Basic Computer Programming and Networking

Computer Network and Communication

Definitions

- 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.

Advantages of networking

- Connectivity and Communication
- Data Sharing
- Hardware Sharing
- Internet Access
- Internet Access Sharing
- Data Security and Management
- Performance Enhancement and Balancing
- Entertainment

The Disadvantages (Costs) of Networking

Network Hardware, Software and Setup Costs

Hardware and Software Management and Administration Costs

Undesirable Sharing

Illegal or Undesirable Behavior

Data Security Concerns

Fundamental Network Classifications

Local Area Networks (LANs)

Wide Area Networks (WANs)

Metropolitan Area Network (MAN)

Fundamental Network Classifications

Local Area Networks (LANs):

A **local area network (LAN)** is a computer network covering a small geographic area, like a home, office, or group of buildings

Wide Area Networks (WANs):

Wide Area Network (**WAN**) 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

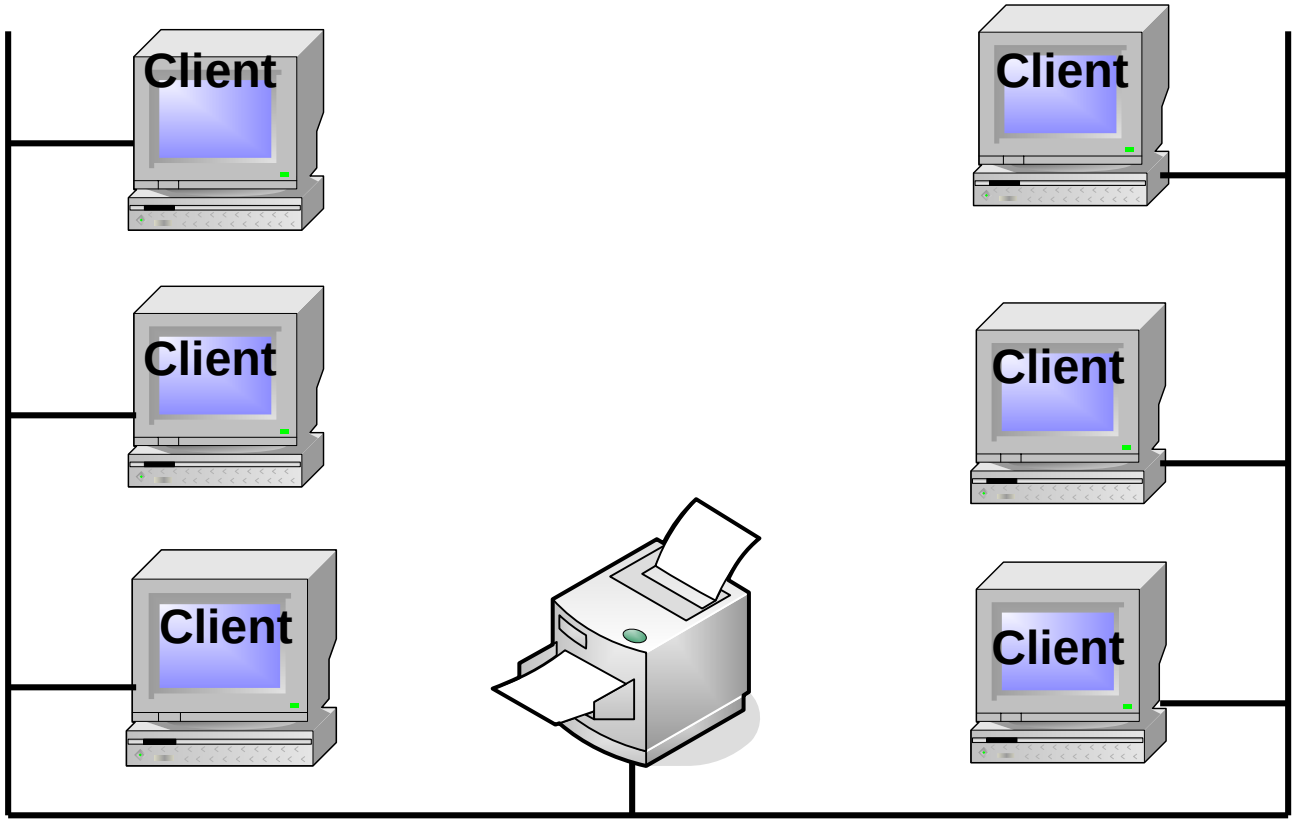
The largest and most well-known example of a WAN is the Internet.

Metropolitan area network (MAN)

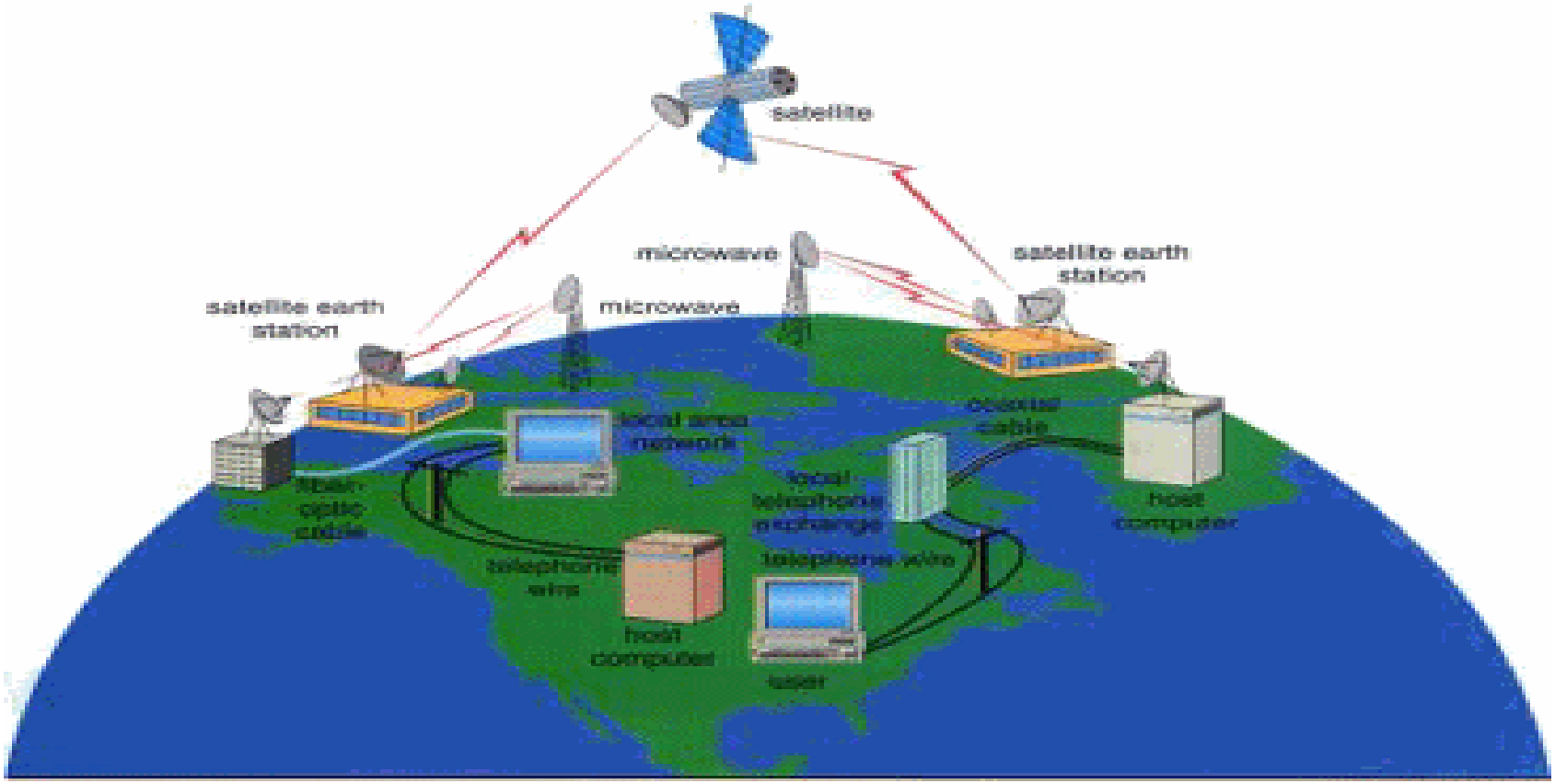
- Network that **interconnects users with computer resources in a geographic area or region larger than that covered by even a large local area network (LAN)** but **smaller than the area covered by a wide area network (WAN).**

- 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).

The Local Network (LAN)

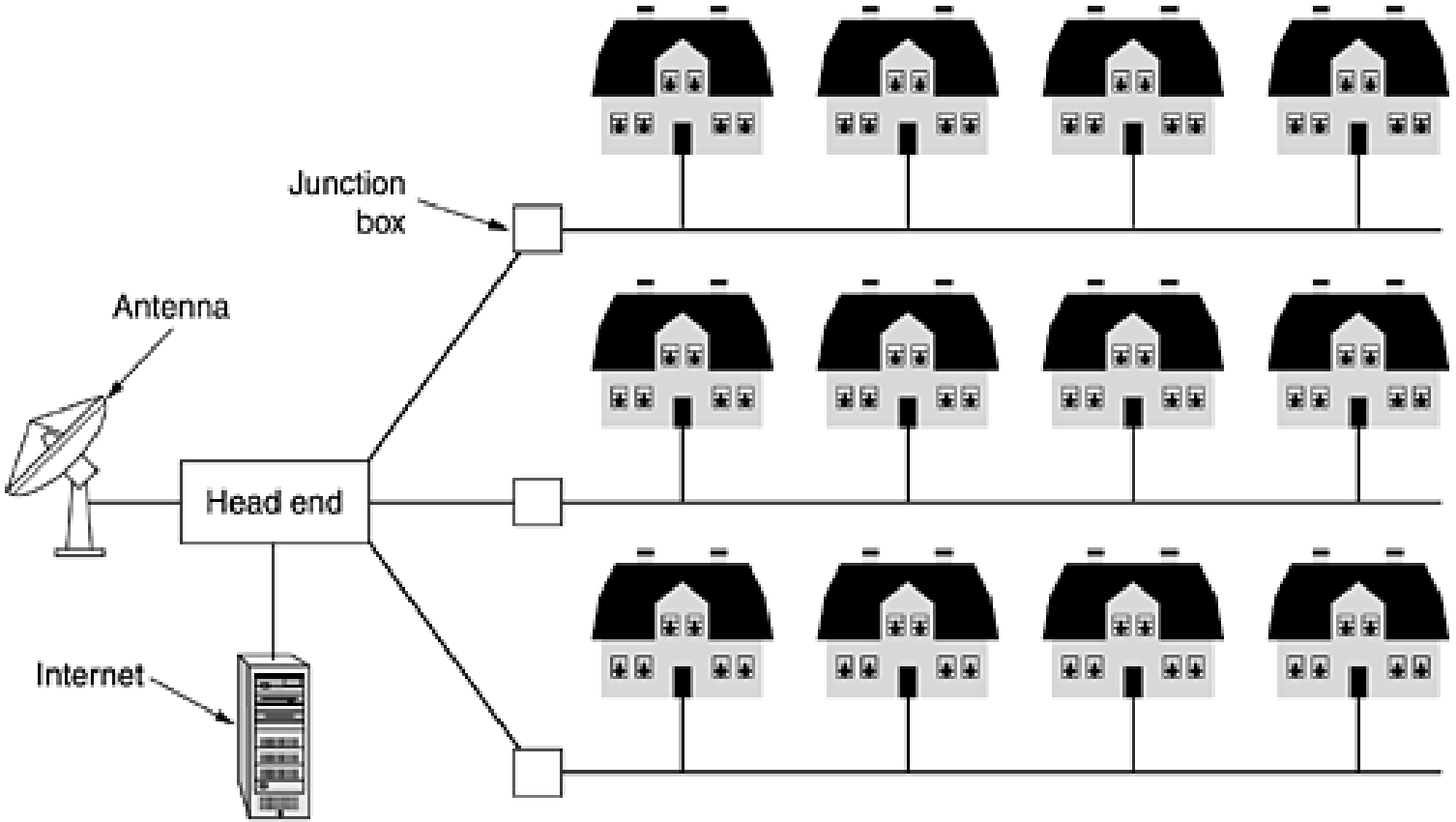


Wide Area Network



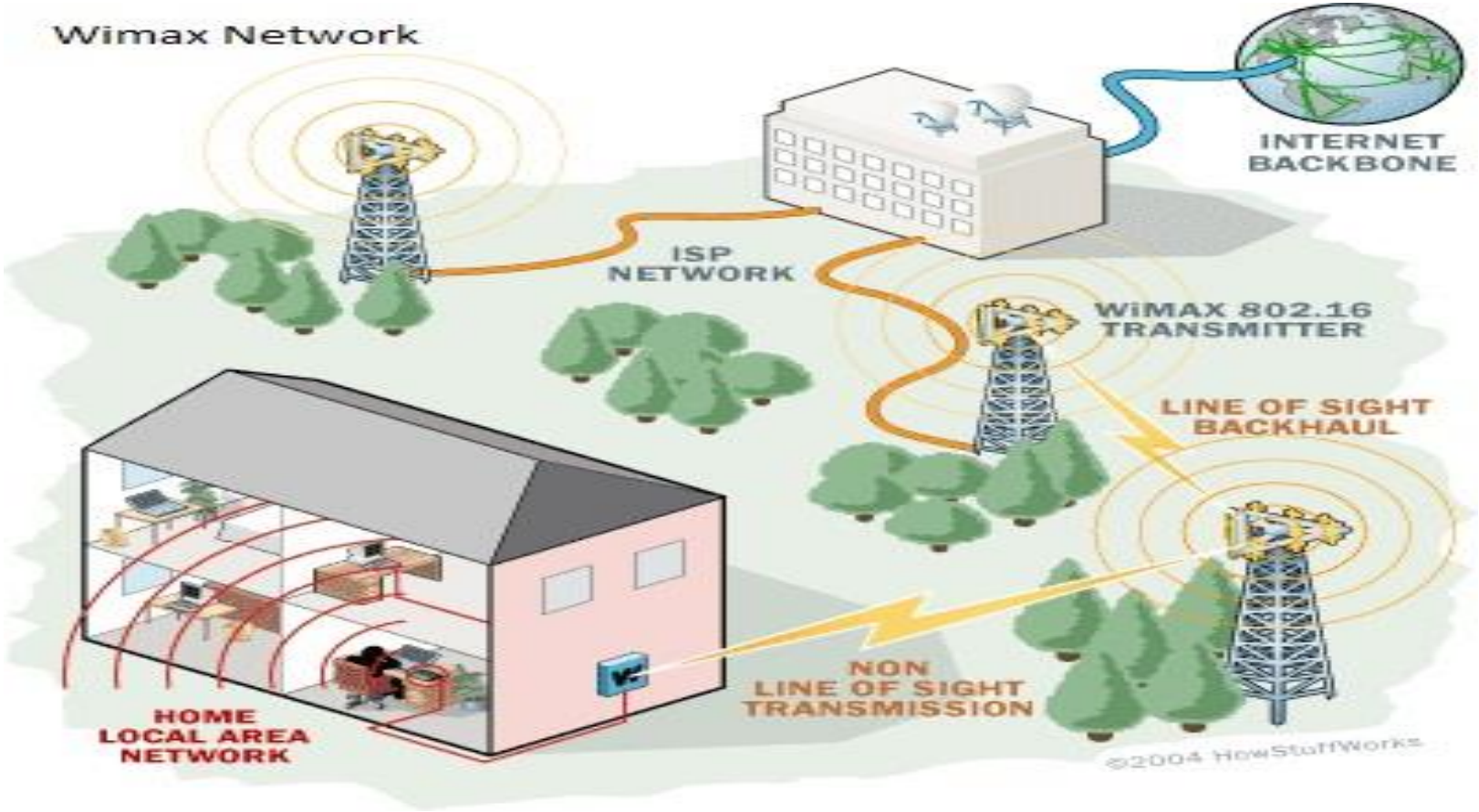
Metropolitan Area Network (MAN)

Cable TV network is wired MAN



Metropolitan Area Network (MAN)

Wimax Network is a Wireless MAN



Types of Networks

Client Server Network

Peer to Peer Network

Client and Server computer role in networking

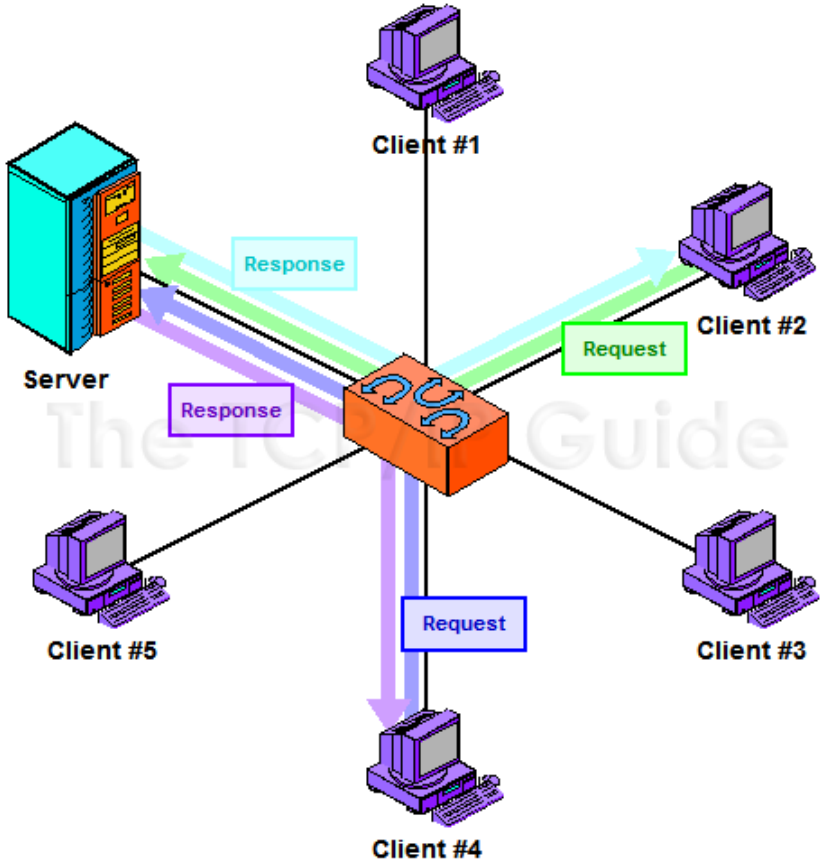
Server computer is a core component of the network, providing links to the resources necessary to perform any task.

Client computers normally request and receive information over the network.

Client/Server Networking

In this design, a small number of computers are designated as centralized *servers* and given the task of providing services to a larger number of user machines called *clients*

Client/Server Networking (cont.)



Peer-to peer network

A peer-to-peer network is a network where the computers act as both workstations and servers.

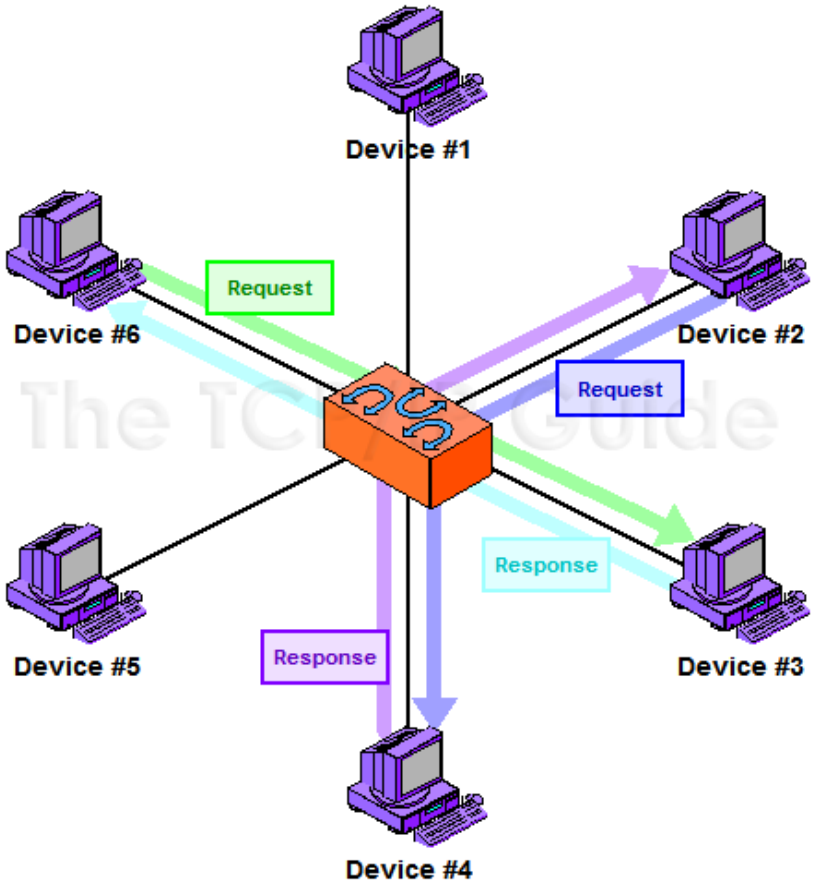
great for small, simple, and inexpensive networks.

In a strict peer-to-peer networking setup, every computer is an equal.

Each machine can have resources that are shared with any other machine.

There is no assigned role for any particular device, and each of the devices usually runs similar software. Any device can and will send requests to any other.

Peer-to peer network (cont.)



Network topology

A *topology* is a way of "laying out" the network. Topologies can be either physical or logical.

Physical topologies describe how the cables are run.

Logical topologies describe how the network messages travel

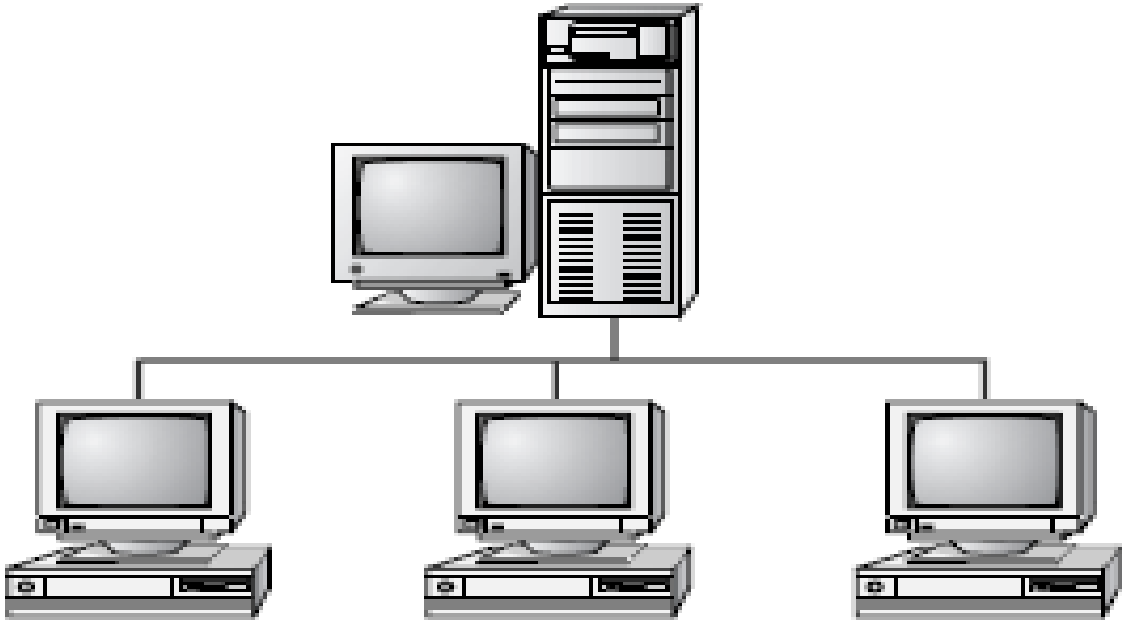
Network topology (cont.)

Physical topologies

- Bus
- Star
- Ring
- Mesh

Network topology (cont.)

Bus topology



Network topology (cont.)

Bus

- A bus is the simplest physical topology. It consists of a single cable that runs to every workstation
- This topology uses the least amount of cabling, but also covers the shortest amount of distance.
- Each computer shares the same data and address path.
- With a logical bus topology, messages pass through the trunk, and each workstation checks to see if the message is addressed to itself. If the address of the message matches the workstation's address, the network adapter copies the message to the card's on-board memory.

Network topology (cont.)

it is difficult to add a workstation

if any one of the cables breaks, the entire network is disrupted (single point of failure) Therefore, it is very expensive to maintain.

Network topology (cont.)

Star Topology

A physical star topology branches each network device off a central device called a *hub*, making it very easy to add a new workstation.

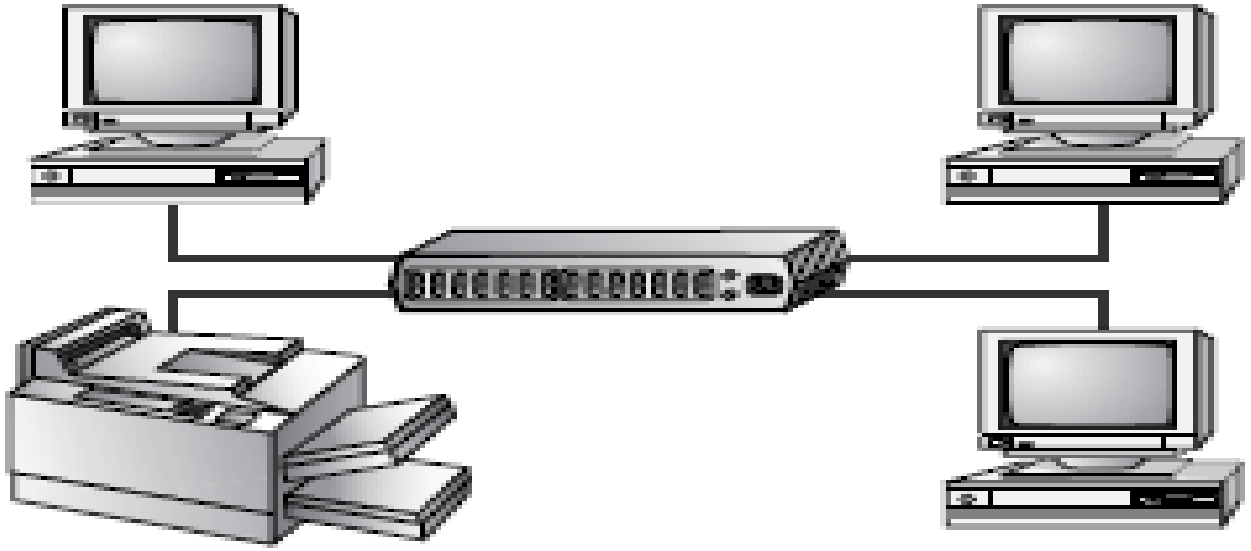
Also, if any workstation goes down it does not affect the entire network. (But, as you might expect, if the central device goes down, the entire network goes down.)

Star topologies are easy to install. A cable is run from each workstation to the hub. The hub is placed in a central location in the office.

Network topology (cont.)

Star topologies are more expensive to install than bus networks, because there are several more cables that need to be installed, plus the cost of the hubs that are needed.

The primary disadvantage of the star topology is that the hub represents a single point of failure



Network topology (cont.)

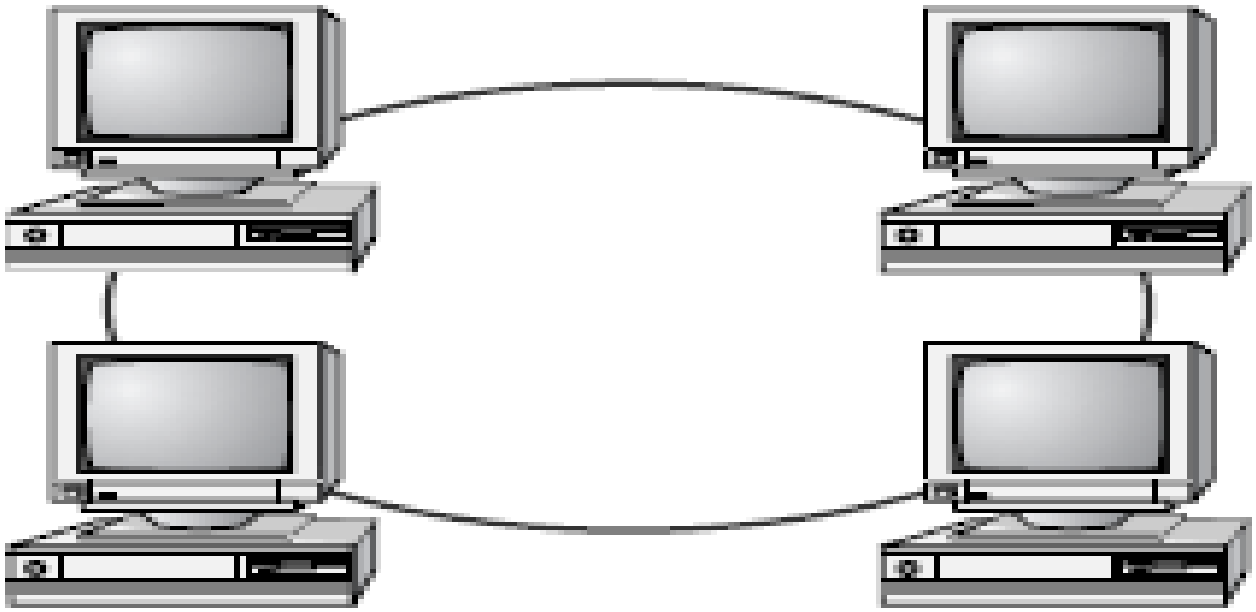
Ring

A network topology that is set up in a circular fashion in which data travels around the ring in one direction and each device on the ring acts as a repeater to keep the signal strong as it travels

Each entity participating in the ring reads a message, then regenerates it and hands it to its neighbor on a different network cable.

Network topology (cont.)

Ring Topology



Network topology (cont.)

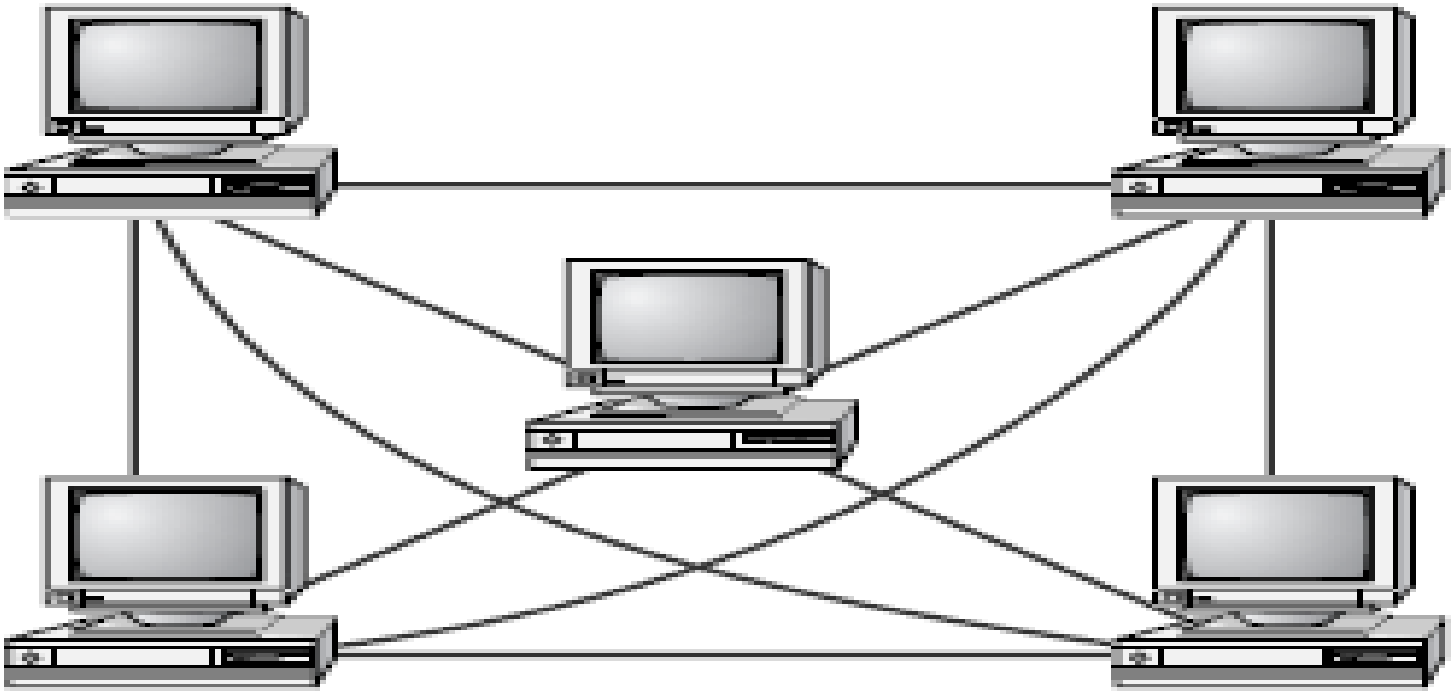
The ring topology makes it difficult to add new computers.

Unlike a star topology network, the ring topology network will go down if one entity is removed from the ring.

Physical ring topology systems don’t exist much anymore, mainly because the hardware involved was fairly expensive and the fault tolerance was very low.

Network topology (cont.)

Mesh Topology



Network topology (cont.)

Mesh

- The mesh topology is the simplest logical topology in terms of data flow, but it is the most complex in terms of physical design.
- In this physical topology, each device is connected to every other device
- This topology is rarely found in LANs, mainly because of the complexity of the cabling.

Network topology (cont.)

If there are x computers,

Cables running on the mesh network

$$(x \times (x–1)) \div 2$$

For example, if you have five computers in a mesh network,

$$5 \times (5 – 1) \div 2 = 10 \text{ cables.}$$

This complexity is compounded when you add another workstation.

Network topology (cont.)

Because of its design, the physical mesh topology is very expensive to install and maintain.

Cables must be run from each device to every other device. The advantage you gain from it is its high fault tolerance.

With a logical mesh topology, however, there will always be a way of getting the data from source to destination.

It may not be able to take the direct route, but it can take an alternate, indirect route. It is for this reason that the mesh topology is still found in WANs to connect multiple sites across WAN links. It uses devices called *routers* to search multiple routes through the mesh and determine the best path.

Network topology (cont.)

Advantages and Disadvantages of Network Topologies

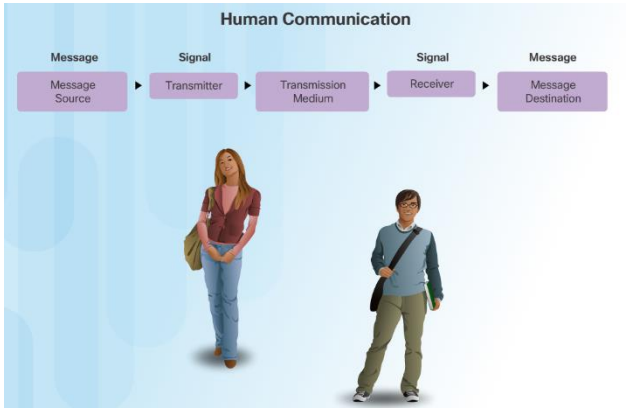
Topology	Advantages	Disadvantages
Bus	Cheap. Easy to install.	Difficult to reconfigure. Break in bus disables entire network.
Star	Cheap. Easy to install. Easy to reconfigure. Fault tolerant.	More expensive than bus.
Ring	Efficient. Easy to install.	Reconfiguration difficult. Very expensive.
Mesh	Simplest. Most fault tolerant.	Reconfiguration extremely difficult. Extremely expensive. Very complex.

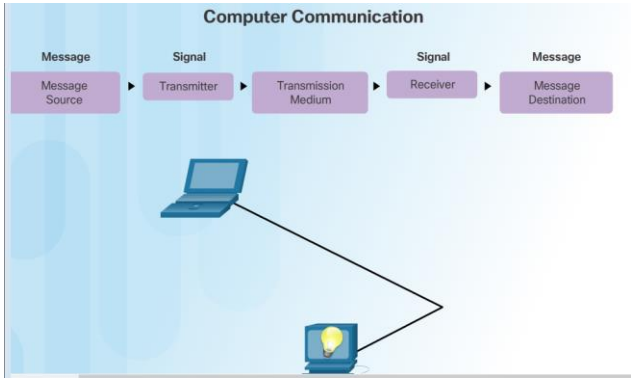
Communication Fundamentals

All communication methods have three elements in common:

- Source or sender
- Destination or receiver
- Channel or media

Rules or protocols govern all methods of communication.

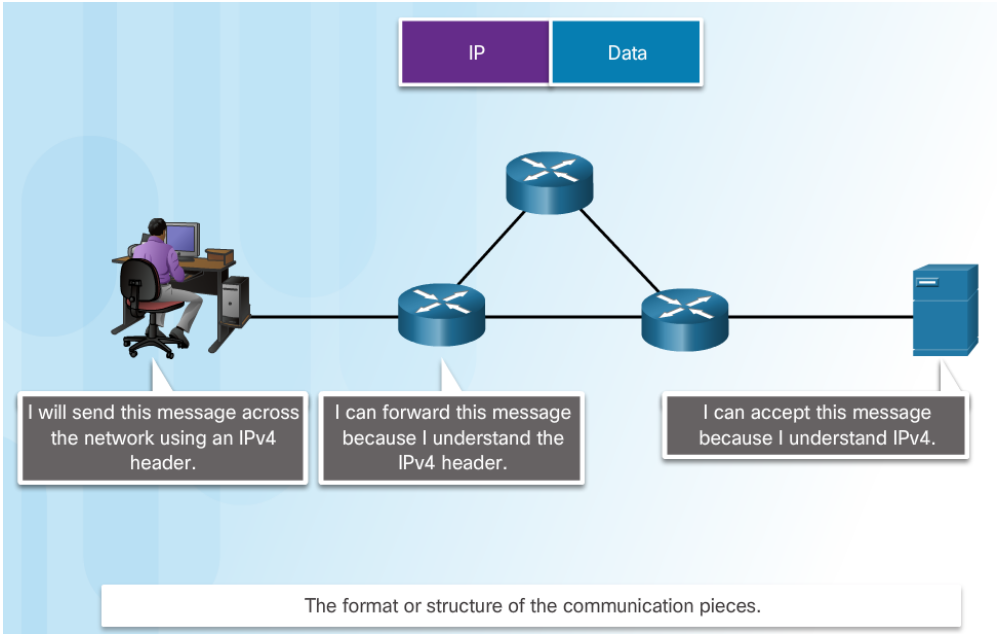




Network Protocols

Networking protocols define a common format and set of rules for exchanging messages between devices.

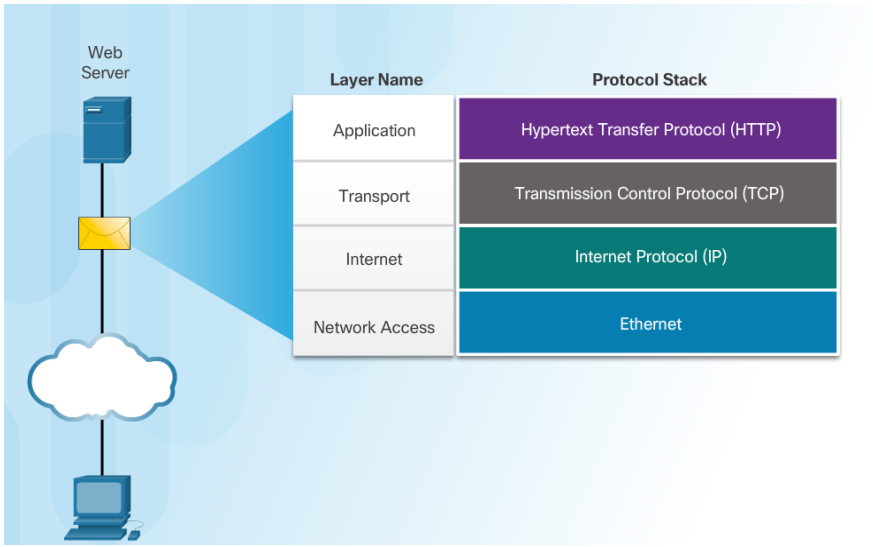
Some common networking protocols are Hypertext Transfer Protocol (HTTP), Transmission Control Protocol (TCP), and Internet Protocol (IP).



Protocol Interaction

Communication between a web server and web client is an example of an interaction between several protocols:

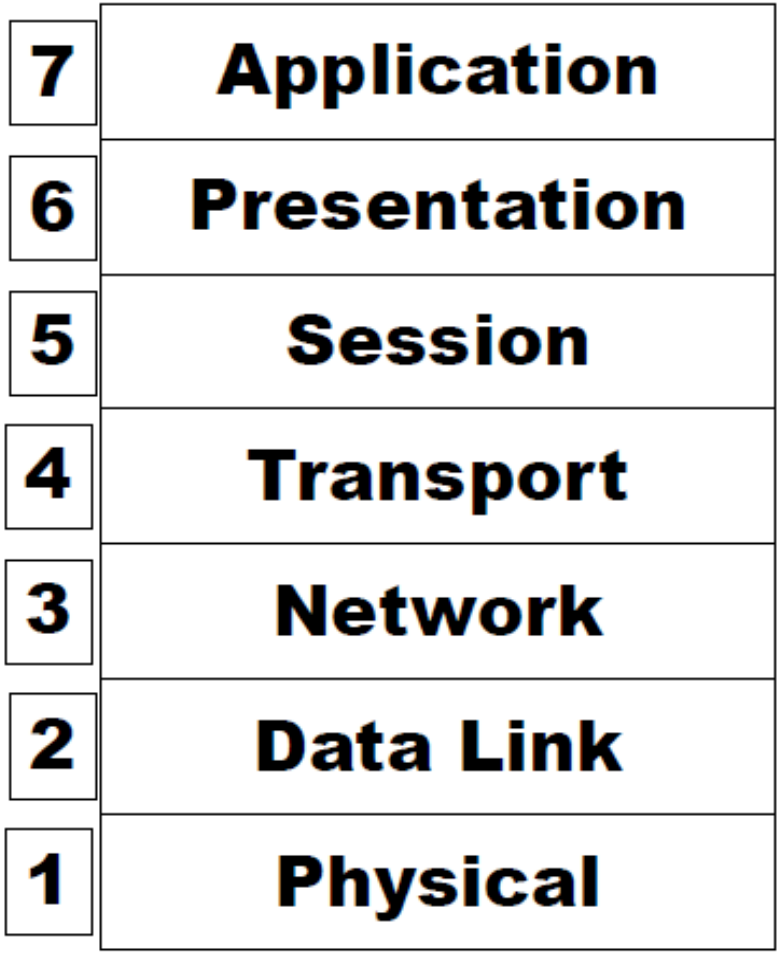
- **HTTP -** an application protocol that governs the way a web server and a web client interact.
- **TCP** - transport protocol that manages the individual conversations.
- **IP –** encapsulates the TCP segments into packets, assigns addresses, and delivers to the destination host.
- **Ethernet** - allows communication over a data link and the physical transmission of data on the network media.



Introducing OSI reference model

- OSI - “ Open Systems Interconnection".
- OSI model was first introduced in 1984 by the International Organization for Standardization (ISO).
- In the OSI model, The specifications needed are contained in 7 different layers that interact with each other.
- Each layer provides a set of functions to the layer above, and relies on the functions of the layer below

OSI Reference Model



OSI Layers

Physical Layer

Concerned with transmission of unstructured bit stream over physical medium. Deals with the mechanical, electrical, functional, and procedural characteristics to access the physical medium.

Data Link Layer

Provides for the reliable transfer of information across the physical link. Sends blocks (frames) with the necessary synchronization, error control, and flow control.

Network Layer

Provides upper layers with independence from the data transmission and switching technologies used to connect systems. Responsible for establishing, maintaining, and terminating connections.

Transport Layer

Provides reliable, transparent transfer of data between end points; provides end-to-end error recovery and flow control.

Session Layer

Provides the control structure for communication between applications; establishes, manages, and terminates connections (sessions) between cooperating applications.

Presentation Layer

Provides independence to the application processes from differences in data representation (syntax).

Application Layer

Provides access to the OSI environment for users and also provides distributed information services.

TCP/IP Model Development

In late-60s,United state - Defense Advance Research Projects Agency (DARPA) originally developed Transmission Control Protocol/Internet Protocol (TCP/IP) to interconnect various defense department computer networks.

The Internet, an International Wide Area Network, uses TCP/IP to connect networks across the world.

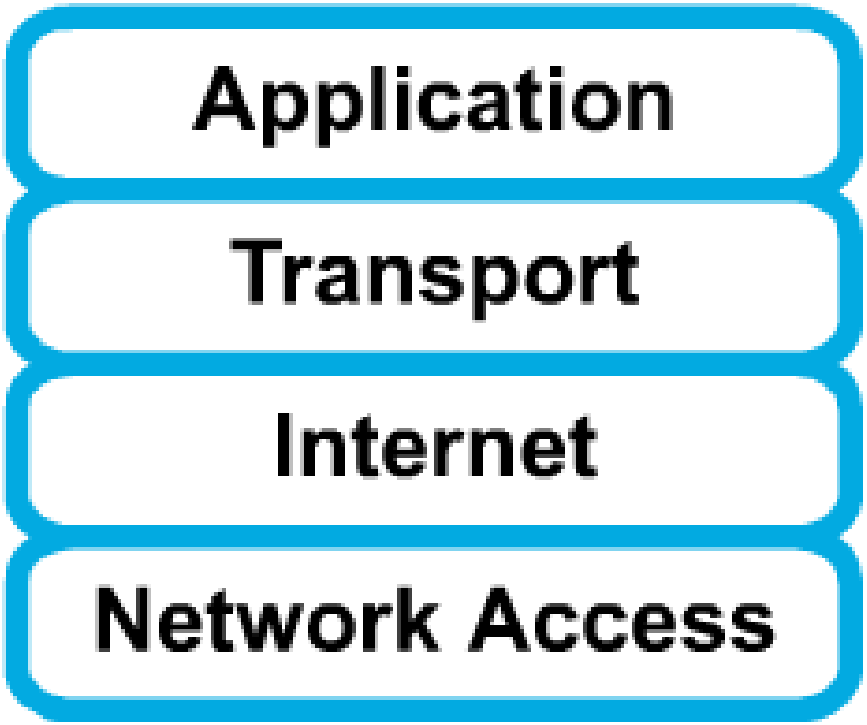
Layers of the TCP/IP model

Layer 4: Application

Layer 3: Transport

Layer 2: Internet

Layer 1: Network access



Network Access Layer

Concerned with all of the issues that an IP packet requires to actually make the physical link.

Electrical, mechanical, procedural and functional specifications.

Frames, physical addressing.

Synchronization, flow control, error control

Internet Layer

Send source packets from any network on the internetwork and have them arrive at the destination independent of the path and networks they took to get there.

Packets, Logical addressing.

Internet Protocol (IP).

Route , routing table, routing protocol.

Transport layer

The transport layer deals with the quality-of-service issues of reliability, flow control, and error correction.

Segments, data stream, datagram.

Transmission control protocol (TCP).

User datagram protocol (UDP).

End-to-end flow control.

Error detection and recovery.

Application Layer

Handles high-level protocols, issues of representation, encoding, and dialog control.

The TCP/IP combines all application-related issues into one layer, and assures this data is properly packaged for the next layer.

- FTP, HTTP, DNS
- Format of data, data structure, encode
- Dialog control, session management