



# **Overview of Computer Networking**

**IIIT Sri City**

**Dr. Shiv Ram Dubey**

# The Computer Network

## What is a Computer Network

A system containing any combination of  
computers,  
computer terminals,  
printers,  
audio or visual display devices,  
or telephones, etc.

interconnected by telecommunication equipment or  
cables: used to transmit or receive information.

# The Network Diagram

(Click on the Words Below and Learn More About Each Component)

[The Internet](#)



# The Network Diagram

(Click on the Words Below and Learn More About Each Component)

The Internet



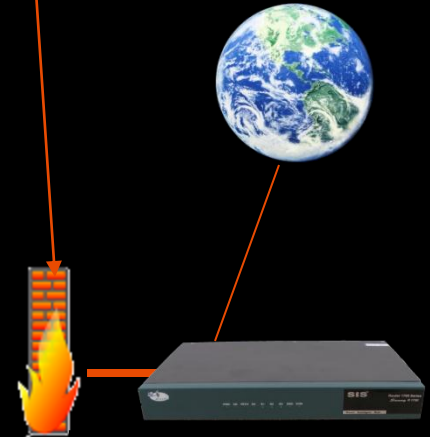
Router

# The Network Diagram

(Click on the Words Below and Learn More About Each Component)

Firewall

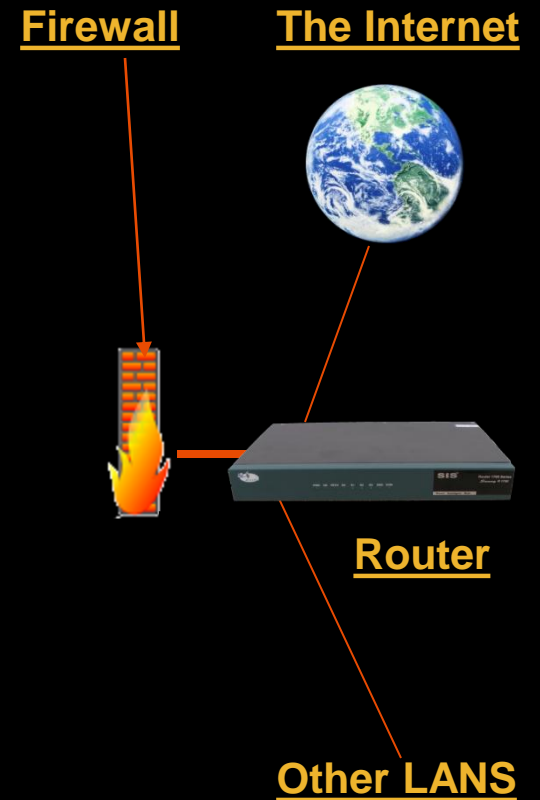
The Internet



Router

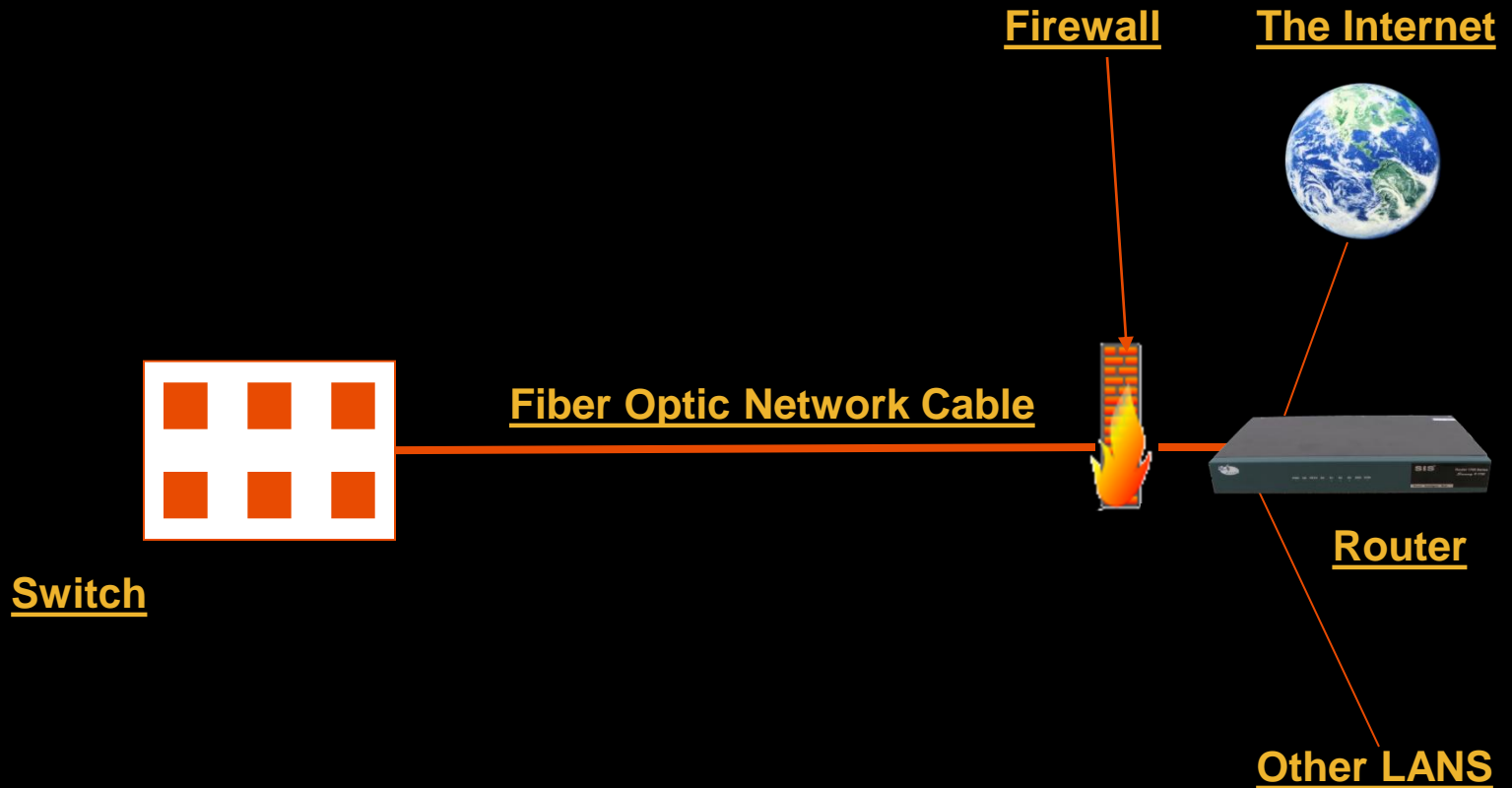
# The Network Diagram

(Click on the Words Below and Learn More About Each Component)



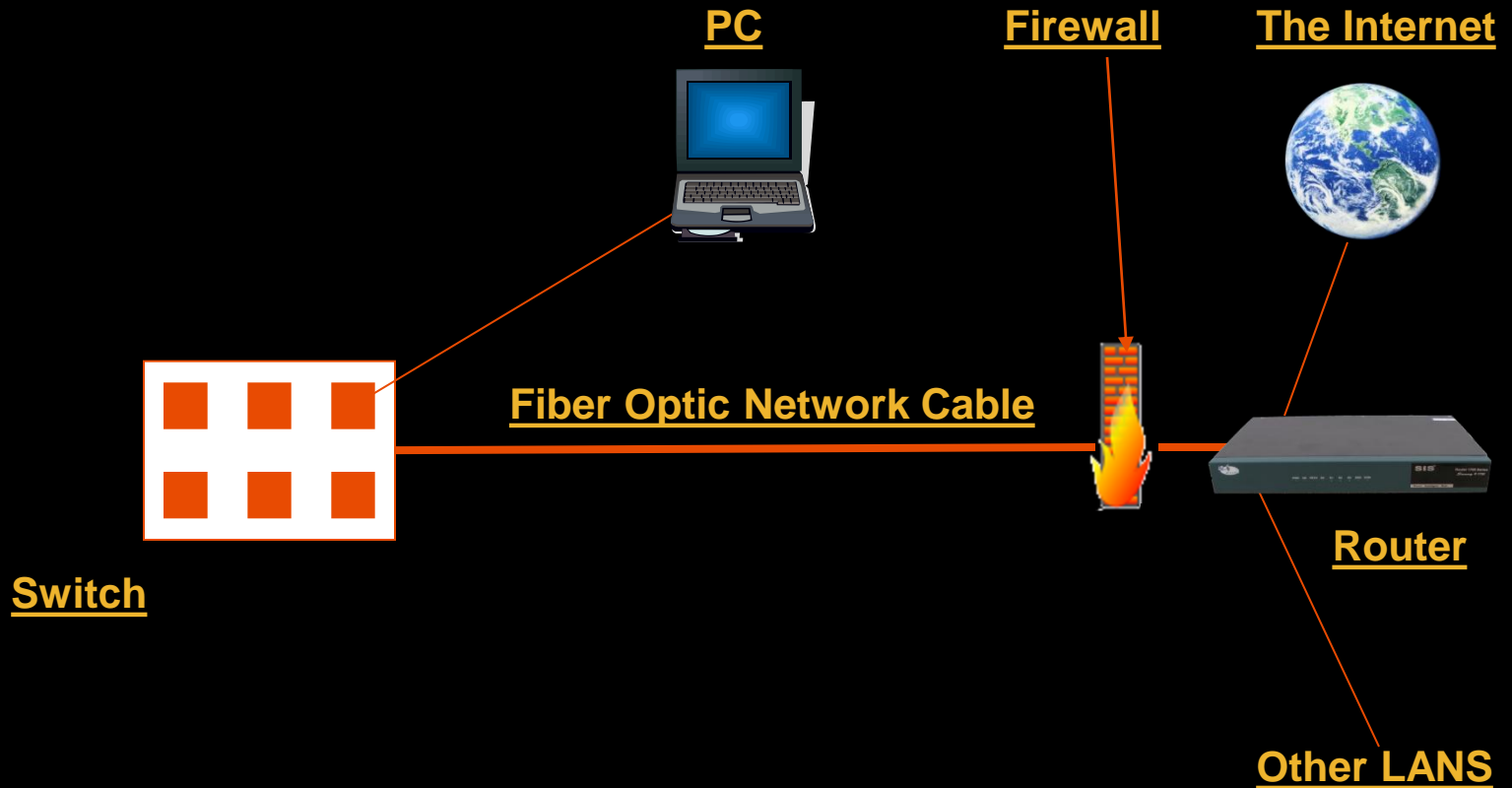
# The Network Diagram

(Click on the Words Below and Learn More About Each Component)



# The Network Diagram

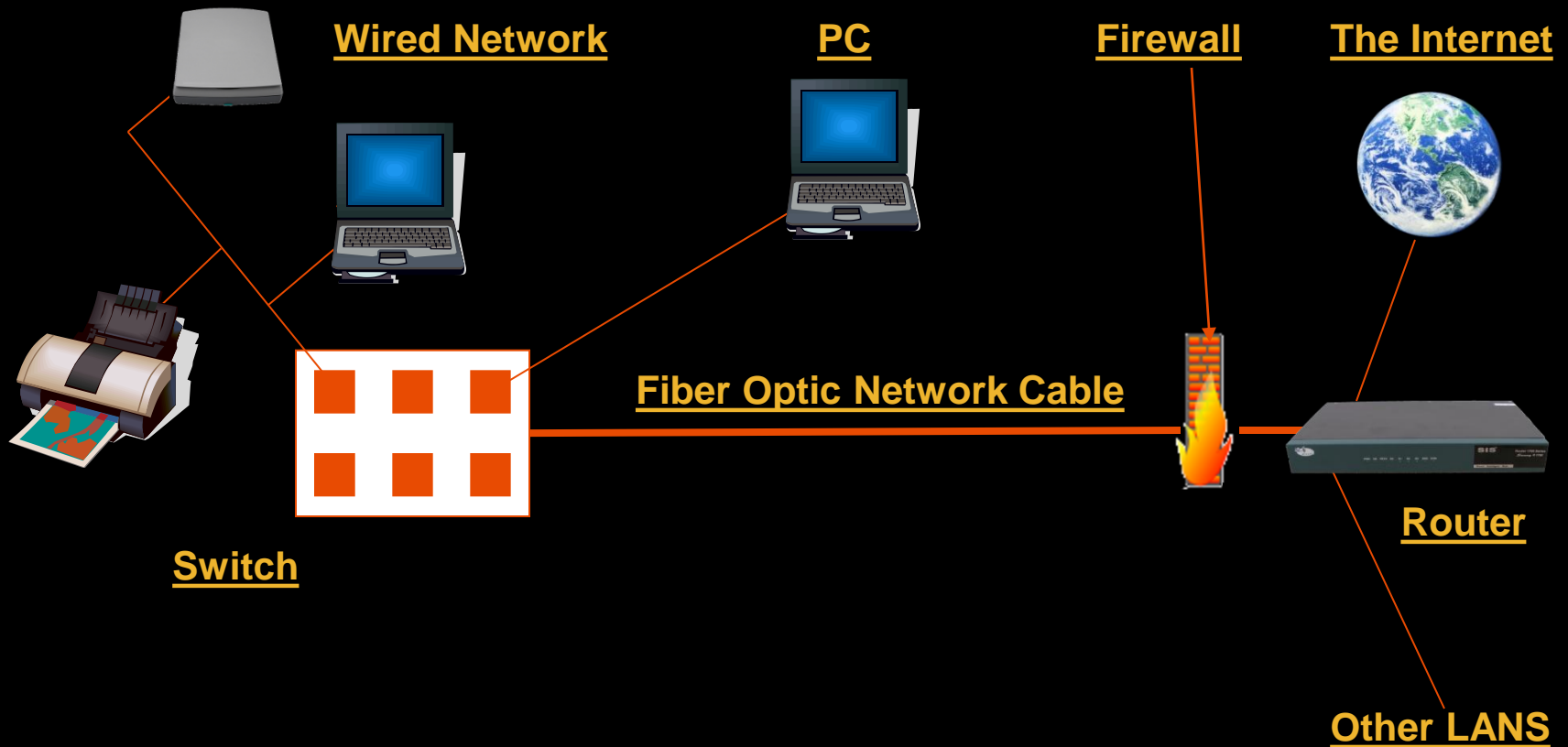
(Click on the Words Below and Learn More About Each Component)





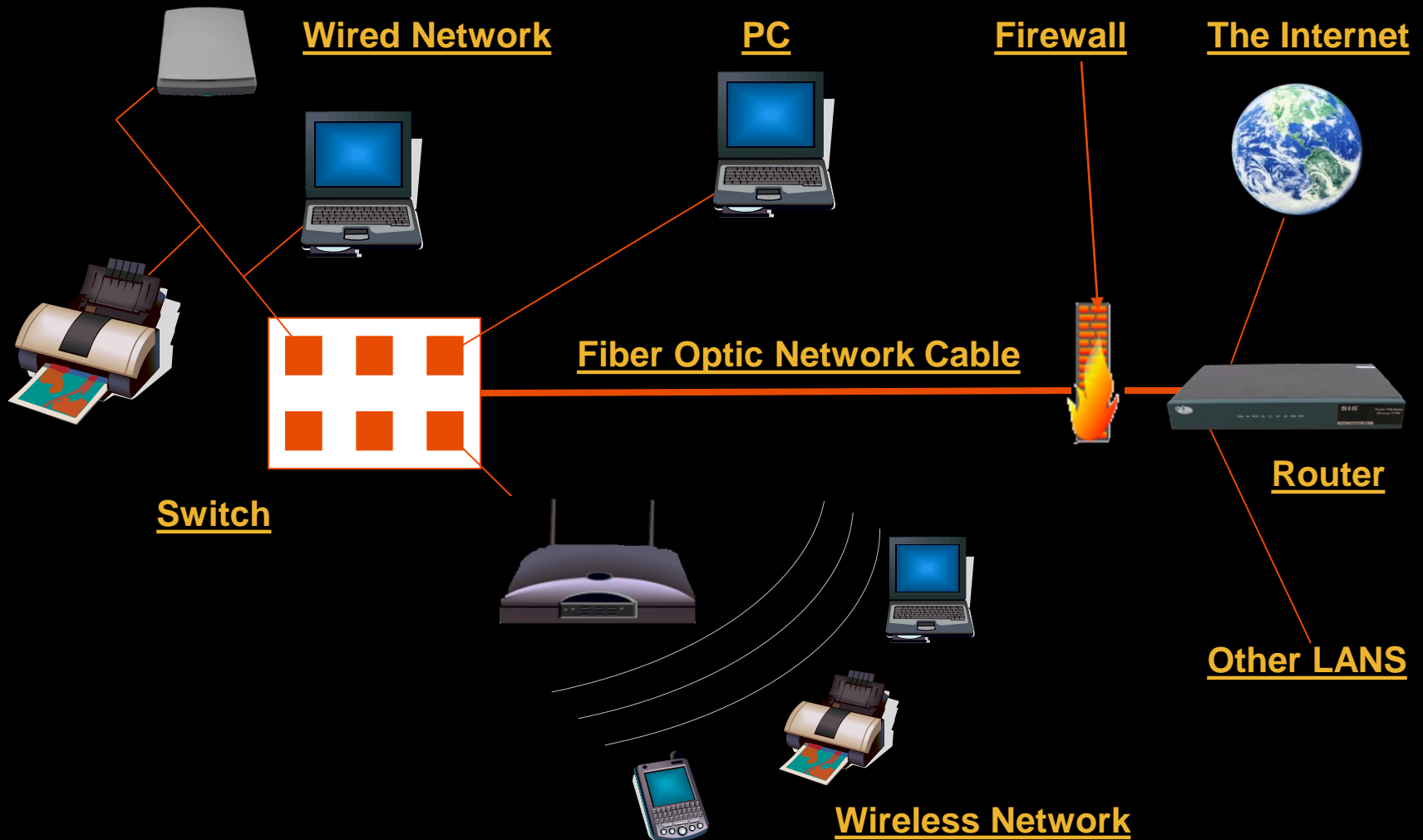
# The Network Diagram

(Click on the Words Below and Learn More About Each Component)



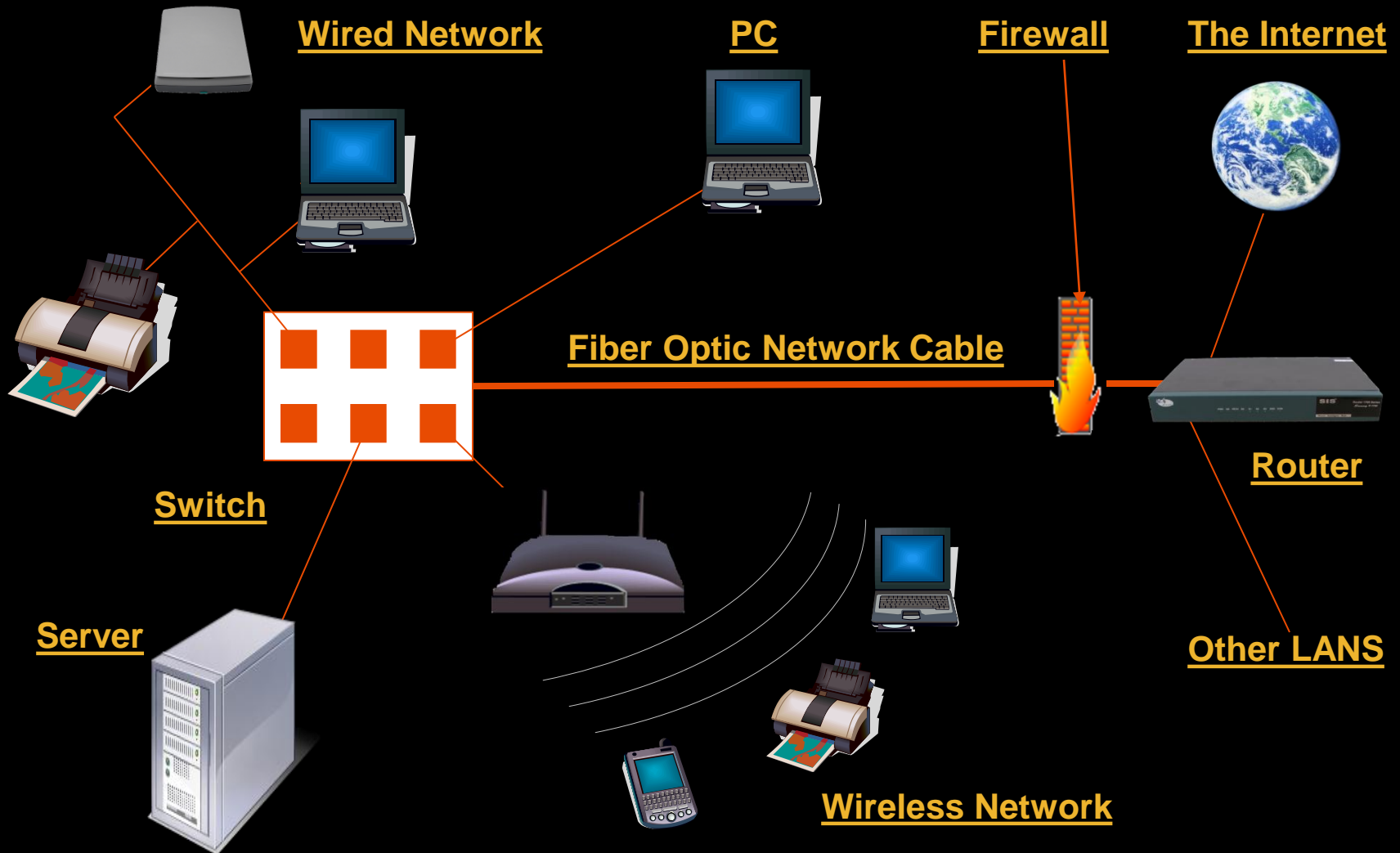
# The Network Diagram

(Click on the Words Below and Learn More About Each Component)



# The Network Diagram

(Click on the Words Below and Learn More About Each Component)



# 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 **network size**: LAN and WAN

Based on **management method**: Peer-to-peer and Client/Server

Based on **topology (connectivity)**: Bus, Star, Ring ...

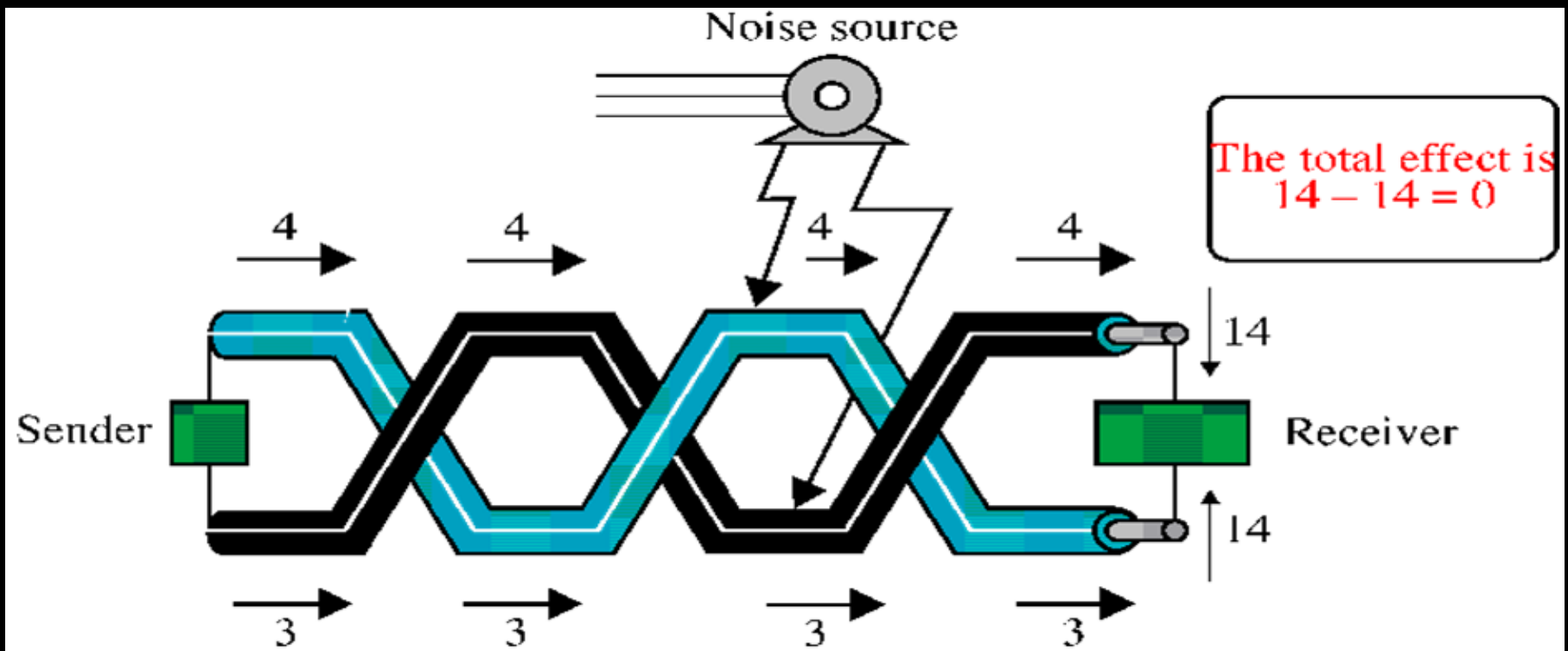
⋮  
⋮

# Transmission Media

- **Two main categories:**
  - **Wired — wires, cables**
  - **Wireless — wireless transmission, e.g. radio, microwave, infrared, sound, sonar**
- **We will concentrate on wired media here:**
  - **Twisted-Pair cables:**
    - **Unshielded Twisted-Pair (UTP) cables**
    - **Shielded Twisted-Pair (STP) cables**
  - **Coaxial cables**
  - **Fiber-optic cables**

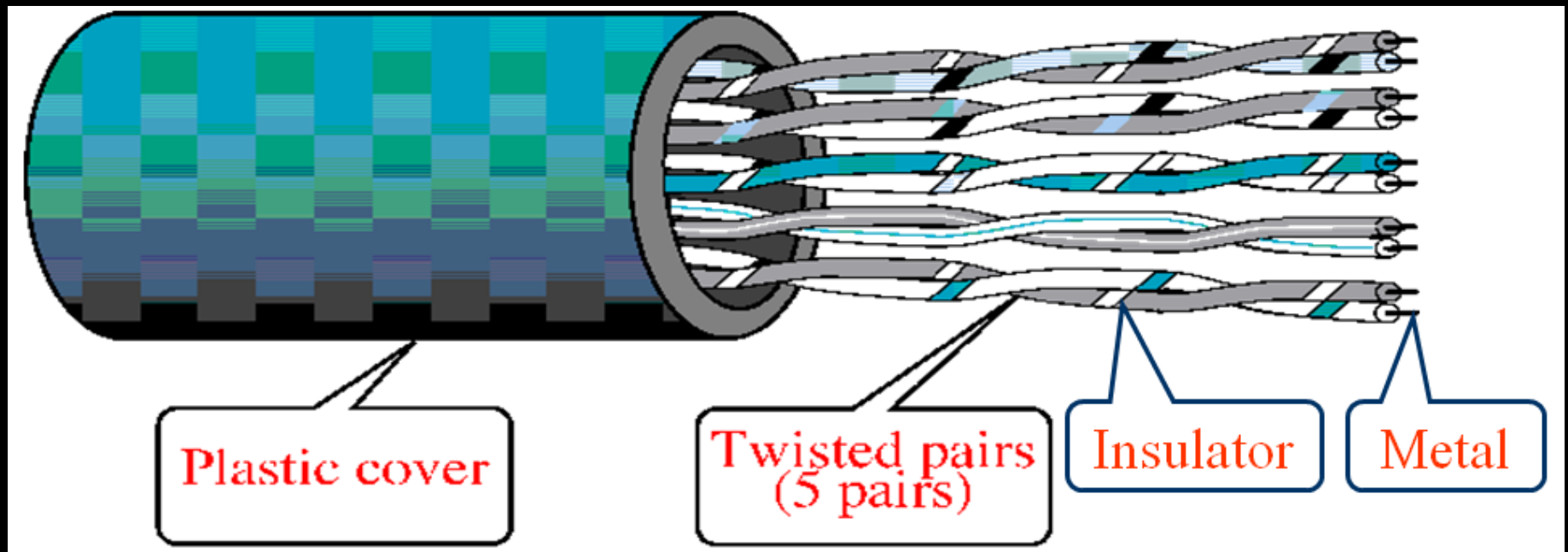
# Twisted-Pair Cables

- If the pair of wires are not twisted, electromagnetic noises from, e.g., motors, will affect the closer wire more than the further one, thereby causing errors



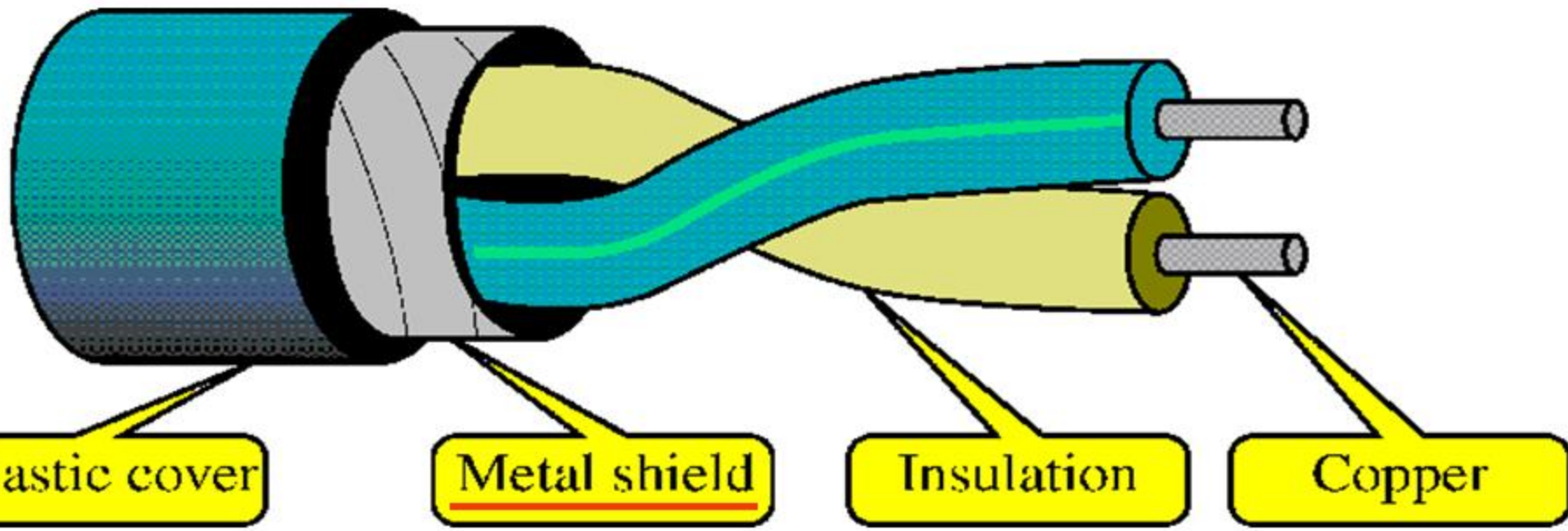
# Unshielded Twisted-Pair (UTP)

- Typically wrapped inside a plastic cover (for mechanical protection)
- A sample UTP cable with 5 unshielded twisted pairs of wires



# Shielded Twisted-Pair (STP)

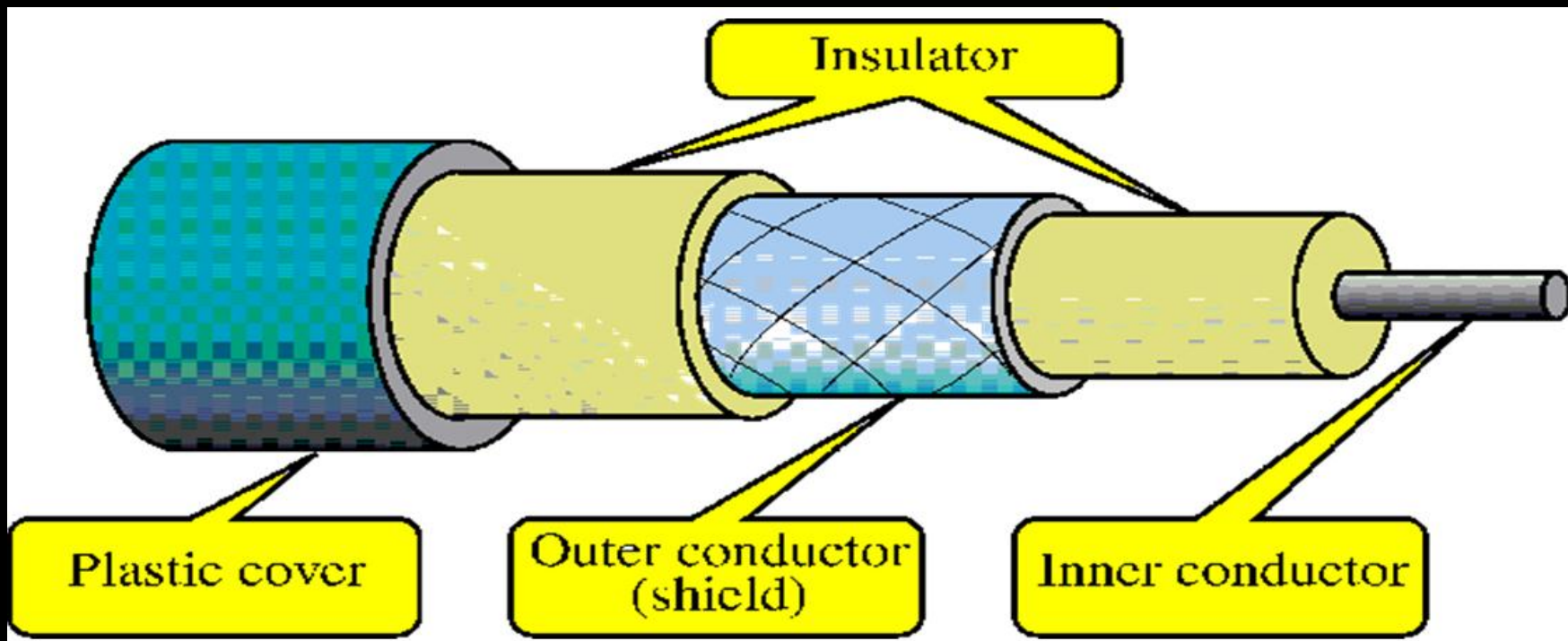
- STP cables are similar to UTP cables, except there is a metal foil or braided-metal-mesh cover that encases each pair of insulated wires





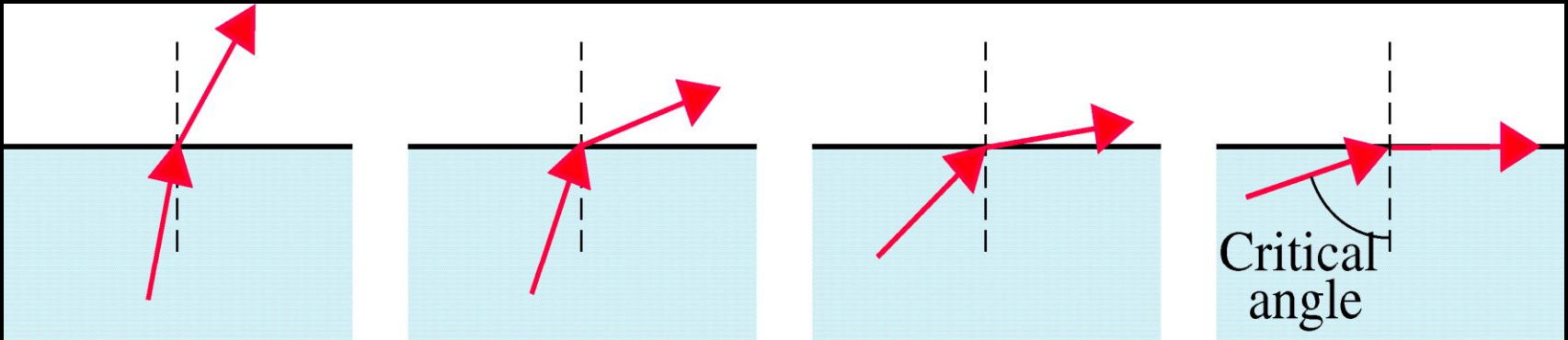
# Coaxial Cables

- In general, coaxial cables, or coax, carry signals of higher freq (100KHz–500MHz) than UTP cables
- Outer metallic wrapping serves both as a shield against noise and as the second conductor that completes the circuit



# Fiber-Optic Cables

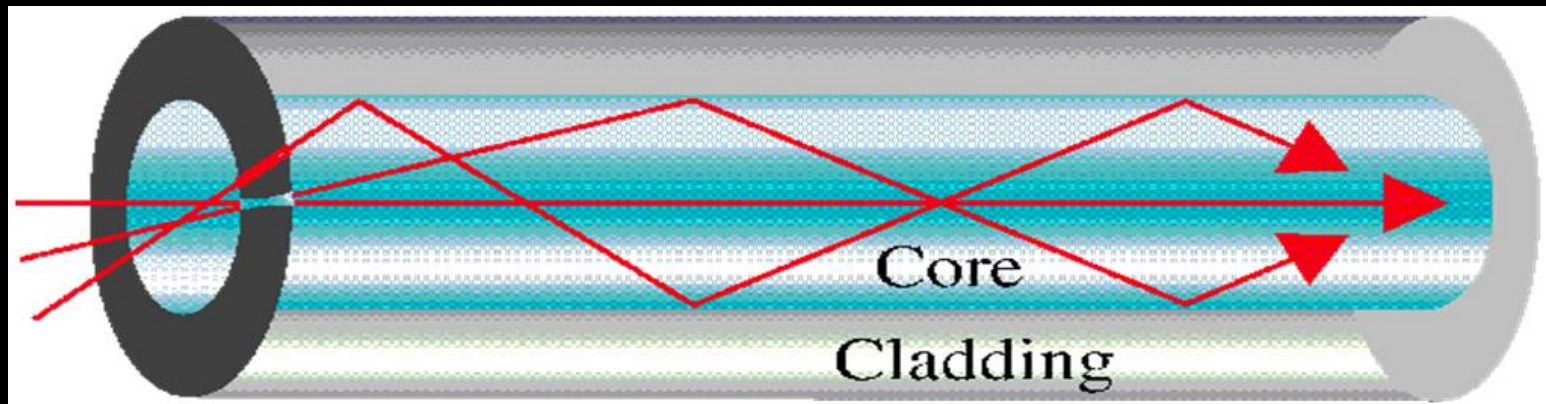
- Light travels at  $3 \times 10^8 \text{ ms}^{-1}$  in free space and is the fastest possible speed in the Universe
- Light slows down in denser media, e.g. glass
- Refraction occurs at interface, with light bending away from the normal when it enters a less dense medium



- Beyond the critical angle  $\Rightarrow$  total internal reflection

# Fiber-Optic Cables

- An optical fiber consists of a core (denser material) and a cladding (less dense material)
- Simplest one is a multimode step-index optical fiber
- Multimode = multiple paths, whereas step-index = refractive index follows a step-function profile (i.e. an abrupt change of refractive index between the core and the cladding)
- Light bounces back and forth along the core
- Common light sources: **LEDs and lasers**

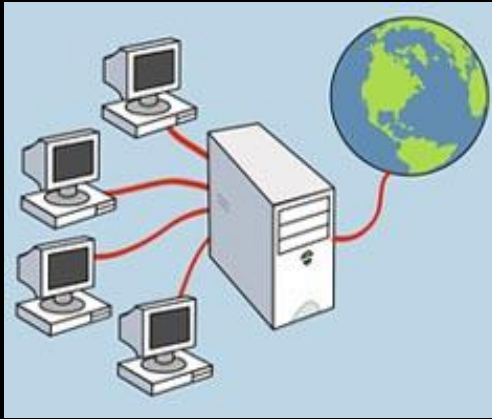


# Fiber-Optic Cables

## Advantages and Disadvantages

- 😊 Noise resistance — external light is blocked by outer jacket
- 😊 Less signal attenuation — a signal can run for miles without regeneration (currently, the lowest measured loss is about ~4% or 0.16dB per km)
- 😊 Higher bandwidth — currently, limits on data rates come from the signal generation/reception technology, not the fiber itself
- 😞 Cost — Optical fibers are expensive
- 😞 Installation/maintenance — any crack in the core will degrade the signal, and all connections must be perfectly aligned

# The Two Types of Networks

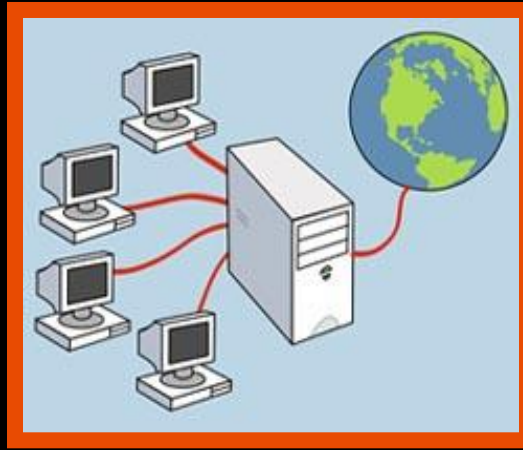


**LOCAL AREA**



**WIDE AREA**

# Local Area Network



- **A Local Area Network spans a relatively small area**
- **LAN are usually confined to one building or a group of buildings**
- **Data travel between network devices via network cables/wi-fi**
- **The most common type of Local Area Network is called Ethernet**

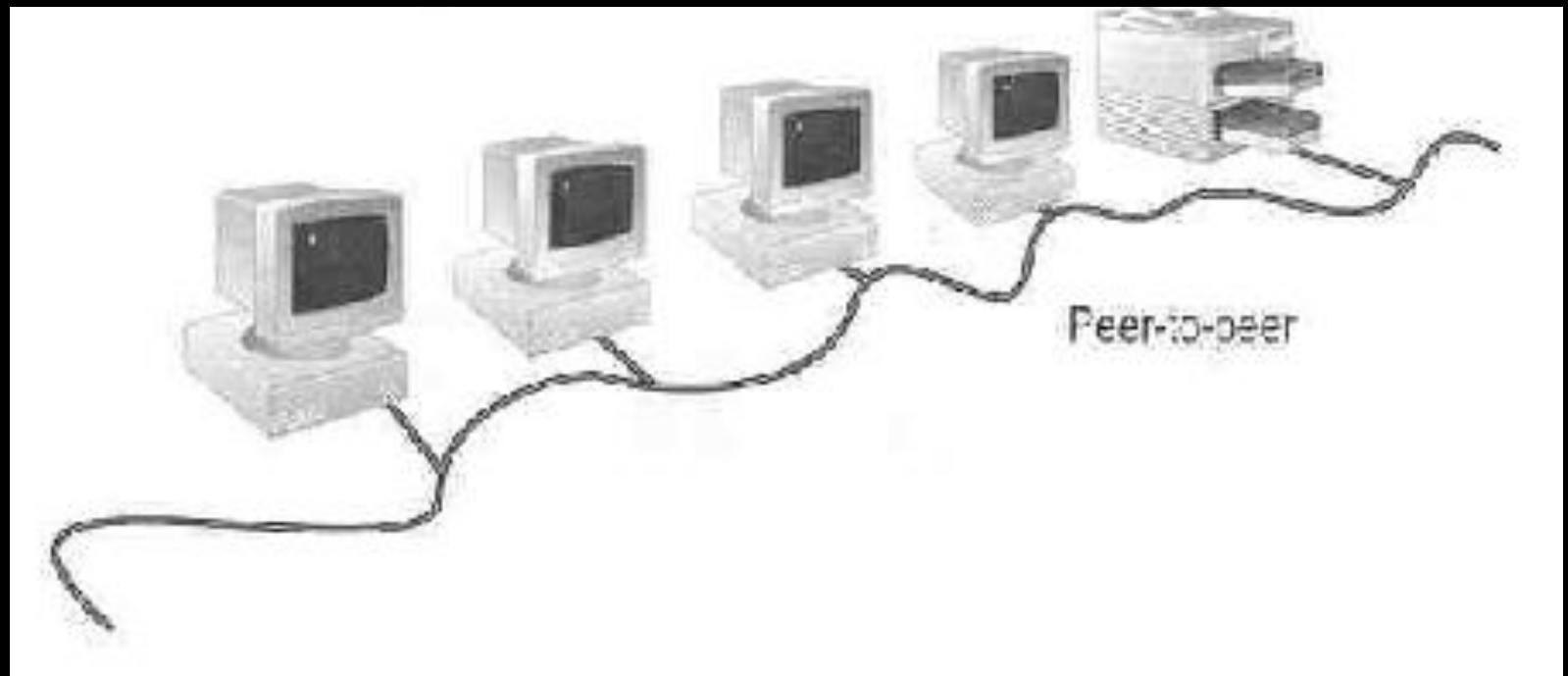
# Wide Area Network



- **A Wide Area Network exist over a large area**
- **Data travels through telephone or cable lines**
- **The world's largest Wide Area Network is the Internet**

# Peer to Peer Network

- Peer-to-peer network is also called **workgroup**
- **No hierarchy** among computers: all are equal
- **No administrator** responsible for the network





# Peer to Peer Network

- **Advantages** of peer-to-peer networks:
  - Low cost
  - Simple to configure
  - User has full accessibility of the computer
- **Disadvantages** of peer-to-peer networks:
  - May have duplication in resources
  - Difficult to uphold security policy
  - Difficult to handle uneven loading
- **Where peer-to-peer network is appropriate:**
  - 10 or less users
  - No specialized services required
  - Security is not an issue
  - Only limited growth in the foreseeable future

# Clients and Servers

## Network **Clients** (**Workstation**)

Computers that request network resources or services

## Network **Servers**

Computers that manage and provide network resources and services to clients

Usually have more processing power, memory and hard disk space than clients

Run **Network Operating System** that can manage not only data, but also **users**, **groups**, **security**, and **applications** on the network

Servers often have a more stringent requirement on its **performance** and **reliability**

# Clients and Servers

- **Advantages of client/server networks**

- Facilitate resource sharing – centrally administrate and control
- Facilitate system backup and improve fault tolerance
- Enhance security – only administrator can have access to Server
- Support more users – difficult to achieve with peer-to-peer networks

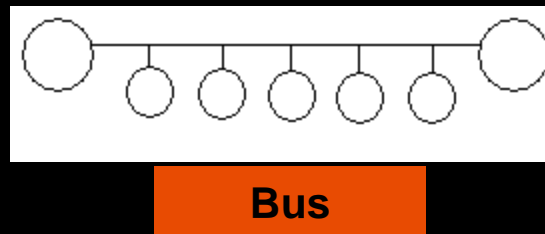
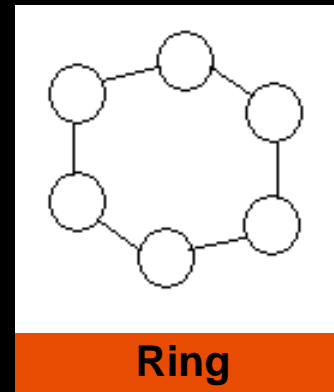
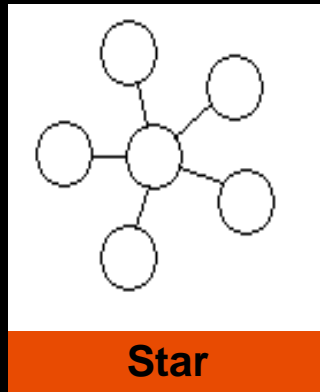
- **Disadvantages of client/server networks**

- High cost for Servers
- Need expert to configure the network
- Introduce a single point of failure to the system

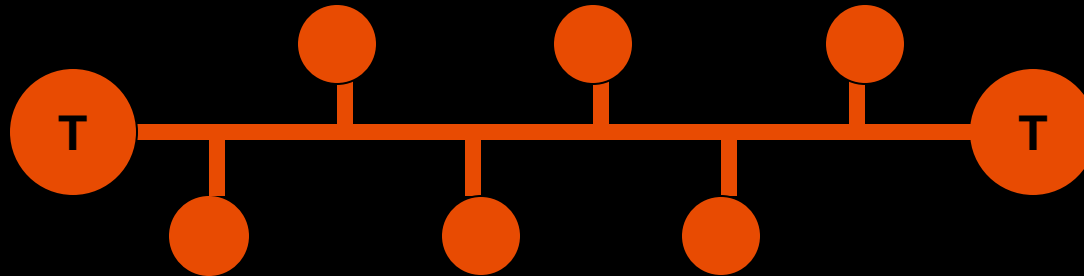
# Network Topologies

**Network Topology** refers to the shape of a network, or the network's layout. How different nodes in a network are connected to each other and how they communicate are determined by the network's topology.

**There are three basic topologies:**

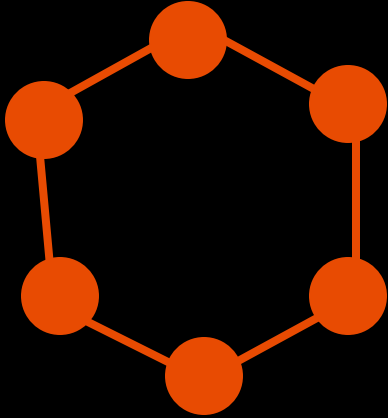


# Bus Topology



- All devices are connected to a central cable, called the bus or backbone.
- There are terminators at each end of the bus that stops the signal and keeps it from traveling backwards.
- Simple and low-cost
- Only one computer can send messages at a time
- Passive topology - computer only listen for, not regenerate data

# Ring Topology



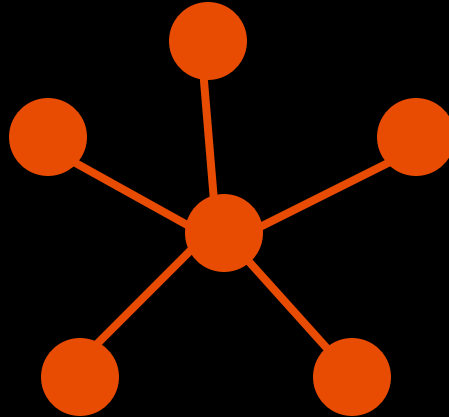
- All devices are connected to one another in the shape of a closed loop.
- Each device is connected directly to two other devices, one on either side of it.
- Disadvantages

**Difficult to add computers**

**More expensive**

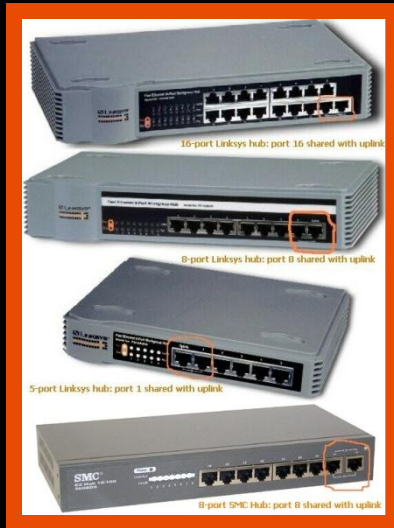
**If one computer fails, whole network fails**

# Star Topology



- All devices are connected to a central hub.
- Nodes communicate across the network by passing data through the hub or switch.
- More cabling, hence higher cost
- All signals transmission through the hub; if down, entire network down

# Hubs and Switches



**Network Hubs**



**Network Switches**

- **Data travels faster** through switches **because data is not sequenced as it is in a hub**
- **The information is more secure** when it passes through a switch as opposed to a hub.
- **Information travels more efficiently** through a switch **because travels directly to it's destination as opposed to being broadcast to all PC's on the network hub.**



# Servers



Rack of Servers

Users are connected to certain servers which will fulfill the required request.

## Server Types

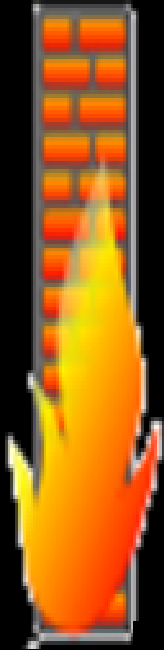
Print Servers

File Servers

Web Servers

GPU Servers

# Firewalls



- A firewall is a software that can be loaded on to a network that can serve as a barrier that keeps destructive forces away from a network of computers.
- Packets of data are analyzed against a set of criteria or standards called filters.
- Filters block certain designated IP addresses.

# Routers



Standard Router



Wireless Router

**Whether a Router is traditional or wireless, its purposes remain the same.**

**Routers are specialized computers that send your messages and those of every other Internet user speeding to their destinations along thousands of pathways.**

**Routers are crucial devices that let messages flow between networks, rather than within networks.**

# Wireless Networks



*Allows for computers to be moved easily without having to worry about wires or cables*

## Walkie-Talkie Network

- You would equip each computer with basically, a walkie-talkie.
- You would give each computer a way to set whether it wants to transmit or receive.
- A wireless network converts binary signal (0's and 1's) into a radio signal (series of beeps).

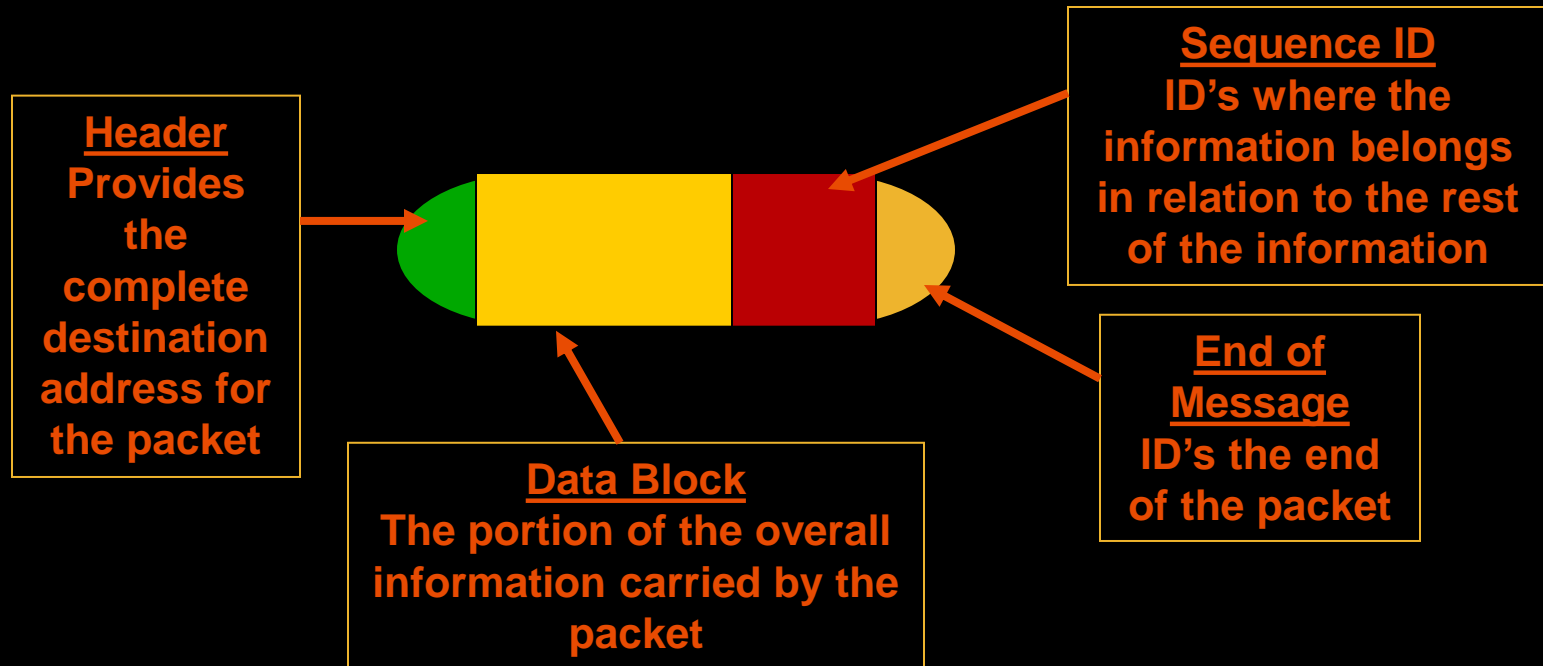
# The Internet



***The simplest definition of the Internet is that  
it's a network of computer networks***

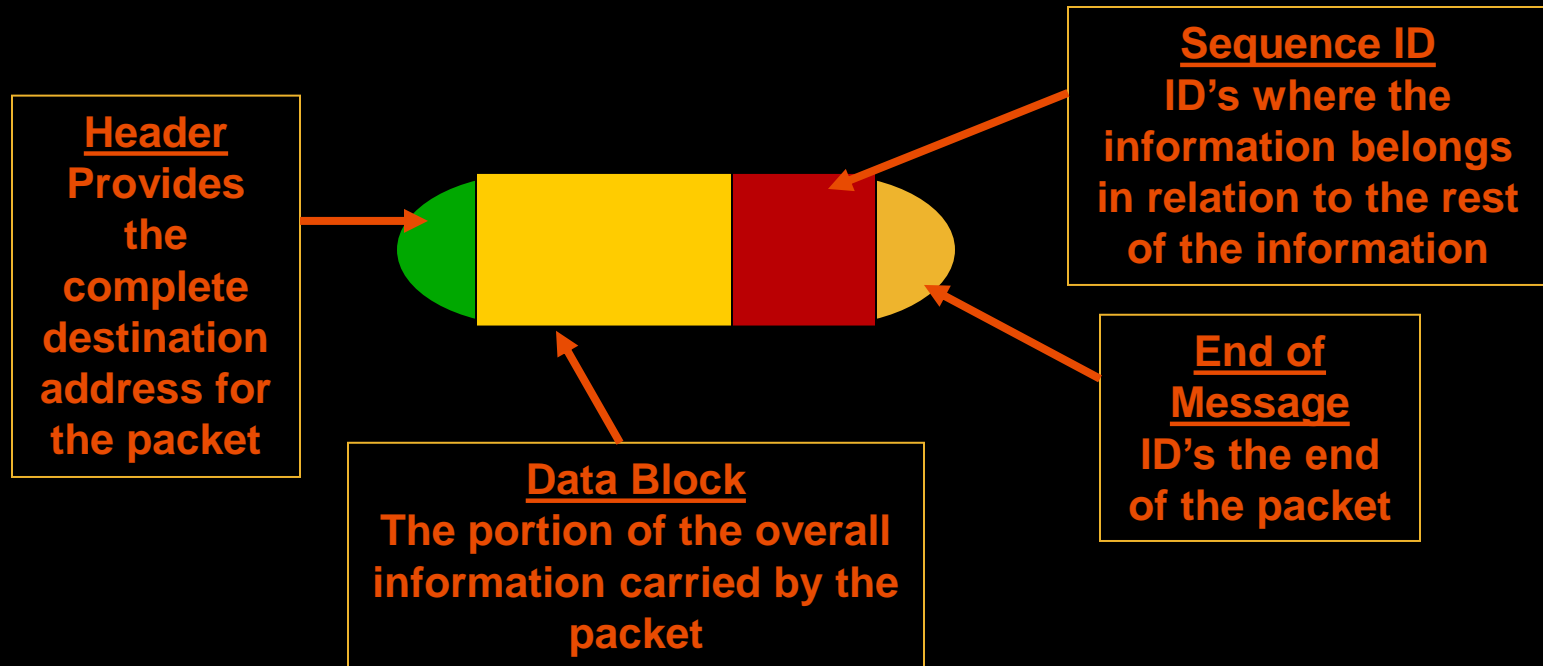
# The Internet

## How Information Travel Through the Internet



# The Internet

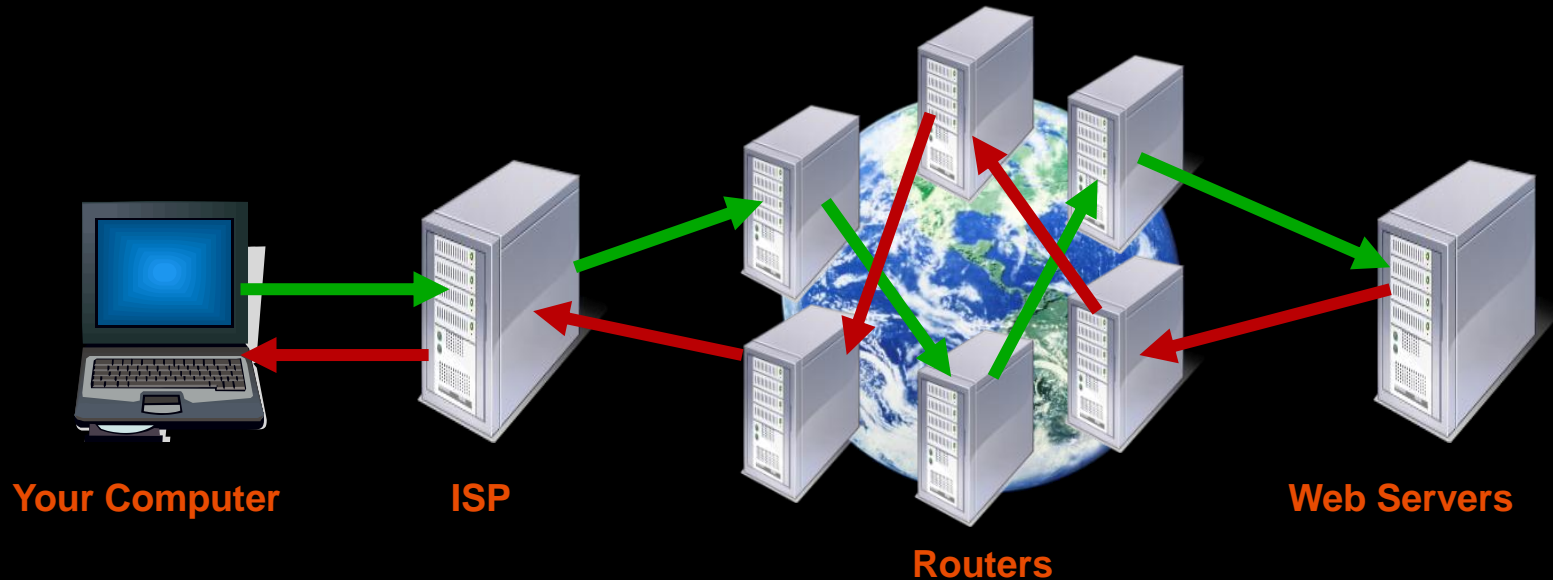
## How Information Travel Through the Internet



A page on the Internet—whether it's full of words, images or both—doesn't come to you in one shipment. It's translated into digital information, chopped into 1500 byte pieces called **PACKETS**, and sent to you like a puzzle that needs to be reassembled. Each part of the packet has a specific function:

# The Internet

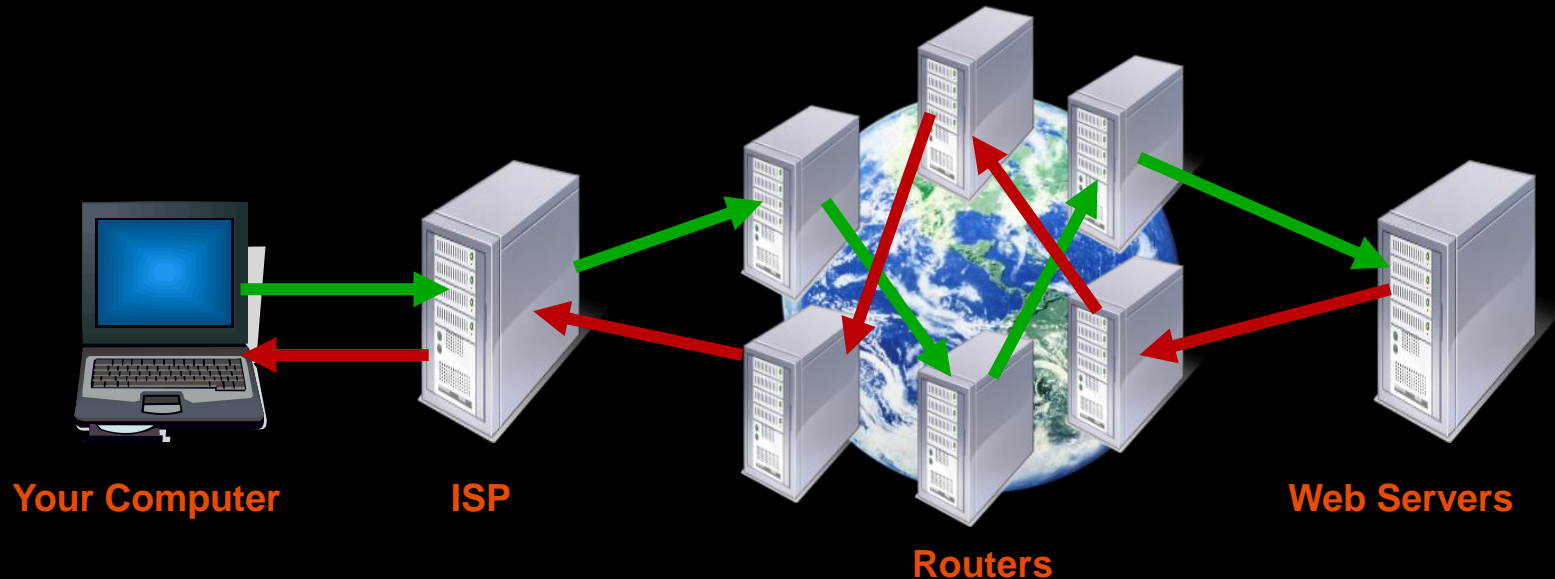
## How Information Travel Through the Internet





# The Internet

## How Information Travel Through the Internet



When you connect to a Web site through an ISP and start exchanging information, there isn't a fixed connection between your computer and the Web server computer hosting the Web site. Instead, **information is exchanged using the best possible path at that particular time.** Special computers called routers determine these paths, avoiding slow links and favoring fast ones.

# Web Servers

## IP Addresses

“IP” stands for Internet Protocol. IP Addresses serve as the location of websites on the Internet as well as the workstations that are connected to the web. IP addresses are made up of four sets of numbers called “**Octets**”. There are two types of IP Addresses: Static and Temporary. Below is a description of both.

# Web Servers

## IP Addresses

“IP” stands for Internet Protocol. IP Addresses serve as the location of websites on the Internet as well as the workstations that are connected to the web. IP addresses are made up of four sets of numbers called “**Octets**”. There are two types of IP Addresses: Static and Temporary. Below is a description of both.

### Static IP Addresses

Static IP addresses are found only on servers and remain the same.

**A Domain Name Server** assigns a “human readable” web address to each static IP address to make it more user friendly.

### Temporary IP Addresses

Temporary IP addresses are found only on PC’s are constantly changing each time it is logged on.

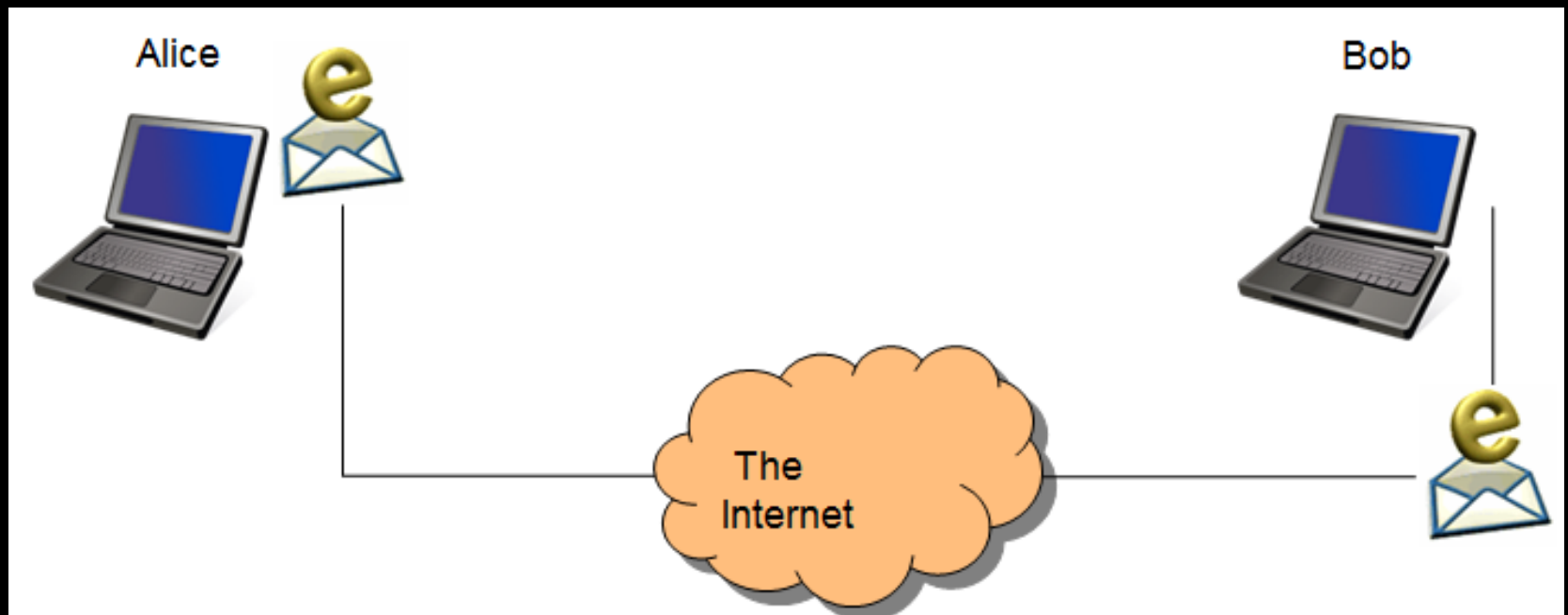
Temporary IP addresses are assigned by an ISP (Internet Service Provider) each time it is logged on to the Internet.

# Intranet vs. Internet

- **Intranet**
  - A private network that is contained within an enterprise
  - Could be LANs and WANs
- **Internet**
  - A public network of networks
- Both are using TCP/IP

# Packets

- A small chunk of data transmitted over the Internet



# VPN (Virtual Private Network)

- A secure tunnel to a private network through a public network
- Once established, local node appears to be a node in the private network in a secure manner

# Host & IP Address

“A host is a computer connected directly to the Internet”

- Each host needs an IP address
- IP address
  - A 32-bit number, arranged in 4 numbers seperated by “.”
  - Eg. 74.125.19.147

# DNS (Domain Name System)

- Domain name to IP address conversion
  - Eg. [www.google.com](http://www.google.com) → ??.???.???.??
- Domain name or IP address lookup
  - <http://cqcouneter.com/whois/>



# Top-level Domains

- gTLDs (generic TLDs)
  - .com, .edu, .net, .org, .gov, .mil
  - .aero, .biz, .coop, .info, .museum, .name, .pro
- ccTLDs (country code TLDs)
  - .au, .ca, .br, .de, .fi, .fr, .jp, .hk, .cn, .tw, .my, ...
  - .us

# Second-level Domains

- Domains that are directly below a TLD
- Eg.
  - ucr.edu
  - google.com
  - sony.co.jp
  - iiits.ac.in
- Must apply to a registrar for the appropriate TLD

# Acknowledgements

David Phenix  
WeeSan Lee