

Computer Networks & Protocols

Year: 2021/2022

Lecture instructor: **Dr. Hadjira BELAIDI**
Office: **B429**

UMBB/IGEE H. BELAIDI: ha.belaidi@univ-boumerdes.dz

Goals

- What you learn in this course?
 - **Insight:** key concepts in networking
 - Protocols
 - Layering
 - Resource allocation
 - Security
 - Naming
 - **Knowledge:** how the internet works
 - Internet architecture
 - IP protocol suite
 - Applications (web, e-mail, P2P, ...)
 - **Skill:** network programming
 - Socket programming
 - Designing and implementing protocols

Cours Outlines

- Chap 1: Introduction to Networking
- Chap 2: Network Protocols and Communications
- Chap 3: IPv4 Addressing
- Chap 4: Ethernet
- Chap 5: Network Layer and Routing protocols
- Chap 6: Transport Layer
- Chap 7: Network Access
- Chap 8: IoT configuration
- Chap 9: Subnetting IPv6 Networks
- Chap 10: Applications

References.

- **Computer networking: A top-down Approach.**
 - By Kurose Ross
- **Computer networks.**
 - By ANDREW S.TANENBAUM
 - DAVID J.WETHERALL
- **Computer networks: Problem solutions**
 - By ANDREW S.TANENBAUM &
 - DAVID J.WETHERALL
- **The Industrial Electronics Handbook: Industrial communication systems**
 - By Bogdan M. Wilamowski &
 - J. david Irwin

Chapter 1

Introduction to Networking

Chap1 Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
- LAN Network Topologies
- Network Cables
- What is protocol?

- Networking can be defined as connecting computers electronically for the purpose of sharing:
 - Information
 - Resources such as files, applications, printers ...
 - Software ...

What is network?

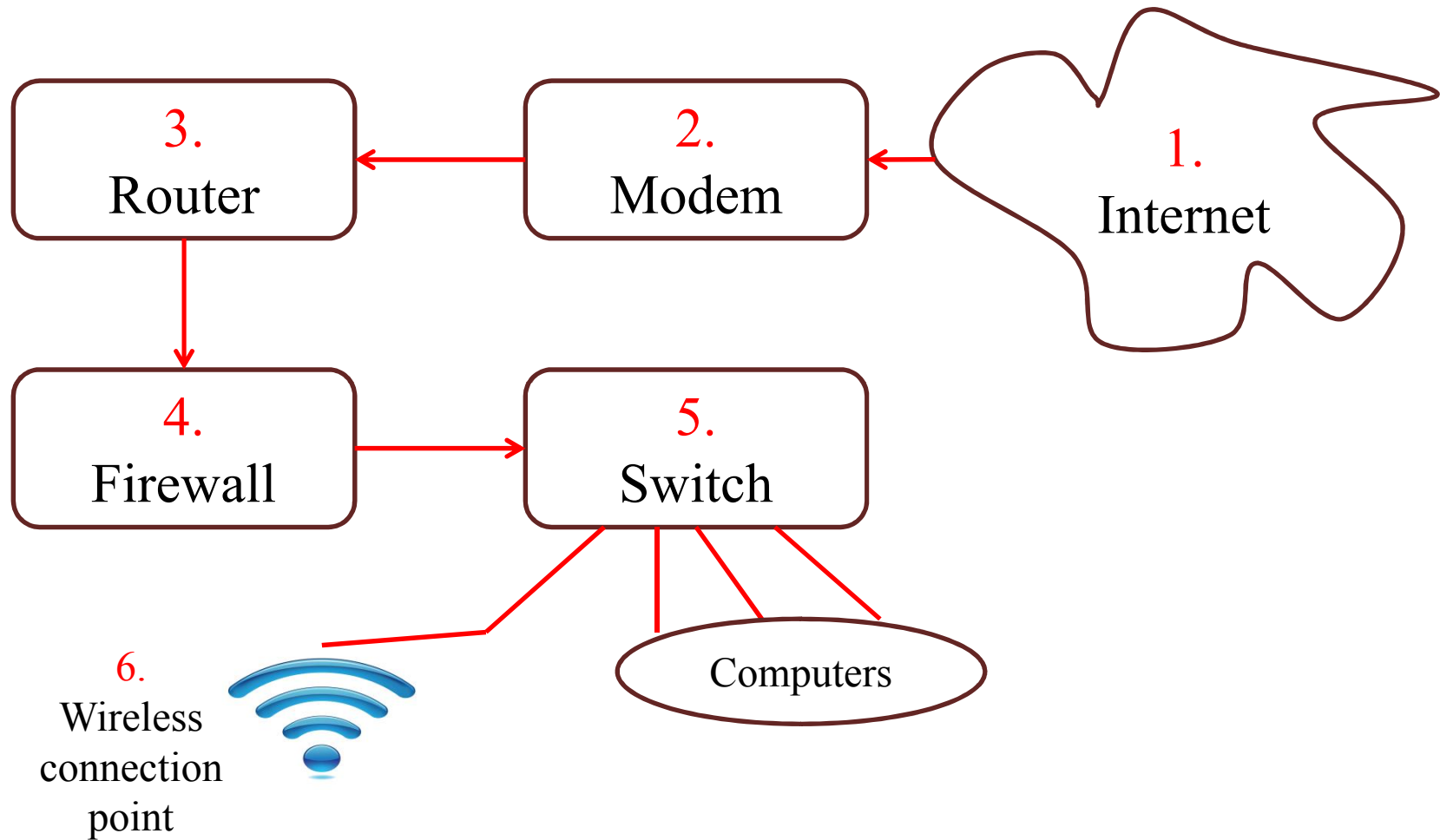
Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network
 - Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

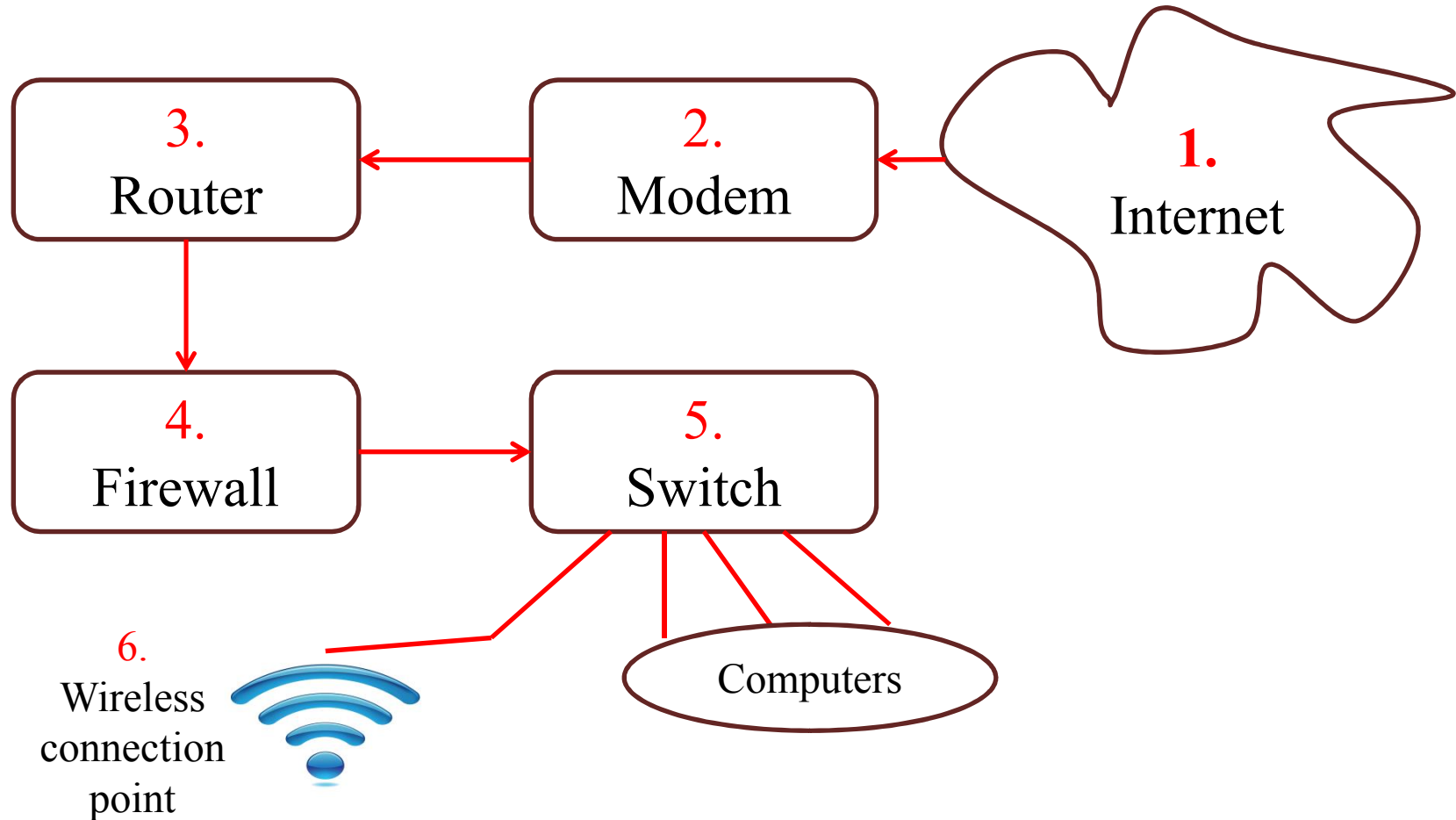
A network is simply a collection of computers or other hardware devices that are connected together, either **physically or logically**, using special hardware and software, to allow them to exchange information and cooperate. Networking is the term that describes the processes involved in designing, implementing, upgrading, managing and otherwise working with networks and network technologies.

- Physical topology defines how the nodes of the network are **physically** connected .
- Logical topology dedicated connections between certain selected **source-destination pairs** using the underlying physical topology.

What is going on



1. What is Internet?

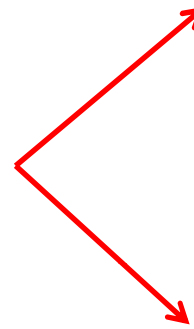


What is Internet?

Outlines

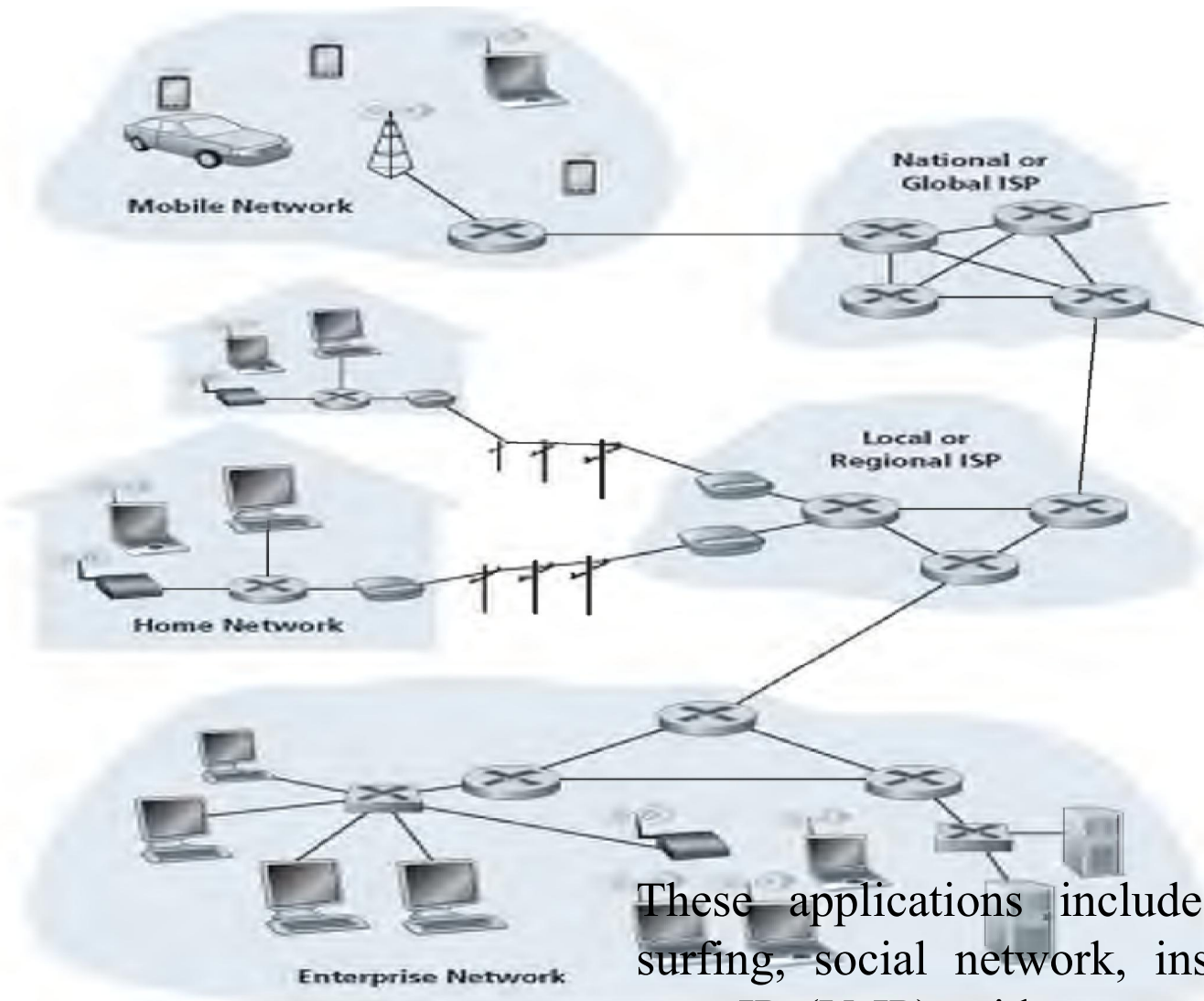
- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network
 - Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

There are a couple of ways to answer this question.



1. It can be described by the nuts and bolts of the Internet, that is, the basic hardware and software components that make up the Internet.

2. It can be described in terms of a networking infrastructure that provides services to distributed applications.

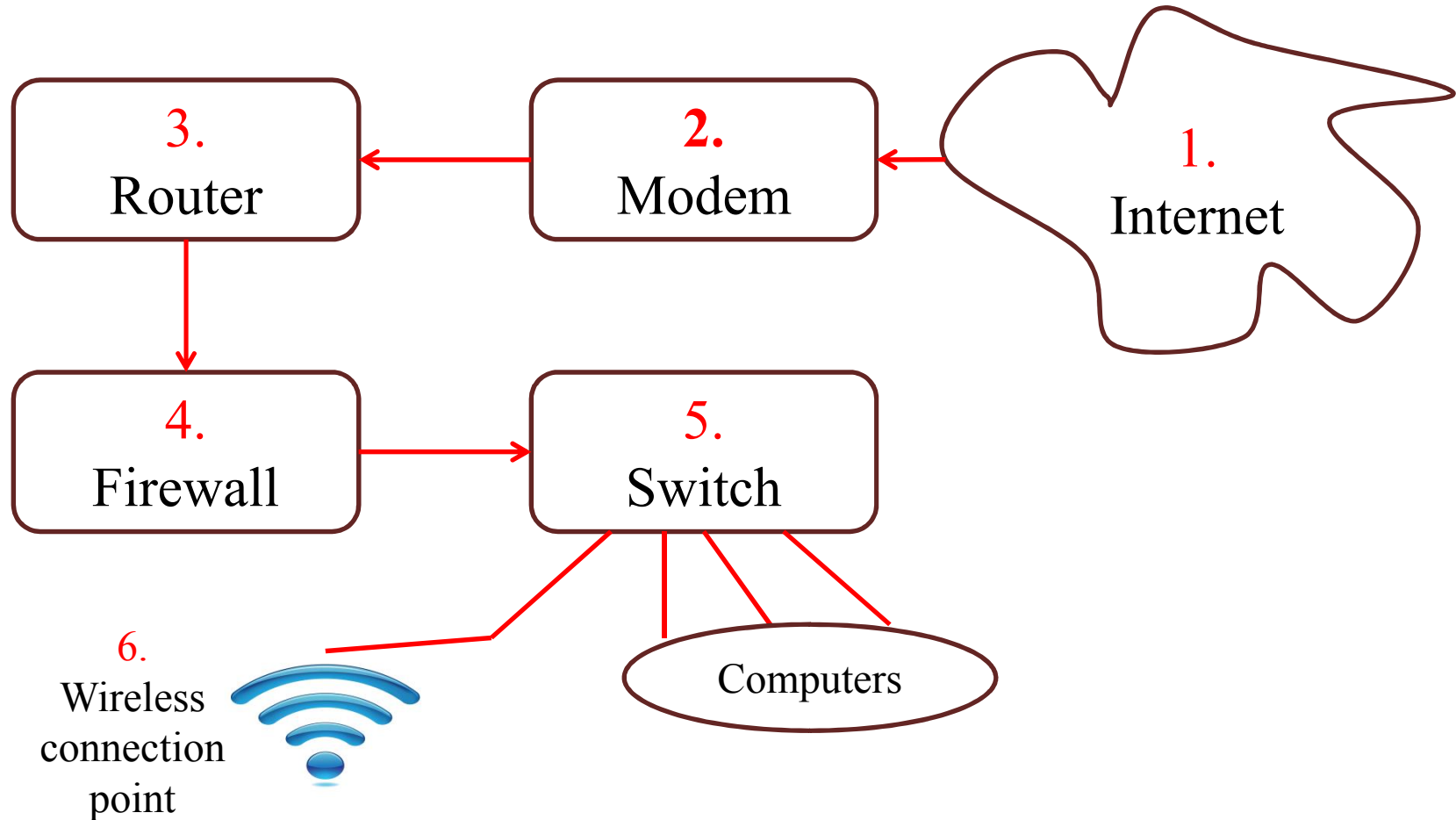


Key:



These applications include: electronic mail, web surfing, social network, instant messaging, voice-over-IP (VoIP), video streaming, distributed games, peer-to-peer (P2P) file sharing, television over the internet, remote login, and much, much more. They involve multiple end system that exchange data with each other.

2. What is Modem?

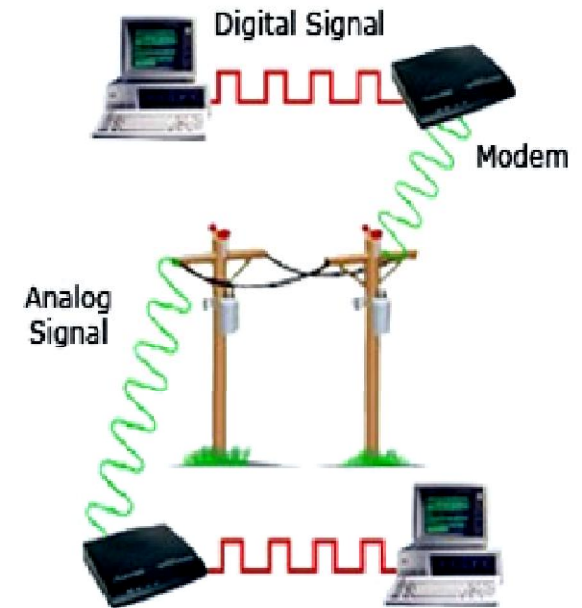


2. What is Modem?

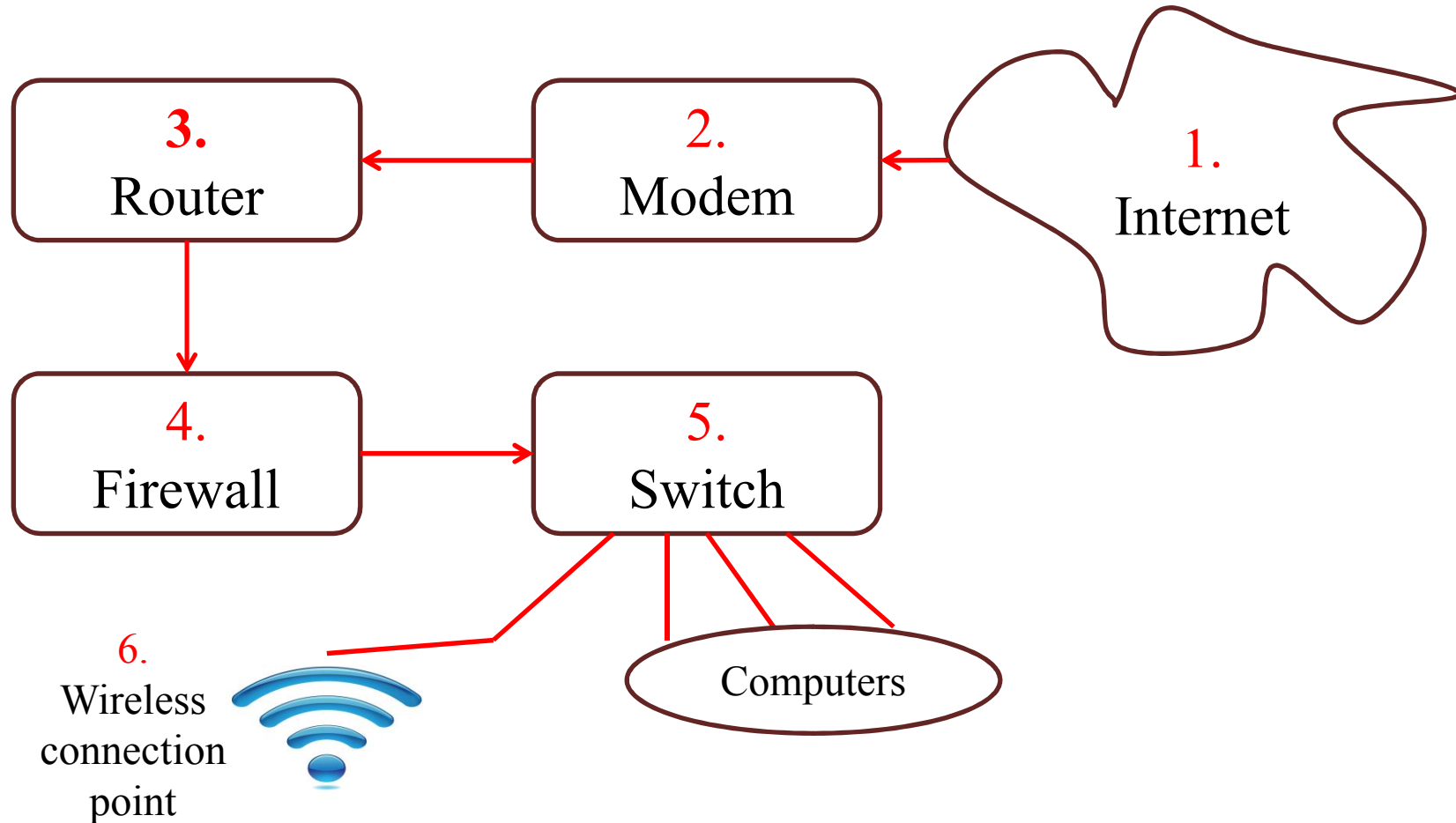
Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

- Short for **modulator-demodulator**. A modem is a device or program that enables a computer to transmit data over, for example, telephone or cable lines. Computer information is stored digitally, whereas information transmitted over telephone lines is transmitted in the form of analog waves. A modem converts between these two forms.



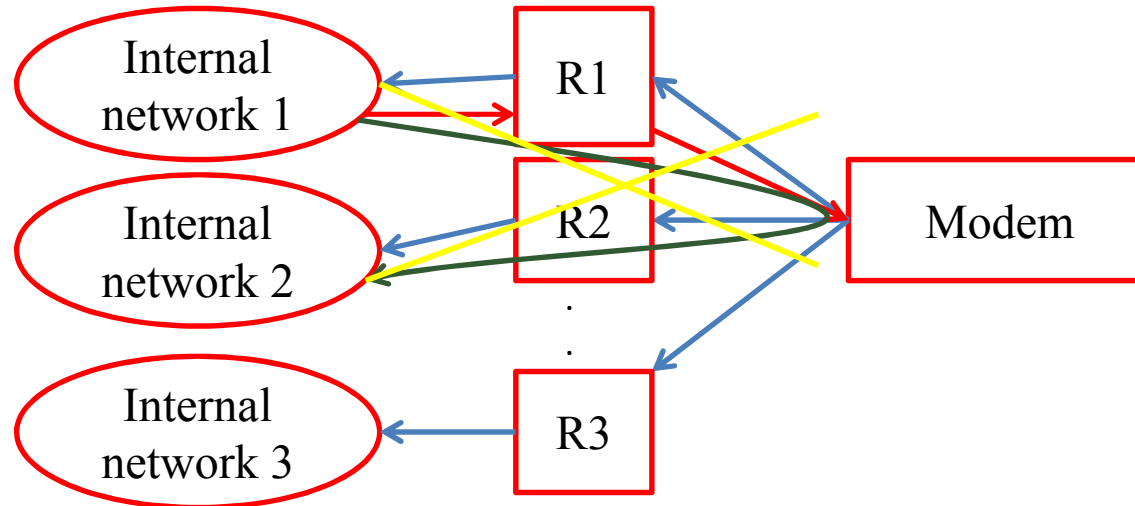
3. What is Router?



Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network
 - WAN Network
 - MAN Network
- Network Cables
- What is protocol?

3. What is Router?



Router is a device which connects different networks-frequently over a large distances.

A router is a device that forwards data packets between computer networks, creating an overlay internetwork.



3. What is Router?

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

A data packet is typically forwarded from one router to another through the networks that constitute the internetwork until it gets to its destination node.

It contains a routing table in which all information about the address of connected networks.

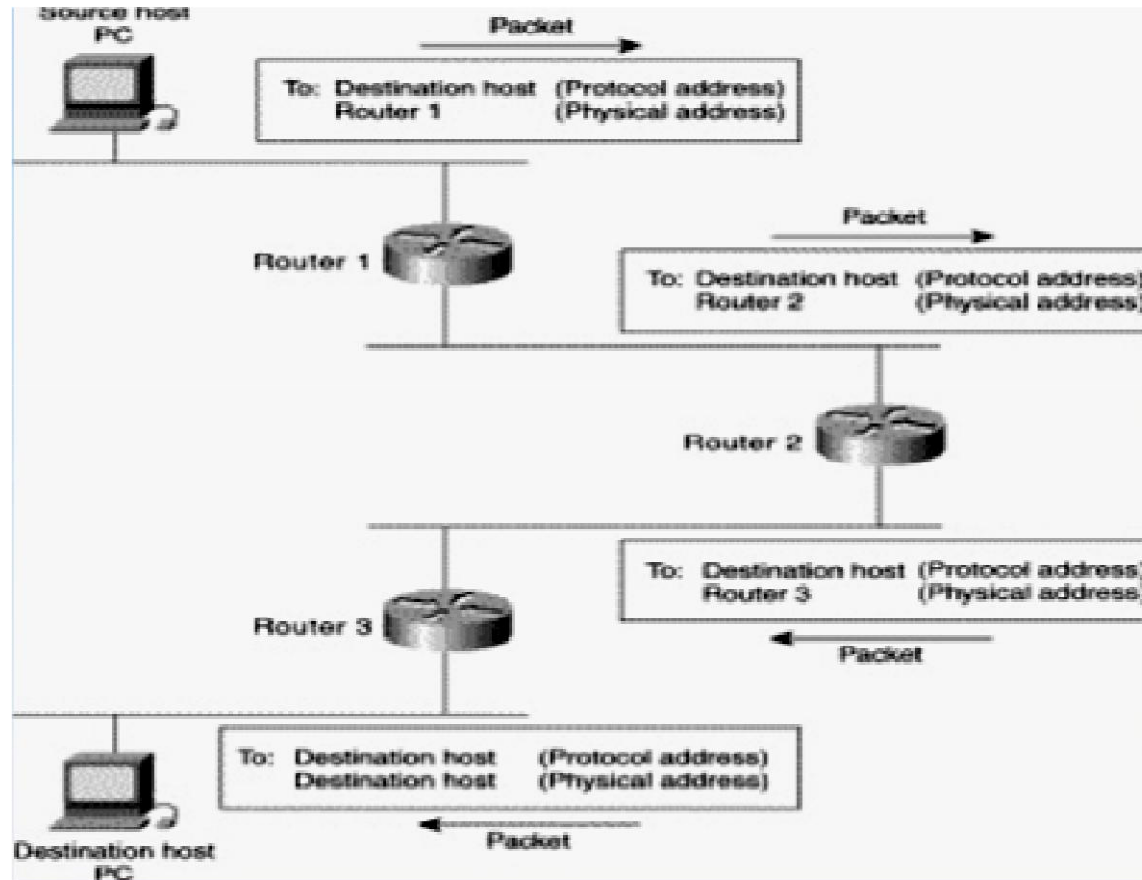


3. What is Router?

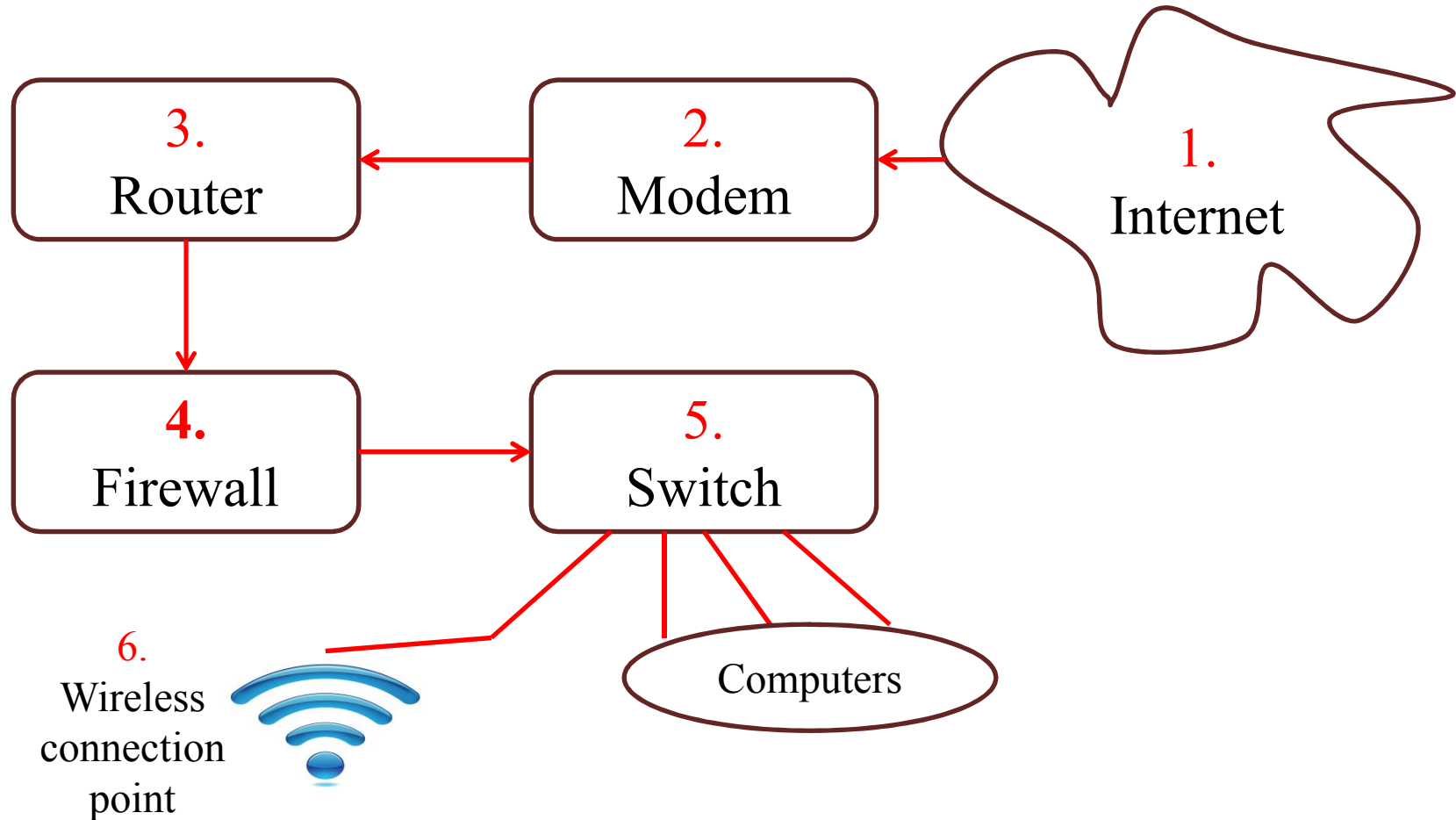
Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network
 - Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

Packets routed by routers to their destination



4. What is firewall?

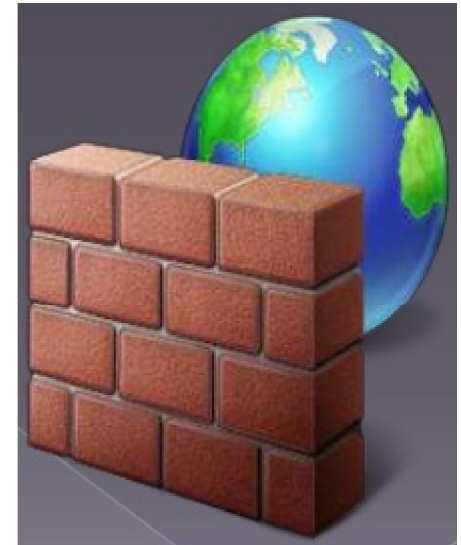


4. What is firewall?

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network
 - Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

- A **choke point** of control and monitoring
- Interconnects networks with differing trust
- Imposes restrictions on network services
 - only authorized traffic is allowed
- Auditing and controlling access
 - can implement alarms for abnormal behavior
- Itself immune to penetration
- Provides **perimeter defence**



4. What is firewall?

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network
 - Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

A firewall may be a hardware, software or a combination of both that is used to prevent unauthorized program or internet users from accessing a private network or a single computer.

All messages entering or leaving the internet pass through the firewall, which examines each message and blocks those that do not meet the specified security criteria.

4. What is firewall?

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network
 - Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

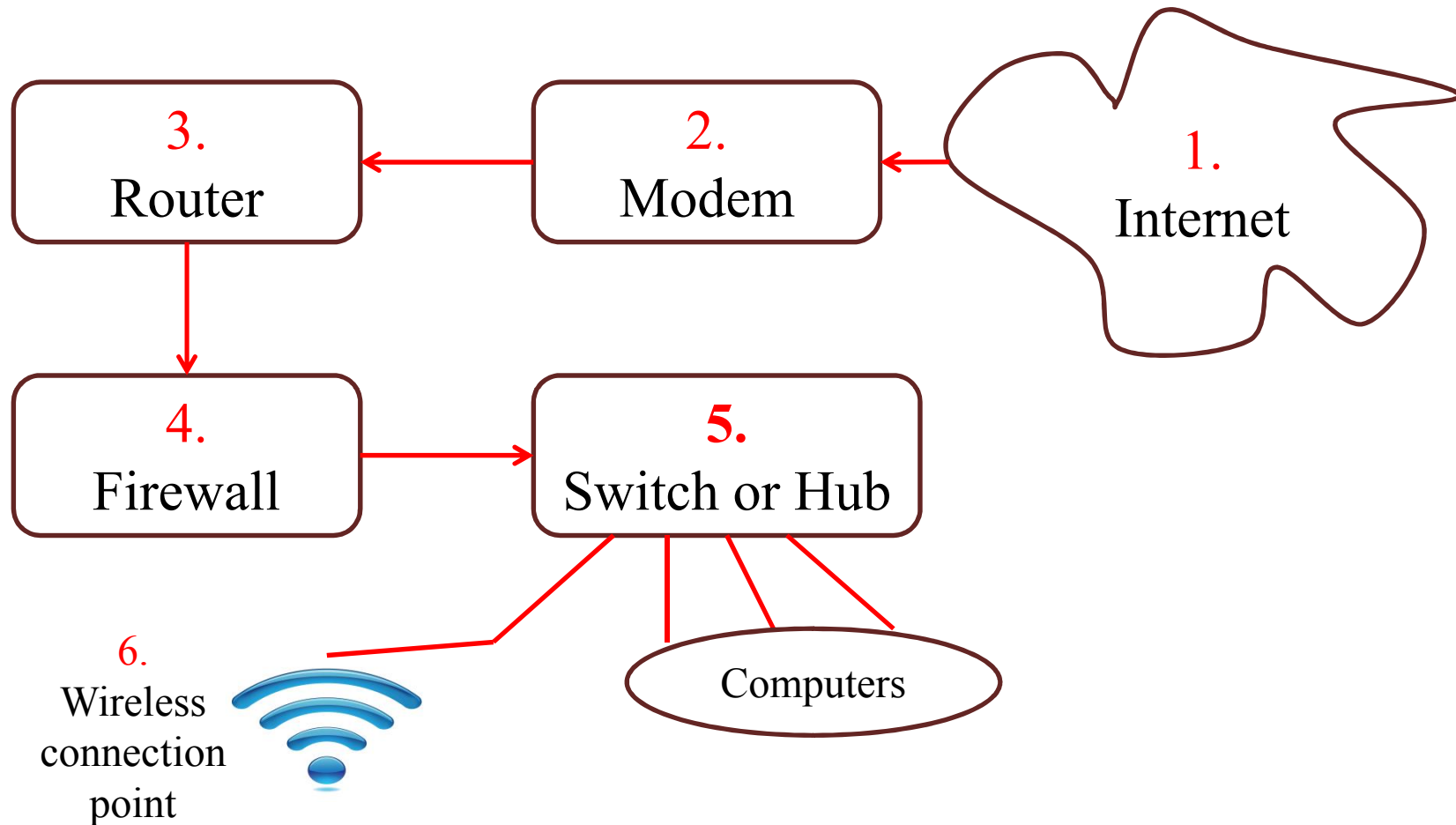
Hardware firewalls

- Protect an entire network
- Implemented on the router level
- Usually more expensive, harder to configure

Software firewalls

- Protect a single computer
- Usually less expensive, easier to configure

5. Switch vs Hub?



5. Switch vs Hub?

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

5.1. What is a Hub?

- A hub is usually a small rectangular box, often made of plastic, which receives its power from an ordinary wall outlet.
- A hub joins multiple computers (or other network devices) together to form a single network segment.
- On this network segment, all computers can communicate directly with each other.
- Larger hubs contain 8, 12, 16, and even 24 ports.

5. Switch vs Hub?

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?**
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

5.1. What is a Hub?

- Many times the last port is reserved for "uplink" which is the **connecting of one hub to another hub** or similar device (joining two segments together).
- Essentially, a hub simply receives incoming packets, possibly amplifies the electrical signal, and **broadcasts** these packets out to all devices on the network - including the one that originally sent the packet!

5. Switch vs Hub?

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?**
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

5.2. Types of hubs :

Passive : do not amplify the electrical signal of incoming packets

Active : amplify the electrical signal of incoming packets back to their original level

Intelligent: is typically stackable (built in such a way that multiple units can be placed one on top of the other to conserve space).

5. Switch vs Hub?

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

5.3. What is a Network Switch?

- A network switch is a small hardware device that joins multiple computers together within one local area network (LAN).
- Unlike hubs, network switches are capable of **inspecting data packets** as they are received, determining the source and destination device of that packet, and forwarding it appropriately.
- By delivering each message only to the connected device it was intended for, a network switch conserves **network bandwidth** and offers generally better performance than a hub.

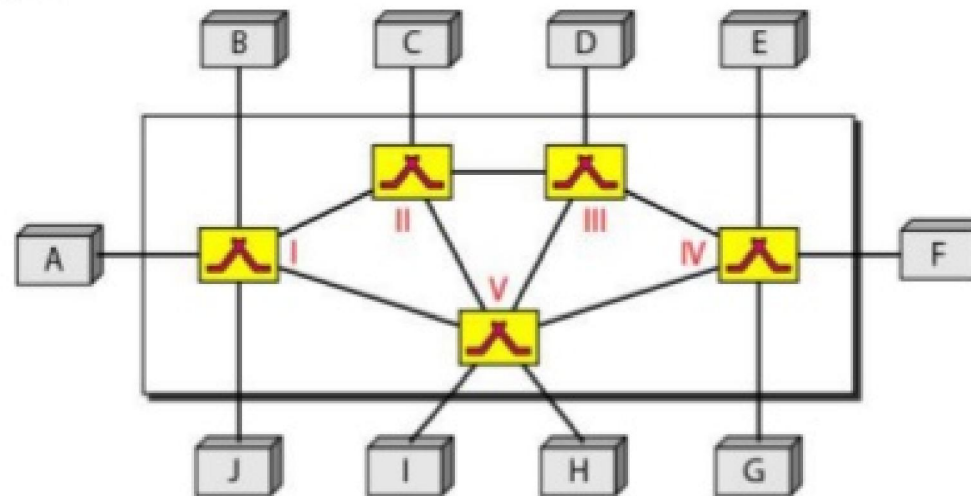
5. Switch vs Hub?

Outlines

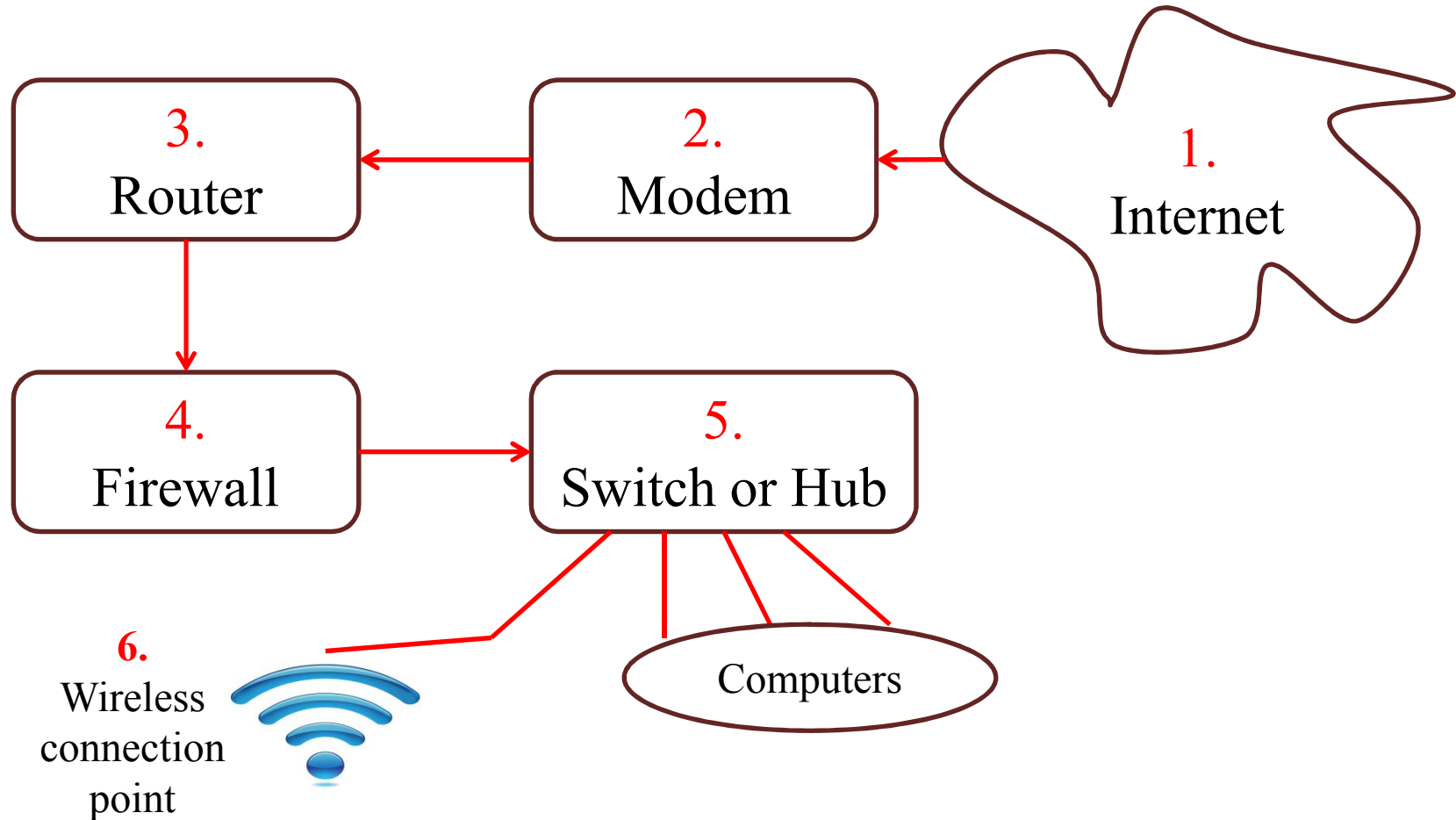
- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

Switched Network: series of interlinked nodes, called switches.

Switches: devices capable of creating temporary connections between two or more devices linked to the switches. Some of these switches are connected to the end systems (computers or telephones). Others used only for routing.



6. What is Wireless connection point?



6. What is Wireless connection point?

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

- Access Point
 - Device that bridges a wireless connection and a wired connection
 - Two types of access points: Hardware access points and Software access points
 - Generally acts as a hub.
- Extension point
 - Used if single access point is not able to cover entire area
 - Acts as wireless relay extending the range of wireless network.

6. What is Wireless connection point?

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

- Hardware access point is physical device that is used to establish a connection between a wired network and a wireless network.

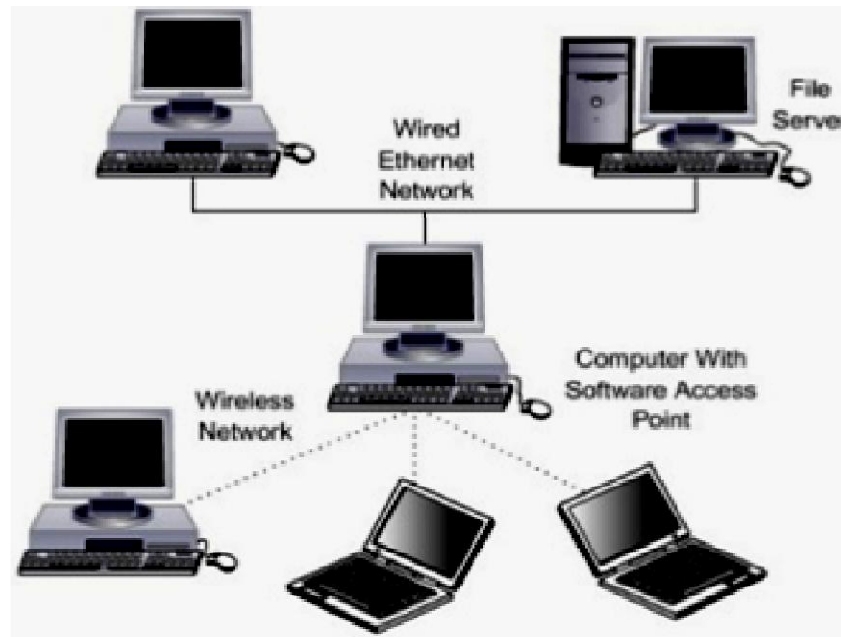


6. What is Wireless connection point?

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network
 - Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

- Software access points are computer which includes a wireless network interface card.

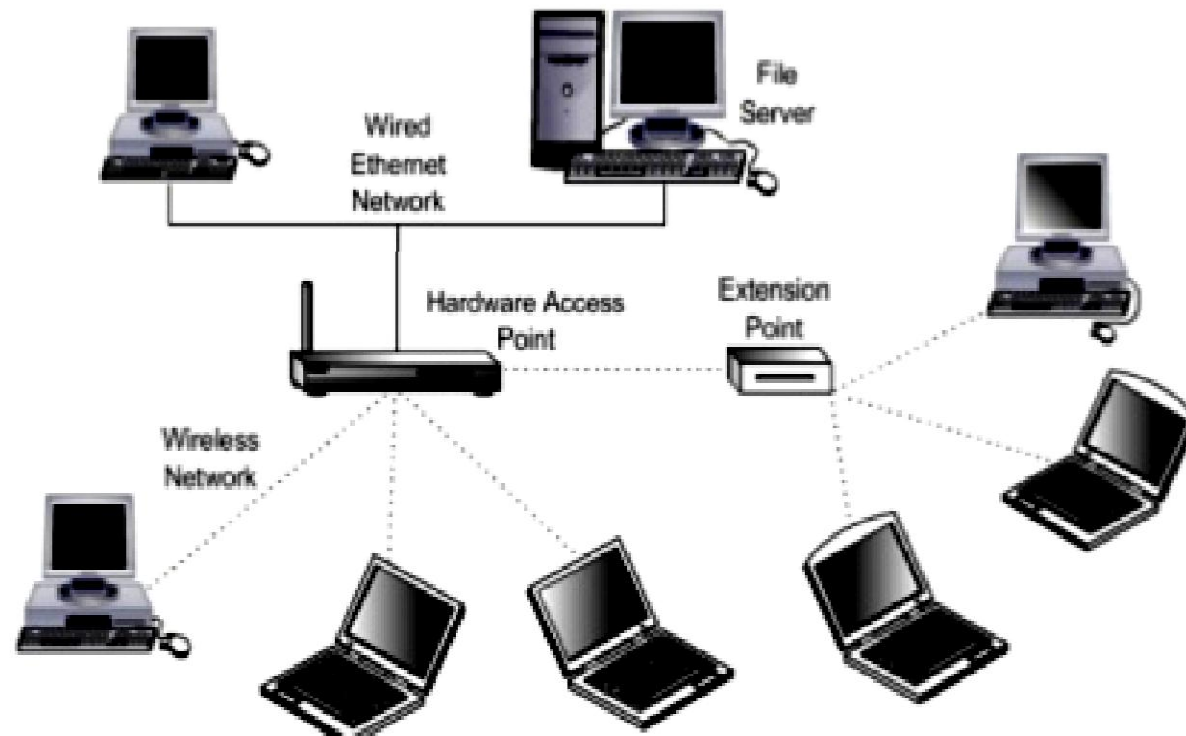


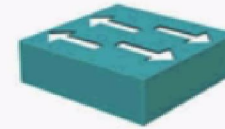
6. What is Wireless connection point?

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

- Extension points are used if a single access point is not able to cover the entire area.





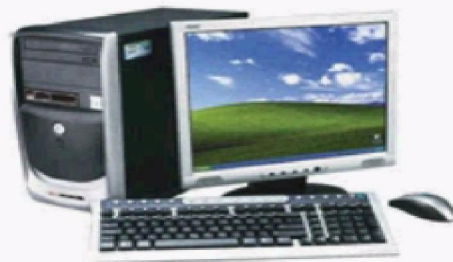
SWITCHES



ROUTERS



WIRELESS ACCESS POINTS



CLIENTS AND SERVERS

Types of Networks

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?



Local Area Network (LAN)

Wide Area Network (WAN)

Types of Networks

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- **Types of Networks**
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

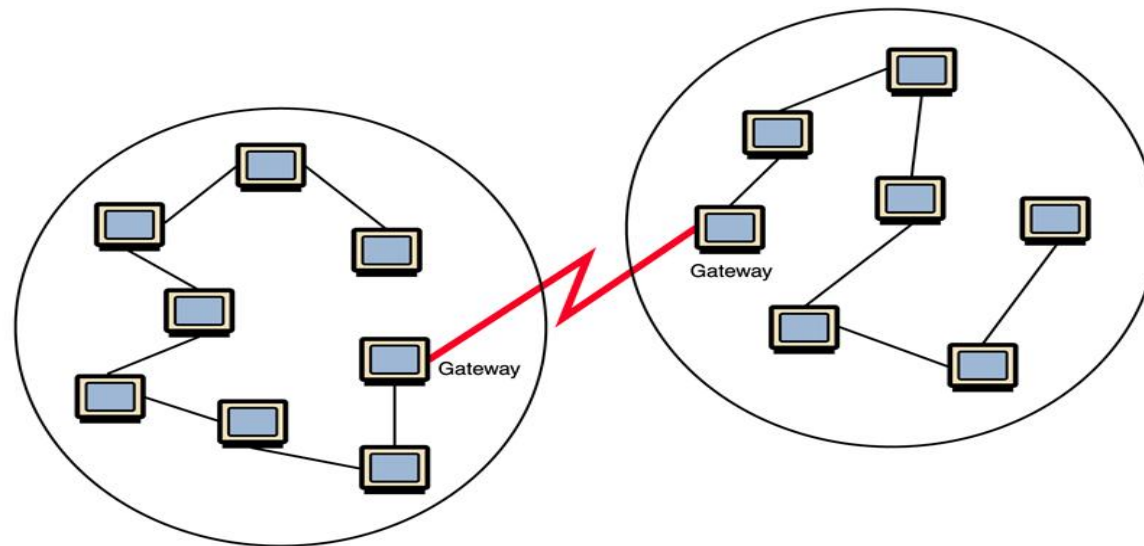
- How many kinds of Networks?
 - Depending on one's perspective, we can classify networks in different ways
 - Based on **transmission media**: Wired (UTP, coaxial cables, fiber-optic cables) and Wireless
 - Based on **management method**: Peer-to-peer and Client/Server
 - Based on **network size**: LAN and WAN (and MAN)
 - Based on **topology** (connectivity): Bus, Star, Ring ...
 - :
 - :

Types of Networks

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- **Types of Networks**
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

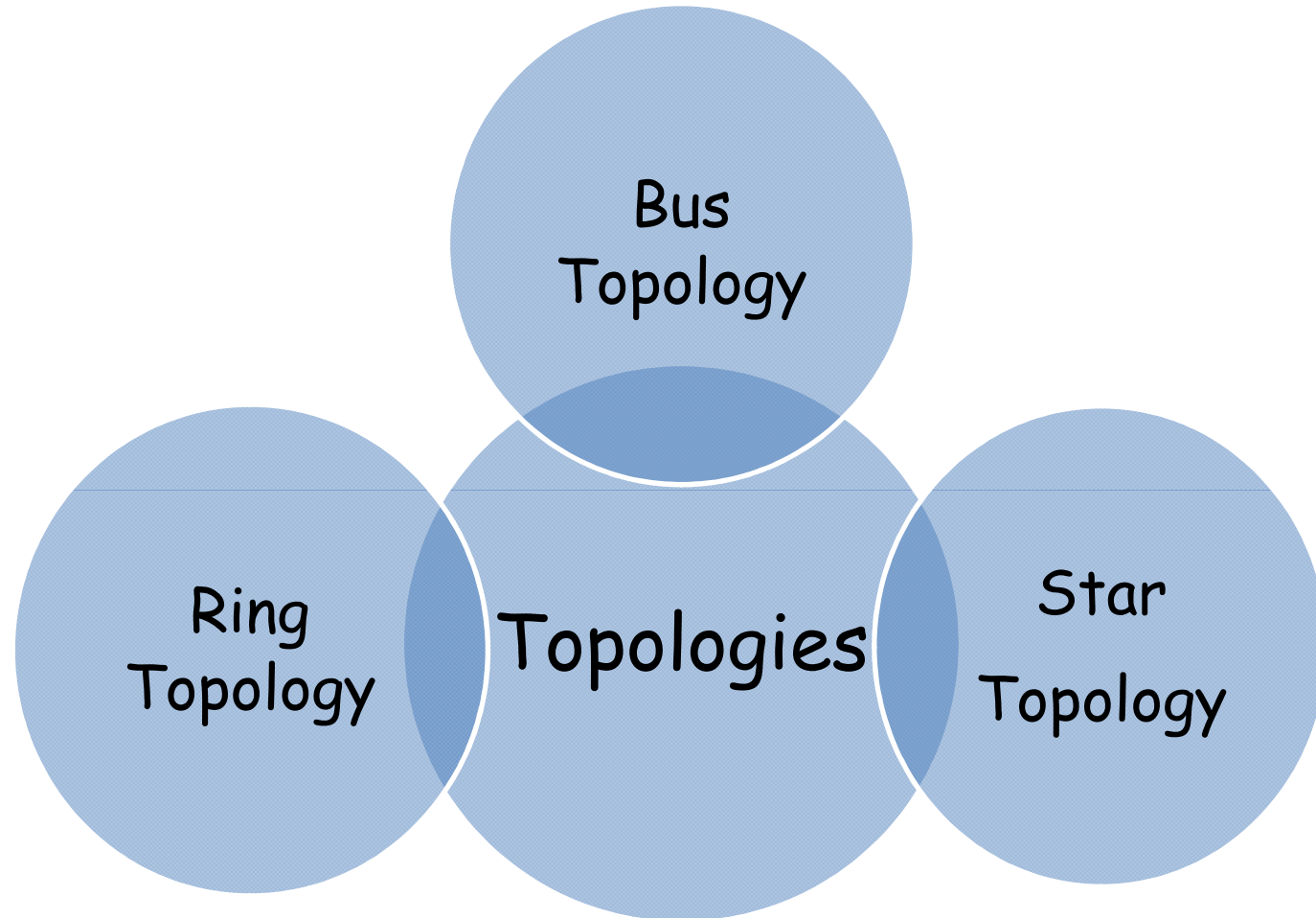
- Local Area Network (LAN) :
 - A network that connects a relatively **small number of machines** in a relatively **close geographical area**.
- Wide Area Network (WAN) :
 - A network that connects **two or more local-area networks** over a potentially **large geographic distance**.



LAN Network Topologies

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?



LAN Network Topologies

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

• Bus Topology:

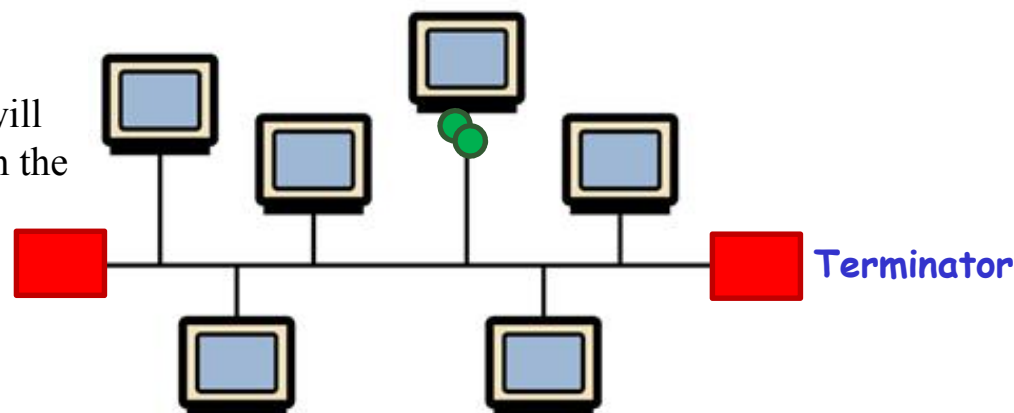
- All nodes are connected to a single communication line that carries messages in both directions.

Example:

- Network inside the Student Computer Room
- Network inside your home

Disadvantages :

- Adding more computers will reduce the access speed on the network.
- Collisions



LAN Network Topologies

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

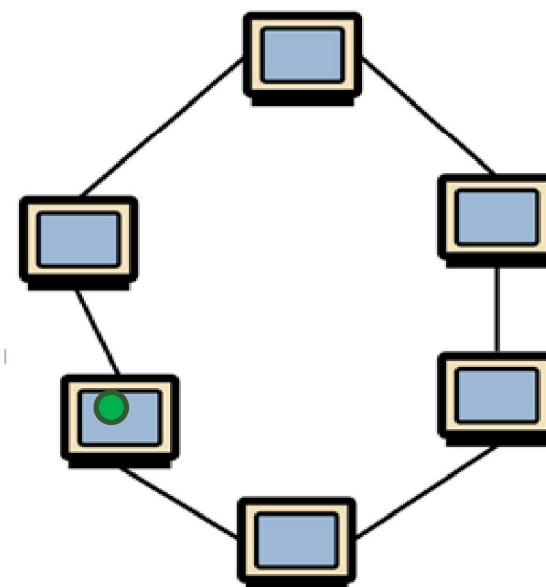
• Ring Topology:

- A configuration that connects all nodes in a closed loop on which messages travel in one direction

Token : In this topology, to transmit on the wire your computer must have control of the token or wait for the token to be free

Disadvantages :

- that a single malfunctioning workstation can disable the whole network



LAN Network Topologies

Outlines

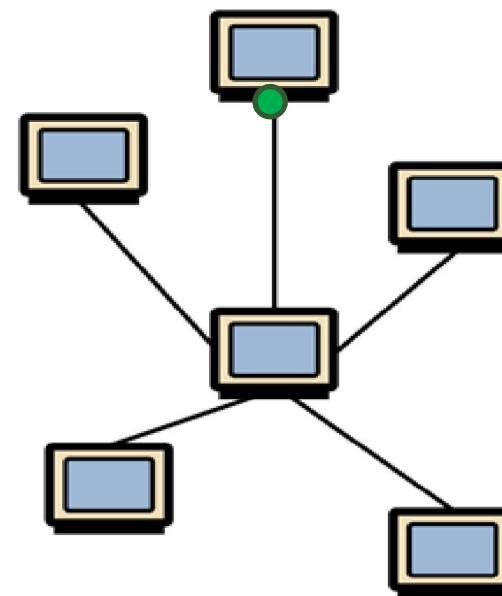
- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - WAN Network
 - MAN Network
 - Network Cables
 - What is protocol?

• Star Topology:

- A configuration that centers around one node to which all others are connected and through which all messages are sent.

Disadvantages :

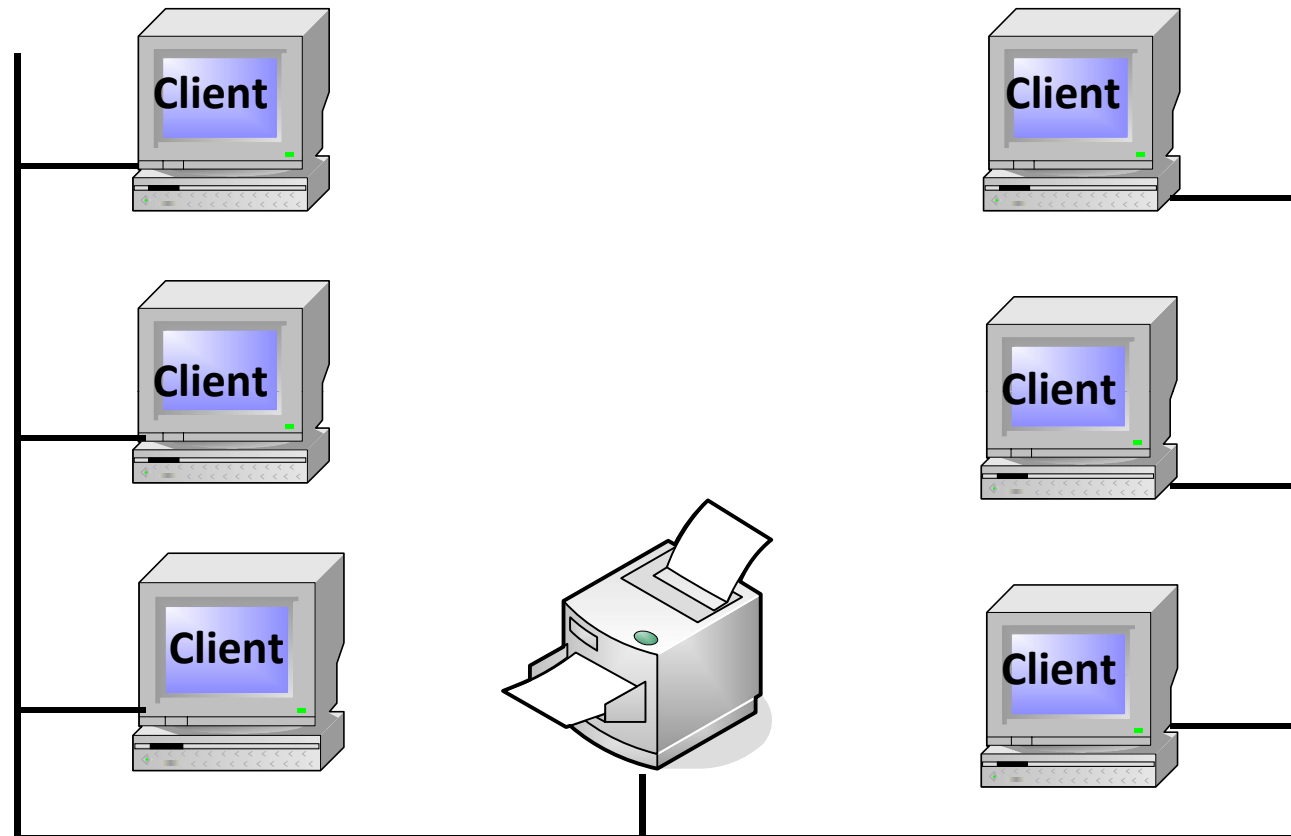
- Expensive
- if a central device was to fail then all computers connected to that device would not be able to see the network.



LAN Network Example

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network
 - WAN Network
 - MAN Network
- Network Cables
- What is protocol?



WAN Network

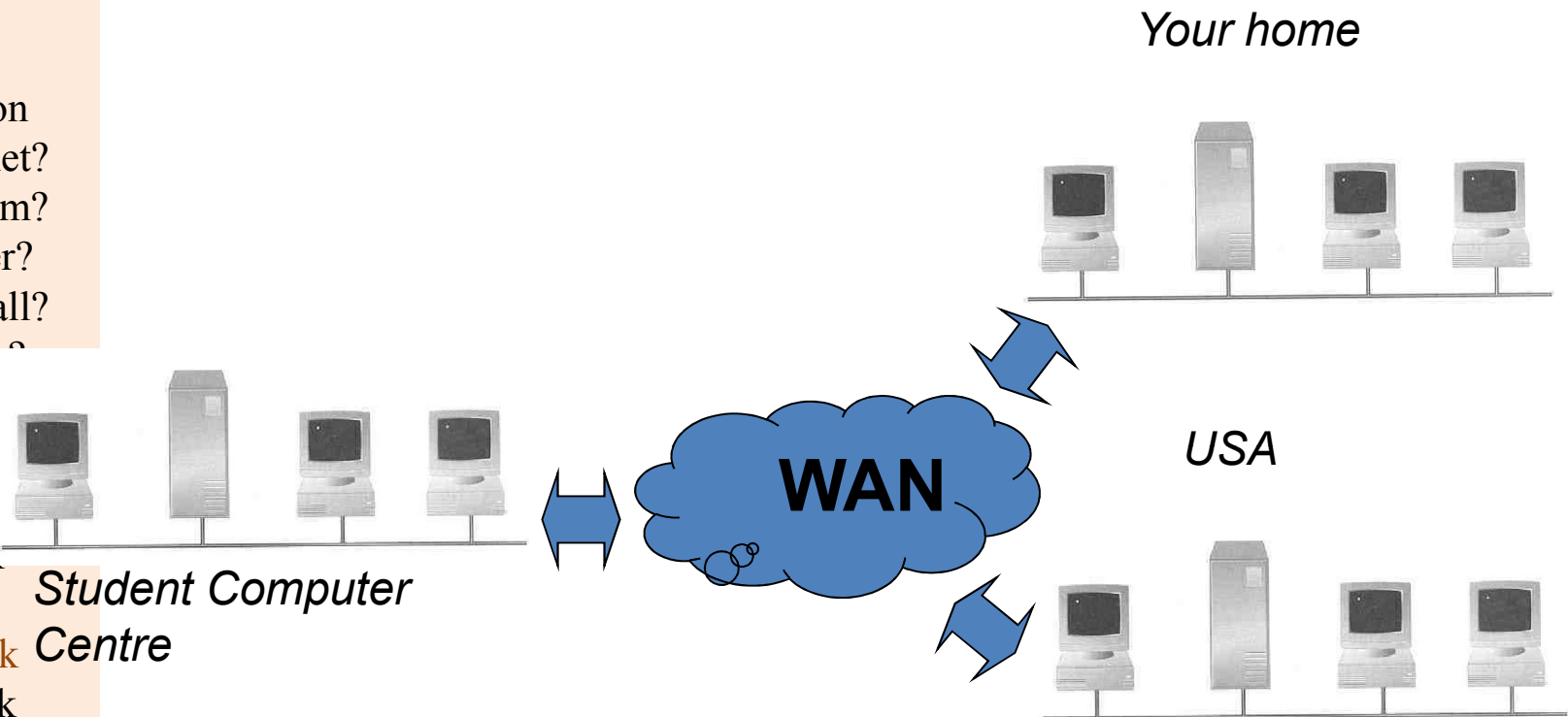
Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network
 - Topologies
 - **WAN Network**
 - MAN Network
 - Network Cables
 - What is protocol?
- It is a computer network that covers a broad area (i.e., any network whose communications links cross metropolitan, regional, or national boundaries). Or, less formally, a network that uses routers and public communications links.
- The largest and most well-known example of a WAN is the Internet.
- WANs are used to connect LANs and other types of networks together, so that users and computers in one location can communicate with users and computers in other locations .

WAN Network

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - **WAN Network**
 - MAN Network
 - Network Cables
 - What is protocol?



Metropolitan Area Network (MAN)

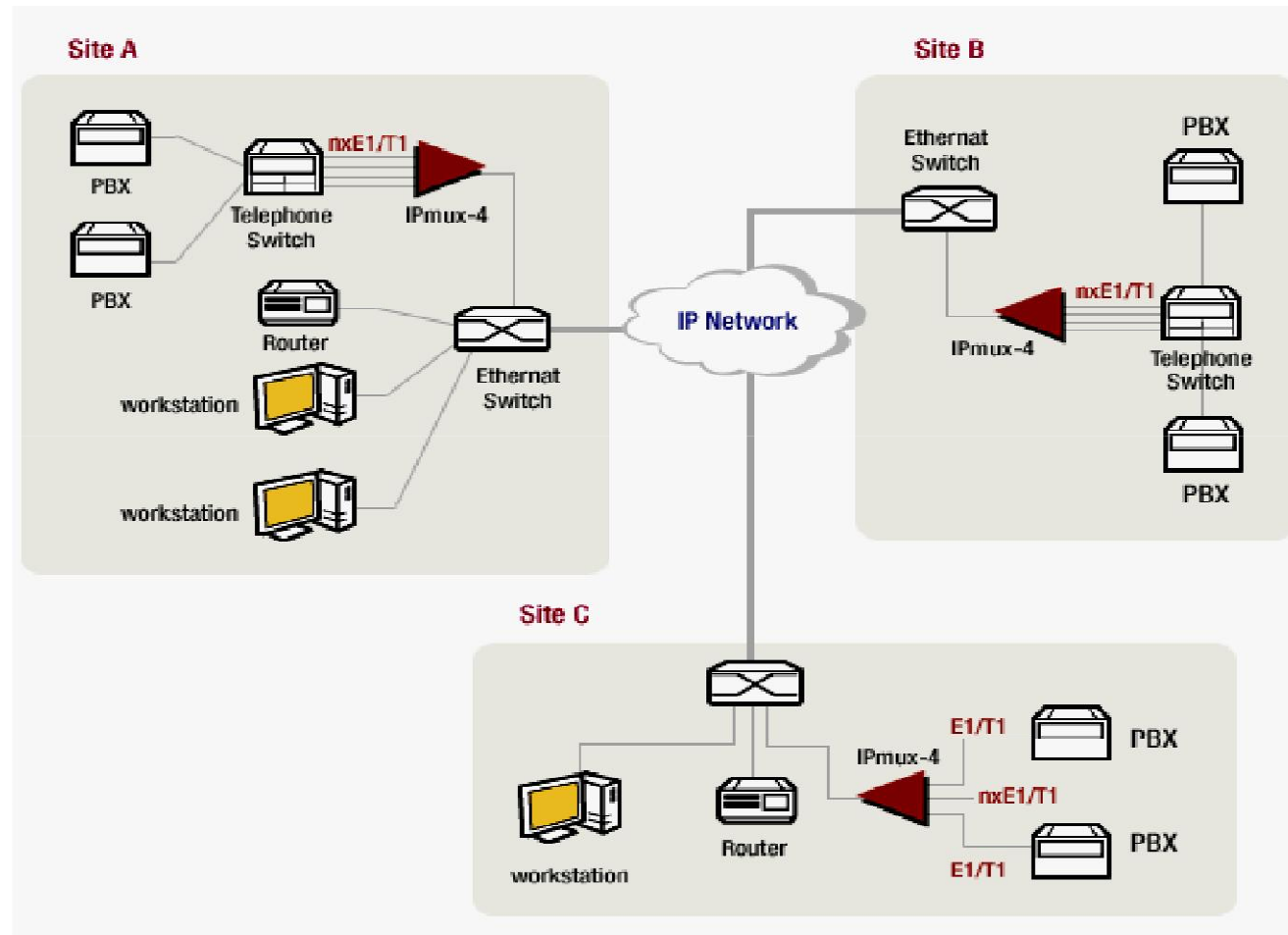
Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network
 - Topologies
 - WAN Network
 - **MAN Network**
 - Network Cables
 - What is protocol?
- A metropolitan area network (MAN) is a network that interconnects users with computer resources in a geographic area or region larger than that covered by even a large local area network (LAN) but smaller than the area covered by a wide area network (WAN). The term is applied to the interconnection of networks in a city into a single larger network (which may then also offer efficient connection to a wide area network). It is also used to mean the interconnection of several local area networks by bridging them with backbone lines. The latter usage is also sometimes referred to as a campus network.

Metropolitan Area Network (MAN)

Outlines

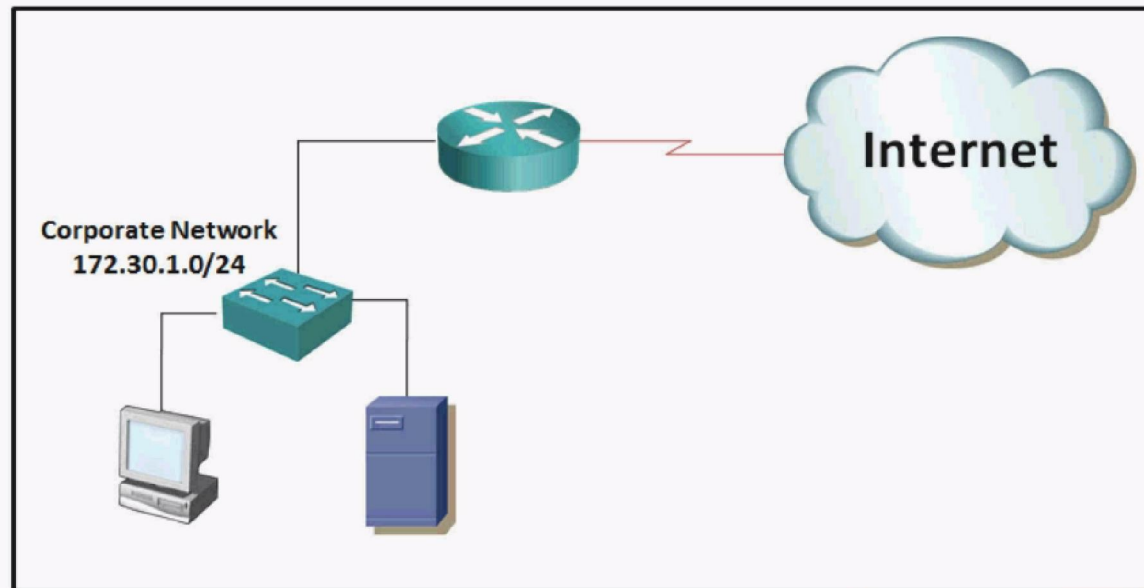
- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network
 - Topologies
 - WAN Network
 - **MAN Network**
 - Network Cables
 - What is protocol?



Network Cables

Outlines

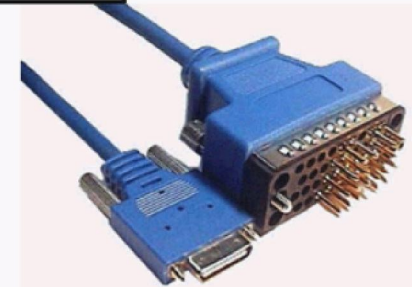
- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network
 - Topologies
 - Network Cables
 - What is protocol?



ETHERNET



FIBER

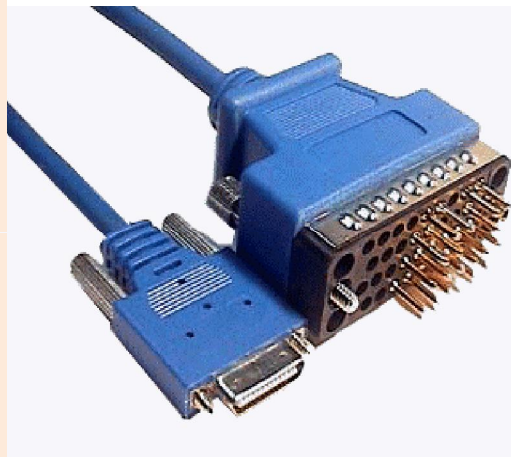


SERIAL

Network Cables

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - **Network Cables**
 - What is protocol?



Serial and Parallel Cables

Because many PCs in the 1980s and early 1990s lacked Ethernet capability, and USB had not been developed yet, serial and parallel interfaces (now obsolete on modern computers) were sometimes used for PC-to-PC networking. So-called [null model cables](#), for example, connected the [serial ports](#) of two PCs enabling data transfers at speeds between 0.115 and 0.45 Mbps.

Network Cables

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - Network Cables
 - What is protocol?



**ETHERNET
CABLE**

Ethernet Cable

A thick cable used to connect a computer to a large network. An Ethernet cable is often used to connect computers to a college network in a dormitory, for example. **Most Ethernet cables are full duplex**, meaning they can upload and download information at the same time.

Network Cables

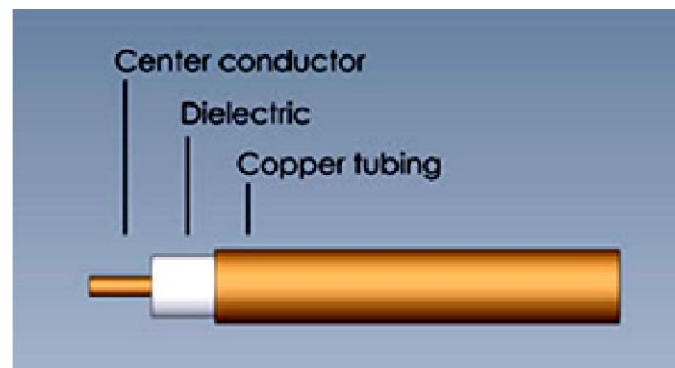
Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network
 - Topologies
 - **Network Cables**
 - What is protocol?



Coaxial Cable

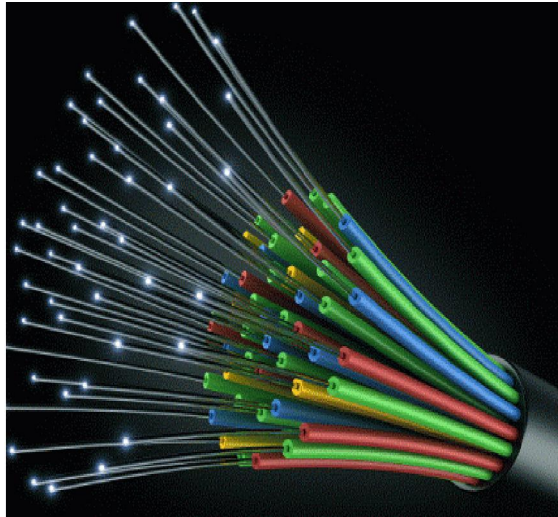
Coaxial cable provide the means for transverse-electromagnetic (TEM) modes of transmission. They serve as a signal path to transfer **high-frequency analog signals** or **high-speed digital signals**.



Network Cables

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network Topologies
 - **Network Cables**
 - What is protocol?



Fiber Optics

Instead of insulated metal wires transmitting electrical signals, [fiber optic network cables](#) work using strands of glass and pulses of light.

These network cables are bendable despite being made of glass. They have proven especially useful in [wide area network \(WAN\)](#) installations where long distance underground or outdoor cable runs are required and also in office buildings where a high volume of communication traffic is common.

What is protocol?

Outlines

- What is going on
 - What is Internet?
 - What is Modem?
 - What is Router?
 - What is firewall?
 - Switch vs Hub?
 - What is Wireless connection point?
- Types of Networks
 - LAN Network
 - Topologies
 - Network Cables
 - What is protocol?

Protocols:

are the rules governing the transfer of data information, it can also be compared to how humans use languages (to get your point across you must talk in the same language as the person you are speaking to).

Home “networkers” often use an Internet Protocol (IP) wired or wireless for communication.

Router/Host configuration

- Introduction
- Rules of Communication
- Network Protocols and Standards
 - Network Protocols
 - Interaction of Protocols
 - Protocol suits and Industry Standards
 - **TCP/IP Protocol Suite and Communication**
 - Open Standards
 - Benefits of Using a Layered Model
 - The OSI Reference Model
 - The TCP/IP Reference Model
- Moving Data in the Network
 - Moving Data in the Network
 - Message Segmentation
 - Data Encapsulation
 - De-Encapsulation
 - Protocol Data Units (PDUs)
 - Network addresses
 - Data Link Addresses
 - Communicating with Device/Same Network
 - Communicating with Device/remote Network

- **Router>** – USER prompt mode
- **Router#** – PRIVILEGED EXEC prompt mode
- **Router(config)** – terminal configuration prompt
- **Router(config-if)** – interface configuration prompt

Example

```
Router>enable
```

```
Router# configure terminal
```

```
Router(config)# hostname RouterA
```

```
RouterA(config)# interface fastethernet IPAddress Mask
```

For the host

```
Press Enter to begin
C:>ipconfig /ip 192.168.200.2 255.255.255.0
C:>ipconfig /dg 192.168.200.1
C:>
```