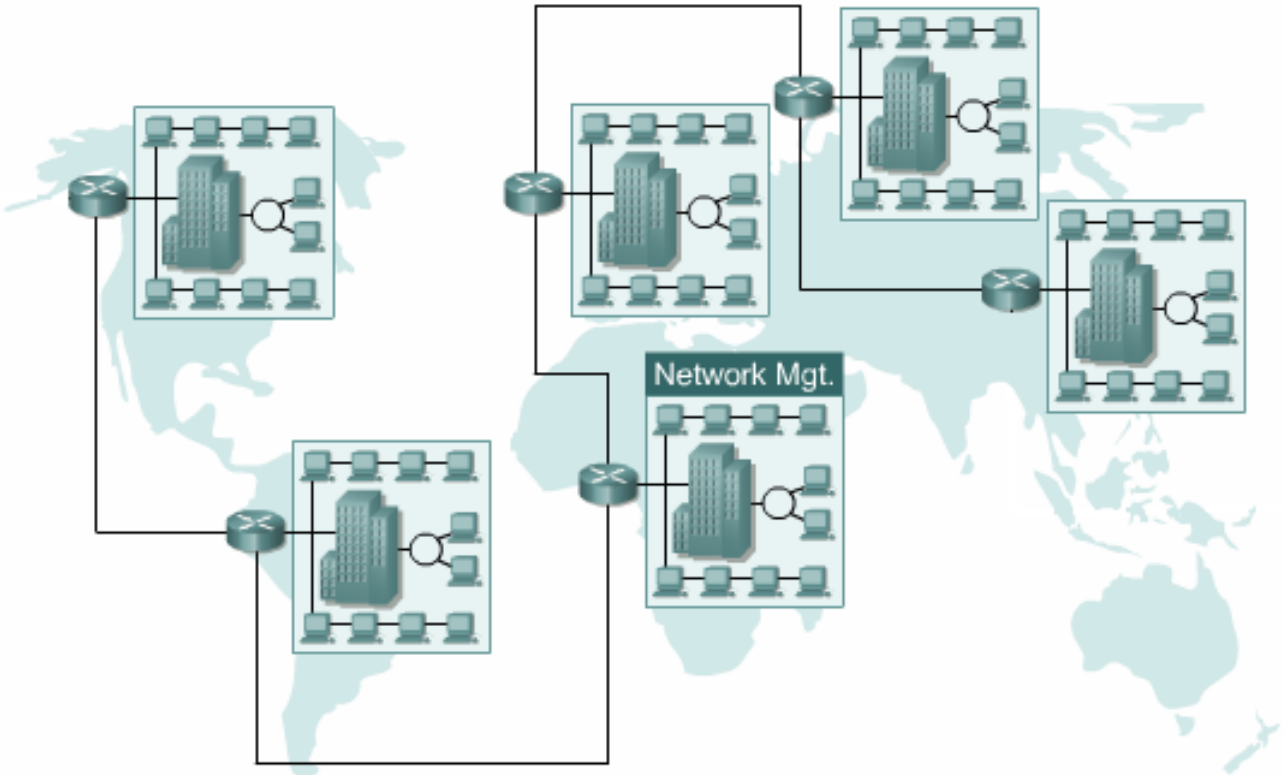
- LAN is distinguished by:
  - Size (# users, or licensing restrictions)
  - Transmission medium (only one type)
  - Topology (bus, ring, star)

- Data Rates (speed):
  - Early: 4 to 16 Mbps
  - Today: 100 to 1000 Mbps



Wide Area Networks (WAN)

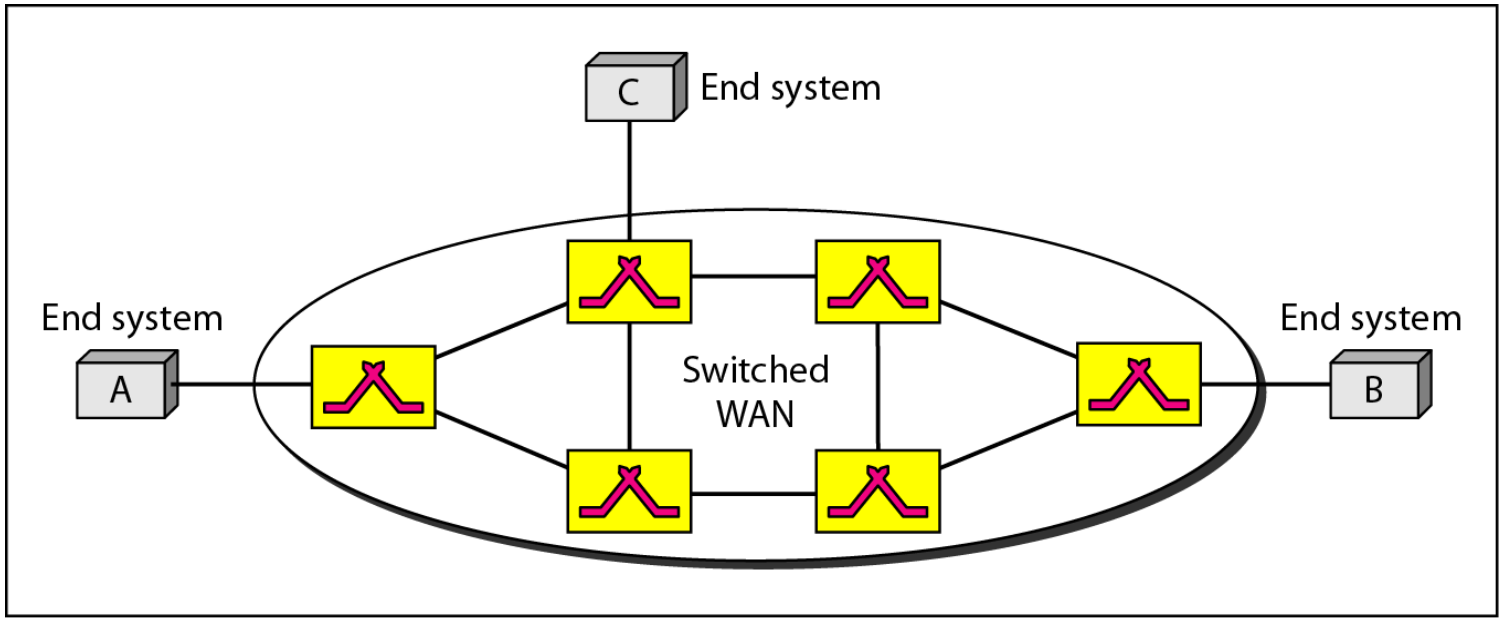
- Provides long-distance transmission of data over large geographic areas (country, continent, world)



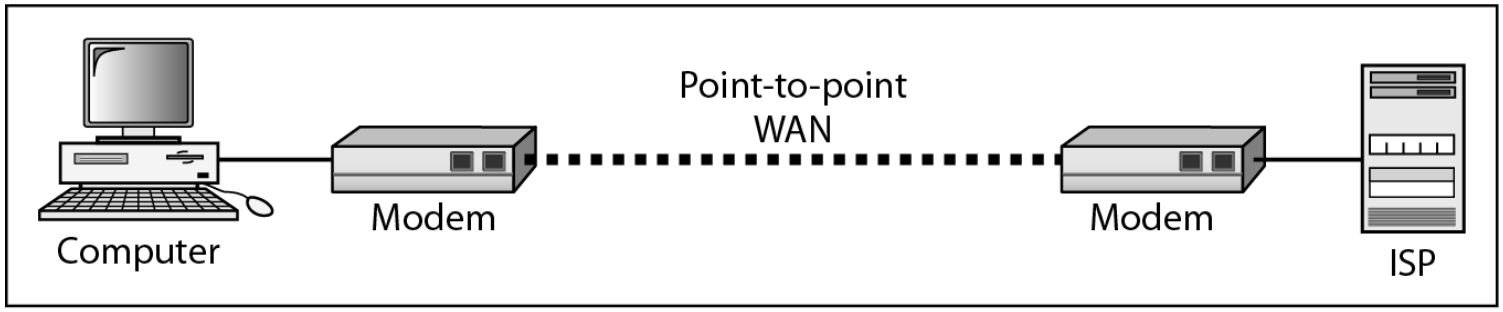
Wide Area Networks (WAN)

- Switched WAN
  - Backbone of the Internet
- Dialup line point-to-point WAN
  - Leased line from a telephone company

Wide Area Networks (WAN)



a. Switched WAN



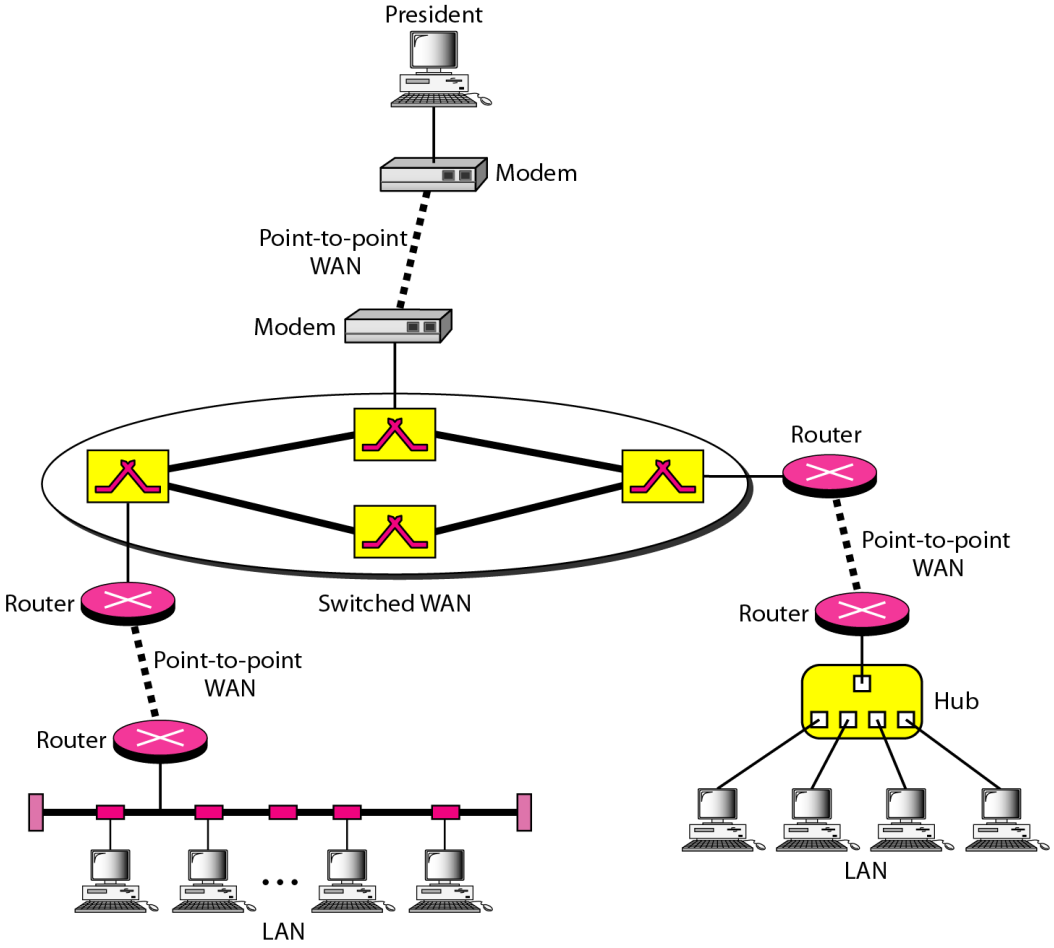
b. Point-to-point WAN

Metropolitan Area Networks (MAN)

- Size between LAN and WAN
- Inside a town or a city
- Example: the part of the telephone company network that can provide a high-speed DSL to the customer

Interconnection of Networks: Internetworks

- Two or more networks connected together



IPv4

- Internet Protocol version 4 (IPv4) is the fourth version in the development of the Internet Protocol (IP) and the first version of the protocol to be widely deployed.
- It is a 32 bit virtual address which can be represented in four octets
- IP provides a mechanism to uniquely identify hosts by an IP addressing scheme

Types of IP addresses

- The IP addresses are divided into three different types, based on their operational characteristics:
- **1. Unicast IP addresses**
- **2. Multicast IP addresses**
- **3. Broadcast IP addresses**

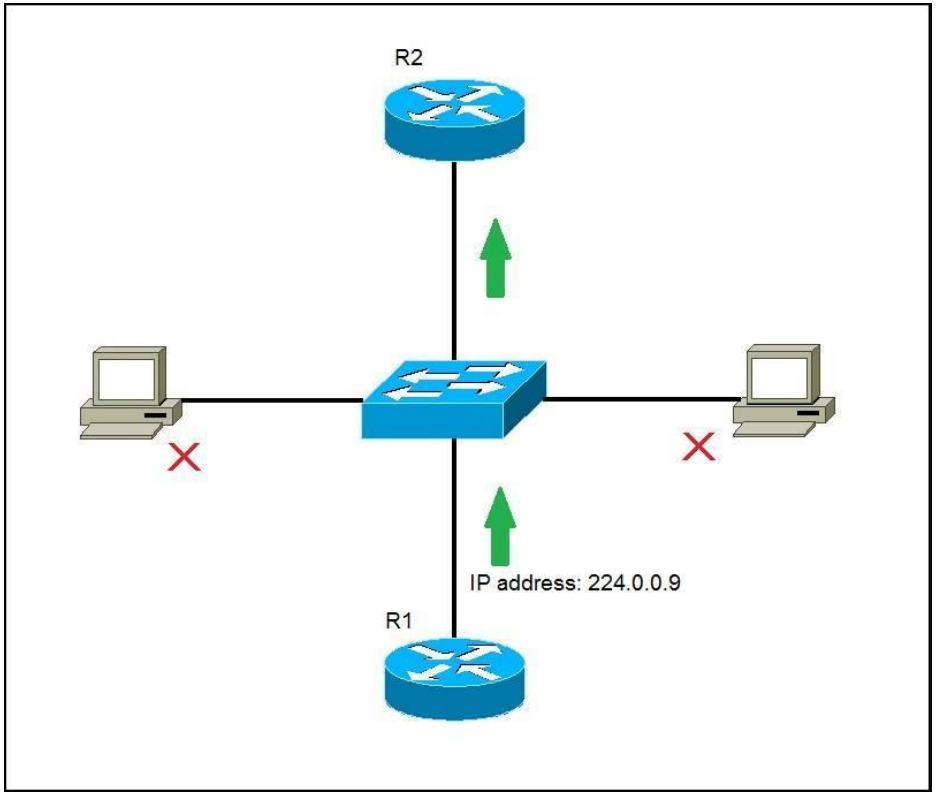
Unicast IP addresses

- An address of a single interface. The IP addresses of this type are used for one-to-one communication.
- Unicast IP addresses are used to direct packets to a specific host.

Multicast IP addresses

- Used for one-to-many communication. Multicast messages are sent to IP multicast group addresses.

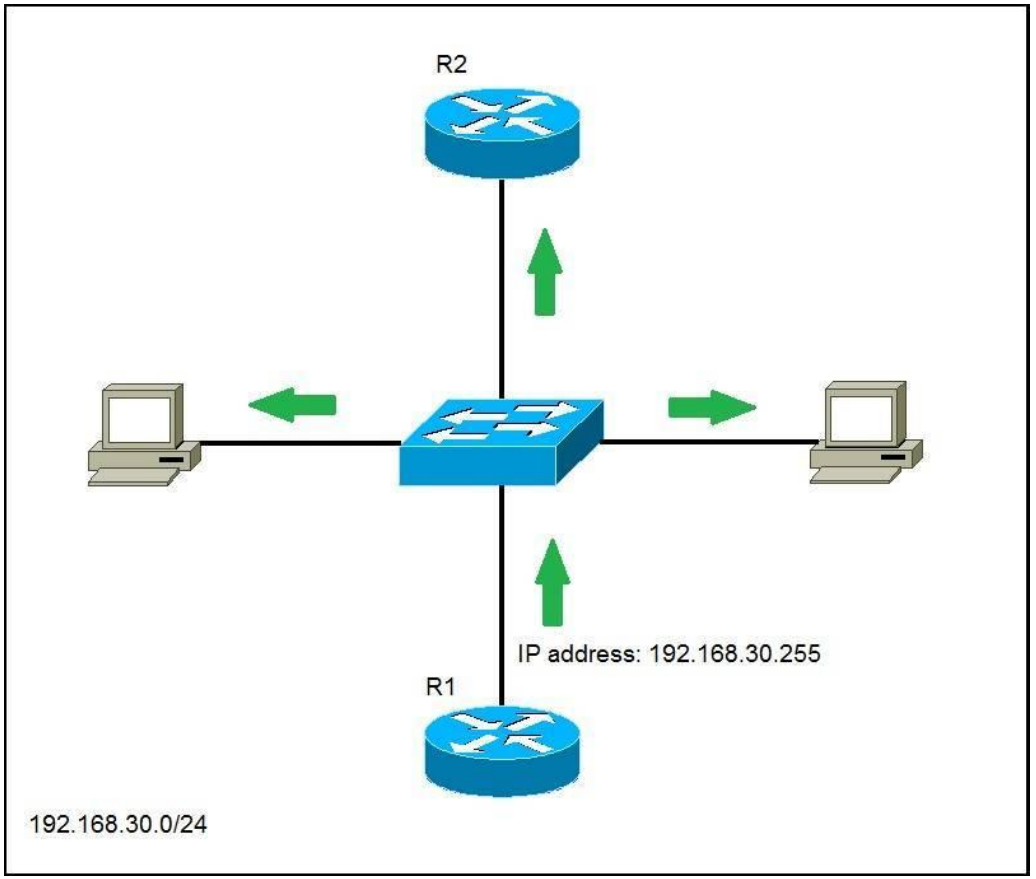
Routers forward copies of the packet out to every interface that has hosts subscribed to that group address. All other hosts on the LAN will discard them.



Broadcast IP addresses

- Used to send data to all possible destinations in the broadcast domain

R1 wants to communicate with all hosts on the network and has sent a broadcast packet to the broadcast IP address of 192.168.30.255. All hosts in the same broadcast domain will receive and process the packet.



IP address classes

Class	1st Octet Decimal Range	Hosts per Network (Usable Addresses)
A	1 – 126*	16,777,214 ($2^{24} – 2$)
B	128 – 191	65,534 ($2^{16} – 2$)
C	192 – 223	254 ($2^{8} – 2$)
D	224 – 239	Reserved for Multicasting
E	240 – 254	Experimental; used for research

Note: Class A addresses 127.0.0.0 to 127.255.255.255 cannot be used and is reserved for loopback and diagnostic functions.

Private IP Addresses

Class	Private Networks	Address Range
A	10.0.0.0	10.0.0.0 - 10.255.255.255
B	172.16.0.0 - 172.31.0.0	172.16.0.0 - 172.31.255.255
C	192.168.0.0	192.168.0.0 - 192.168.255.255