MURANG'A UNIVERSITY OF TECHNOLOGY
DEPARTMENT OF IT

SIT404: CLIENT SERVER SYSTEMS
CREDIT HOURS: 3 HOURS

COURSE NOTES – 2020/2021

CLIENT SERVER MODELS

Recall:- A distributed system is one in which both data and transaction processing are divided between one or more computers connected by a network, each computer playing a specific role in the system

The client-server model, or client-server architecture, is a distributed application framework dividing tasks between servers and clients, which either reside in the same system or communicate through a computer network or the Internet.

It is a distributed application structure that partitions task or workload between the providers of a resource or service, called servers, and service requesters called clients

CLIENT SERVER MODELS

A Client or a Server is so named depending on the extent to which the processing is shared between the client and server.

i) A thin client is one that conducts a minimum of processing on the client side
ii) A fat client is one that carries a relatively larger proportion of processing load.

The concept of Fat Clients or Fat Servers is given by one of the important criterion, that is, how much of an application is placed at the client end vs. the server end.

Thus the client/server models can be distinguished by the service they provide and how the distributed application is split between the client and the server.

FAT SERVER MODEL

This architecture places more application functionality on the client machine(s). They are used in traditional of Client/Server models. Their use can be a maintenance headache for Client/Server systems.

Characteristics of this model are:

=> Place more functions on the server

=> Usually used for the mission-critical applications.

=>Applications are easier to manage on the network as most of the work is done on the server.

=>The fat servers create abstract level of services by which the network interchange is minimized.

=>The Transaction Servers and the Object Server embed the concept of encapsulation of database by exporting the procedure/ methods, which act on the data instead of the raw data.

=>The client interacts with such fat servers using the remote procedure call.

=>The examples are the Groupware, Transaction Servers, and Web Servers

FAT CLIENT MODEL

This architecture places more application functionality on the server machine(s). Typically, the server provides more abstract, higher level services. The current trend is more towards fat servers in Client/Server Systems.

In that case, the client is often found using a fast web browser.

The biggest advantage of using the fat server is that it is easier to manage because only the software on the servers needs to be changed, whereas updating potentially thousands of client machines is a real headache.

CHARACTERISTICS OF FAT CLIENT INCLUDE

=> Places more function on the client. In a client/server architecture, a client that performs the bulk of the data processing operations. The data itself is stored on the server.

=> They are the traditional form of the client/server systems

=>They are generally used for decision support and personal software

=>They lead to the creation of the front-end tools and applications.

=>The best places are – the file server and the database server models where the client knows how the data is organized and stored on the server.

CLIENT/SERVER: STATELESS OR STATEFUL

Stateless Server

=> A stateless server is a server that treats each request as an independent transaction that is unrelated to any previous request.

=> The biggest advantage of stateless is that it simplifies the server design because it does not need to dynamically allocate storage to deal with conversations in progress or worry about freeing it if a client dies in mid-transaction.

=> There is also one disadvantage that it may be necessary to include more information in each request and this extra information will need to be interpreted by the server each time.

=> An example of a stateless server is a World Wide Web server.

STATEFUL SERVER

=> Client data (state) information are maintained by server on status of ongoing interaction with clients and the server remembers what client requested previously and at last maintains the information as an incremental reply for each request.

=> The advantages of stateful server is that requests are more efficiently handled and are of smaller in size.

=> Some disadvantages are their like state information becomes invalid when messages are unreliable.

=> Another disadvantage is that if clients crash (or reboot) frequently, state information may exhaust server's memory.

=> The best example of stateful server is remote file server.

COMPARISON BETWEEN STATELESS & STATEFUL SERVERS

There are some comparative analysis about stateless and stateful servers.

=> A stateful server remembers client data (state) from one request to the next.

=> A stateless server keeps no state information. Using a stateless file server, the client must specify complete file names in each request specify location for reading or writing and re-authenticate for each request.

=> Using a stateful file server, the client can send less data with each request. A stateful server is simpler.

SERVERS AND MAINFRAMES

From a hardware perspective, a mainframe is not greatly different from a personal computer. The CPU inside a mainframe was, however, much faster than a personal computer.

A mainframe was 'larger' in terms of:

=> The raw speed expressed in instructions per second, or cycles.

=> The amount of memory that could be addressed directly by a program.

There is a common believe that a mainframe is 'database'. Reasons behind this belief are:

i) Many servers are either file or database servers running sophisticated database such as Sybase, Oracle and DB2.

ii)These servers connect to the mainframe primarily to access databases.

iii) Organisations use servers specifically to replace mainframe databases.

iv) Organisations keep applications on the mainframe usually for better database performance, integrity and functionality

DIFFERENCE BETWEEN MAINFRAME AND CLIENT/SERVER SYSTEMS

Various other factors, which can have, prime considerations to differentiate the mainframe and *Client/Server systems:*

i) Application development: Mainframe systems are over structured, time-consuming and create application backlogs. On the other hand, PC-based Client/Server systems are flexible, have rapid application development and have better productivity tools.

ii) Data manipulation: Mainframe systems have very limited data manipulation capabilities whereas these techniques are very flexible in the case of Client/Server systems.

iii) System management: Mainframe systems are known to be integrated systems but in the case of Client/Server systems only few tools are available for system management.

iv) Security: Mainframe systems are highly centralized whether as Client/Server systems are relaxed or decentralized.

v) End user platform: Mainframe systems comprise of dumb terminals, are character based, single task oriented and of limited productivity. On the other hand, Client/Server systems are intelligent PC's with graphical user interface having multitasking OS with better productivity tools.

CLIENT/SERVER FUNCTIONS

The main operations of the client system are listed below:

=> Managing the user interface.

=> Accepts and checks the syntax of user inputs.

=> Processes application logic.

=> Generates database request and transmits to server.

=> Passes response back to server.

CLIENT/SERVER FUNCTIONS CONT'D

The main operations of the server are listed below:

=> Accepts and processes database requests from client.

=> Checks authorization.

=> Ensures that integrity constraints are not violated.

=> Performs query/update processing and transmits responses to client.

=> Maintains system catalogue.

=> Provide concurrent database access.

=> Provides recovery control

CLIENT/SERVER TOPOLOGIES

A Client/Server topology refers to the physical layout of the Client/Server network in which all the clients and servers are connected to each other.

This includes all the workstations (clients) and the servers.

The possible Client/Server topological design and strategies used are as follows:

(i) Single client, single server

(ii) Multiple clients, single server

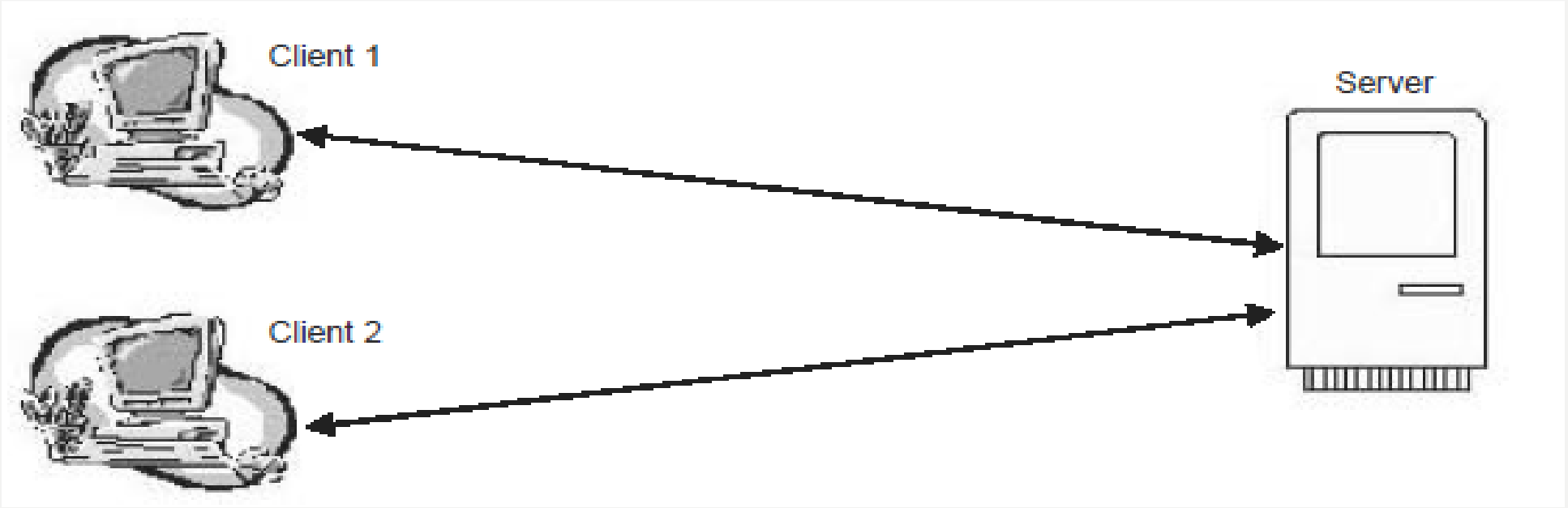
(iii) Multiple clients, multiple servers

SINGLE CLIENT, SINGLE SERVER

(i) This topology is shown in the Fig. 1.7 given below. In this topology, one client is directly connected to one server.

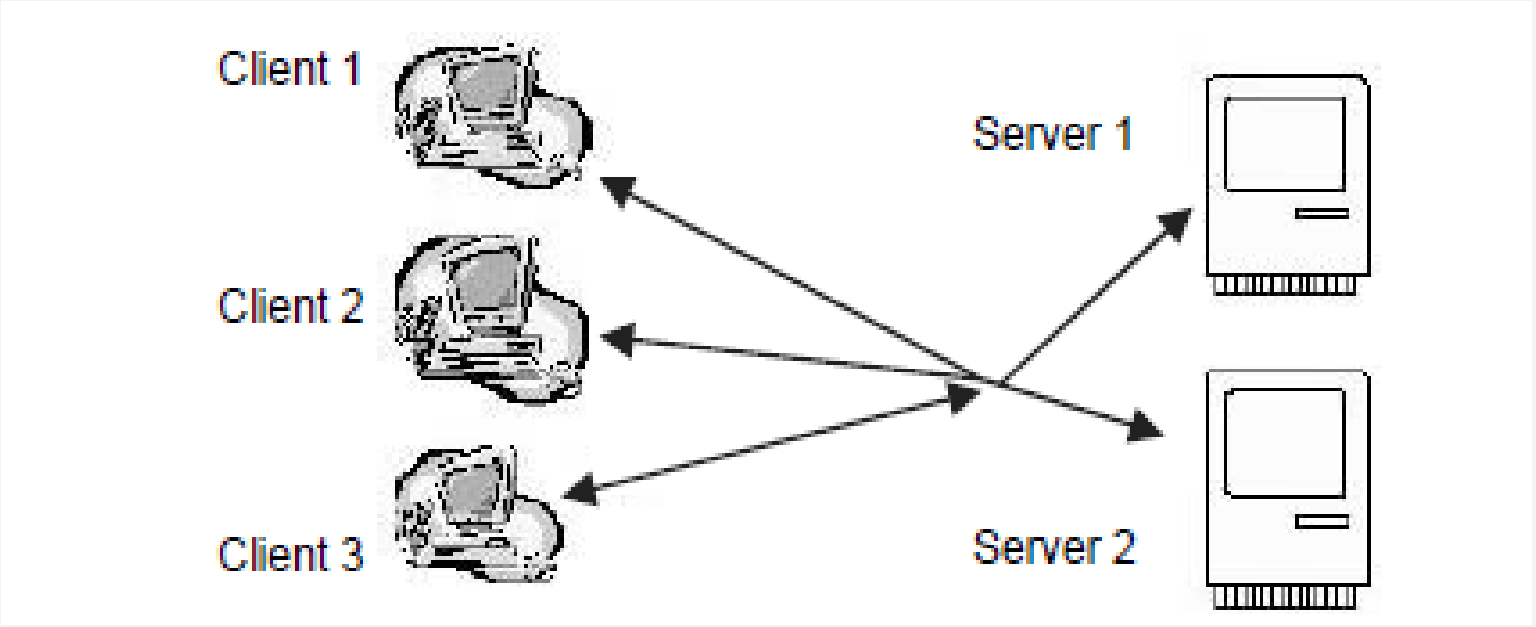
MULTIPLE CLIENTS, SINGLE SERVER

(i) Multiple clients, single server - This topology is shown in the Fig. 1.8 given below. In this topology, several clients are directly connected to only one server.



MULTIPLE CLIENTS, MULTIPLE SERVERS

(i) Multiple clients, multiple servers - This topology is shown in the following Fig. 1.9 In this topology several clients are connected to several servers



CLIENT/SERVER STANDARDS

Standards assure that dissimilar computers, networks, and applications scan interact to form a system.
But what constitutes standards?
A standard is a publicly defined method to accomplish specific tasks or purposes within a given discipline and technology. Standards make networks practical.

Open systems and Client-Server computing are often used as if they were synonymous. It does not make long-term sense for users to adopt a Client/Server environment that is not based on standards.

There are currently very few Client/Server technologies based on standards at every level. Proprietary Client/Server technologies (applications, middleware etc.) will always lock you into a particular supplier. The existing costs are always high

CLIENT/SERVER STANDARDS CONT'D

Failure to appreciate the spectrum of technologies within the Client-Server model, will always lead to dysfunctional Client/Server solutions. This will result in compromises in key areas of any company's Client/Server infrastructure, such as Usability, Security, and Performance.

There are quite a few organizations whose members work to establish the standards that govern specific activities. For example,

i) the Institute of Electrical and Electronics Engineers (IEEE) are dedicated to define the standards in the network hardware environment.
ii) the American National Standards Institute (ANSI) has created standards for programming languages such as COBOL and SQL.
iii) the International Organization for Standardization (ISO) produces the Open System Interconnection (OSI) reference model to achieve network systems communications compatibility.

BENEFITS OF OPEN STANDARDS

i) Standards allow us to incorporate new products and technology with existing I.T. investments — hardware, operating environments, and training, with minimum effort.
ii) Standards allow us to mix and match the 'best of breed' products. Thus databases and development tools, and Connectivity software become totally independent.
iii) Standards allow us to develop modular applications that do not fall apart because the network has been re-configured (e.g., change of topology, or transport protocol etc.), or the graphical user interface standard as changed, or a component-operating environment has changed.
iv) Standards maintain tighter security.
v) Standards reduce the burden of overall maintenance and system administration.
vi) Standards provide faster execution of pre-compiled code.
vii) Standards prevent the database and its application and possibly others on the server from having their response time degraded in a production environment by inefficient queries.

ORGANIZATIONAL EXPETATIONS

As we have already discussed the advantages and disadvantages associated with Client/Server computing, from the organizational point of view the managers are looking for the following Client/Server benefits.

i) Flexibility and adaptability (in regard to technological changes)

ii) Improved employee productivity (ease manipulation of corporate data)

iii) Improved company work flow and a way to re-engineering business operations (providing the right data, to the right people at the right time).

iv) New opportunities to provide competitive advantages.

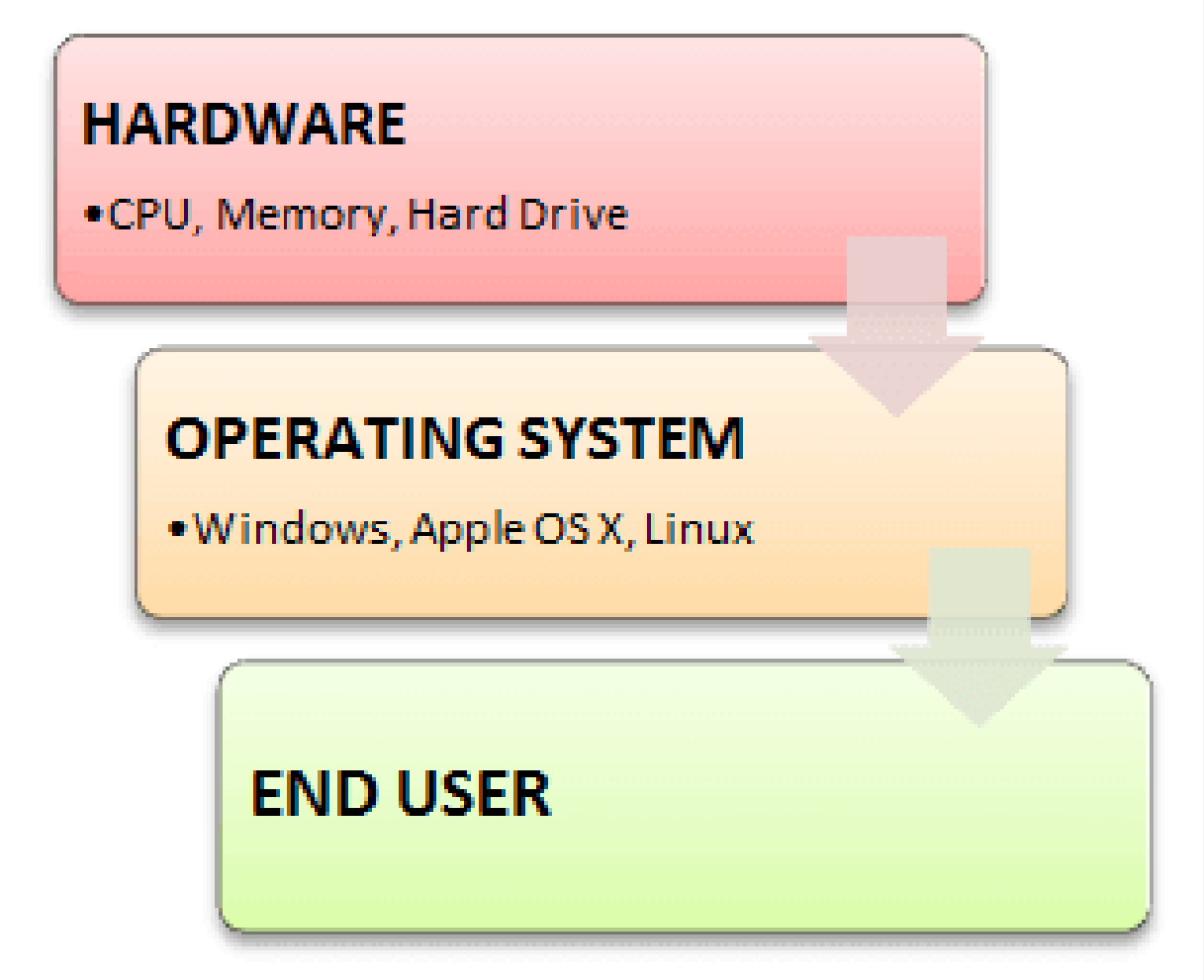
v) Increased customer service satisfaction (efficient handling of customer enquiries)

OPERATING SYSTEMS

An Operating System (OS) is a software that acts as an interface between computer hardware components and the user. Every computer system must have at least one operating system to run other programs. Applications like Browsers, MS Office, Notepad Games, etc., need some environment to run and perform its tasks.

The OS helps you to communicate with the computer without knowing how to speak the computer's language. It is not possible for the user to use any computer or mobile device without having an operating system.

OPERATING SYSTEMS CONT'D



Types of Operating System (OS)

- Batch Operating System
- Multitasking/Time Sharing OS
- Multiprocessing OS
- Real Time OS
- Distributed OS
- Network OS
- Mobile OS

OPERATING SYSTEMS CONT'D

We have identified three components of the client/server systems namely client, network and the server.

For the system to operate properly each one of these components requires an operating system to provide the necessary functionality hence we have client OS, Server OS and network OS

i) Client OS

The client always provides presentation services, all the user Input and Output are presented at client workstation. Software to support specific functions like field edits, context-sensitive help, navigation, training, personal data storage, and manipulation frequently get executed on the client workstation. All these functions use the GUI and windowing functionality

OPERATING SYSTEMS CONT'D

A client workstation uses a local operating system to host both basic services and the network operating system interfaces.

This operating system may be the same or different from that of the server. Numbers of OS are installed depending upon the application and user requirement running on Client/Server environment.

There are various OS in use as a client platform like DOS, Windows 3.1, OS/2, UNIX, Windows NT (New Technology), AIX and Mc systems 7.

The client workstation frequently provides personal productivity functions, such as word processing, which use only the hardware and software resident right on the workstation

OPERATING SYSTEMS CONT'D

When the client workstation is connected to a LAN, it has access to the services provided by the network operating system (NOS) in addition to those provided by the client workstation.

The workstation may load software and save word-processed documents from a server and therefore use the file server functions provided through the NOS.

It also can print to a remote printer through the NOS. The client workstation may be used as a terminal to access applications resident on a host minicomputer or mainframe processor

OPERATING SYSTEMS CONT'D

ii) Servers OS

Servers provide the platform for application, database, and communication services as well as providing and controlling shared access to server resources. Applications on a server must be isolated from each other so that an error in one cannot damage another.

Preemptive multitasking ensures that no single task can take overall the resources of the server and prevent other tasks from providing service. There must be a means of defining the relative priority of the tasks on the server. These requirements are specific to the Client/Server implementation and not to the file server implementation (file servers execute only the single task of file service, therefore can operate in a more limited operating environment without the need for application isolation and preemptive multitasking).

The server is a multiuser computer. There is no special hardware requirement that turns a computer into a server

OPERATING SYSTEMS CONT'D

The hardware platform should be selected based on application demands and economics. There is no pre-eminent hardware technology for the server.
The primary characteristic of the server is its support for multiple simultaneous client requests for service.
Therefore, the server must provide multitasking support and shared memory services.
Servers for Client/Server applications work best when they are configured with an operating system that supports shared memory, application isolation, and preemptive multitasking.
The server is responsible for managing the server-requester interface so that an individual client request response is synchronized and directed back only to the client requester. This implies both security when authorizing access to a service and integrity of the response to the request. Some of the operating system dominating the server world nowadays are NetWare, Windows NT, OS/2, MVS, VMS, and UNIX

OPERATING SYSTEMS CONT'D

iii) Network OS

A Network Operating System (NOS) is a system software that controls a network and its message (e.g., packet) traffic and queues, controls access by multiple users to network resources such as files, and provides for certain administrative functions, including security. Also includes special functions for connecting computers and devices into a local-area network (LAN) or Inter-networking.

A Network Operating System (NOS) is an operating system that has been specifically written to keep networks running at optimal performance with a native structure for use in a network environment

OPERATING SYSTEMS CONT'D

Some of the important features of Network Operating System includes:

- Provide file, print, web services, back-up and replication services.
- Provide basic operating system features such as support for processors, protocols, automatic hardware detection and support multi-processing of applications.
- Security features such as authentication, authorization, logon restrictions and access control.
- Provide name and directory services.
- User management and support for logon and logoff, remote access, system management, administration and auditing tools with graphic interfaces.
- Support Internetworking such as routing and WAN ports.

OPERATING SYSTEMS CONT'D

Some of the components that an NOS usually has built in that a normal operating system might not have are built in NIC (network interface card) support, file sharing, server log on, drive mapping, and native protocol support.

Most operating systems can support all of these components with add-on either by the original manufacture of the operating system or from a third party vendor.

Some of the operating system dominating the networking OS are Novell NetWare, LAN Manager, IBM LAN Server, Banyan VINES etc

NETWORKING

Communication Interface Technology

For the data communication to be taking place on a network, four basic elements are involved there:

=> Sender: the device that creates and transmits the data.

=> Message: the data to be sent. It could be a spreadsheet, database, or document, converted to digital form.

=> Medium: the physical material that connects the devices and carries the data from the sender to the receiver. The medium may consist of an electrical wire or airwaves.

=> Receiver: the destination device for the data.

NETWORKING CONT'D

To communicate with other devices, a sending device must know and follow the rules for sending data to receiving devices on the network.

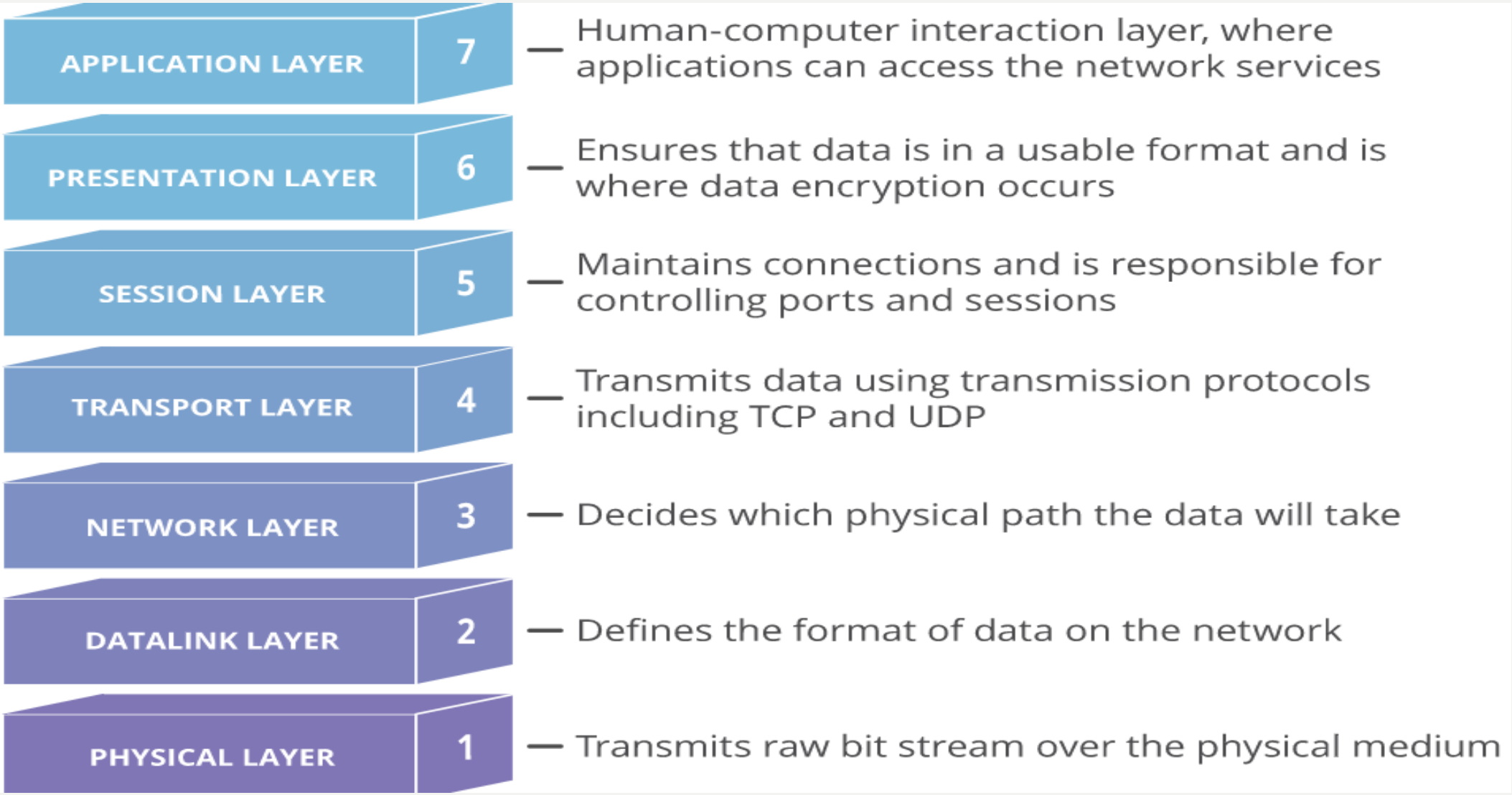
These rules for communication between devices are called protocols.

Numerous standards have been developed to provide common foundations for data transmission.

The International Standards Organization (ISO) has divided the required communication functions into seven levels to form the Open Systems Interconnections (OSI) model.

Each layer in the OSI model specifies a group of functions and associated protocols used at that level in the source device to communicate with the corresponding level in the destination device

NETWORKING CONT'D



NETWORKING CONT'D

Connectivity and interoperability between the client and the server are achieved through a combination of physical cables and devices and software that implements communication protocols.

To communicate on a network the following components are required:

=> A network interface card (NIC) or network adapter.

=>Software driver.

=> Communication protocol stack.

Computer networks may be implemented using a variety of protocol stack architectures, computer buses or combinations of media and protocol layers, incorporating one or more Network Interface Card.

The physical connection from the computer to the network is made by putting a network interface card (NIC) inside the computer and connecting it to the shared cable eg. LAN Cabling, WAN, Ethernet, IEEE NIC, Token Ring, Ethernet and FDDI

NETWORKING CONT'D

i) Network Interface Card

A network interface card is a device that physically connects each computer to a network. This card controls the flow of information between the network and the computer. The circuit board needed to provide network access to a computer or other device, such as a printer.

Network interface cards, or NICs, mediate between the computer and the physical media, such as cabling, over which transmissions travel.

NIC is an adapter card that is installed in the controller that allows it to connect to a network (for example, Ethernet and Token Ring)etc.

The card contains both the hardware to accommodate the cables and the software to use the network's protocols. The NIC is also called a network adapter card.

NETWORKING CONT'D

The connection to the network is made via any one of the following

- Ethernet
- Wi-Fi
- Token – Ring
- ATM

Functions of NIC

=> It acts like a translator, which converts data into a digital signal.

=> Communication can be either by using cable wire or by the router which is wireless over the server network

=> To communicate over a long distance a network adapter is used.

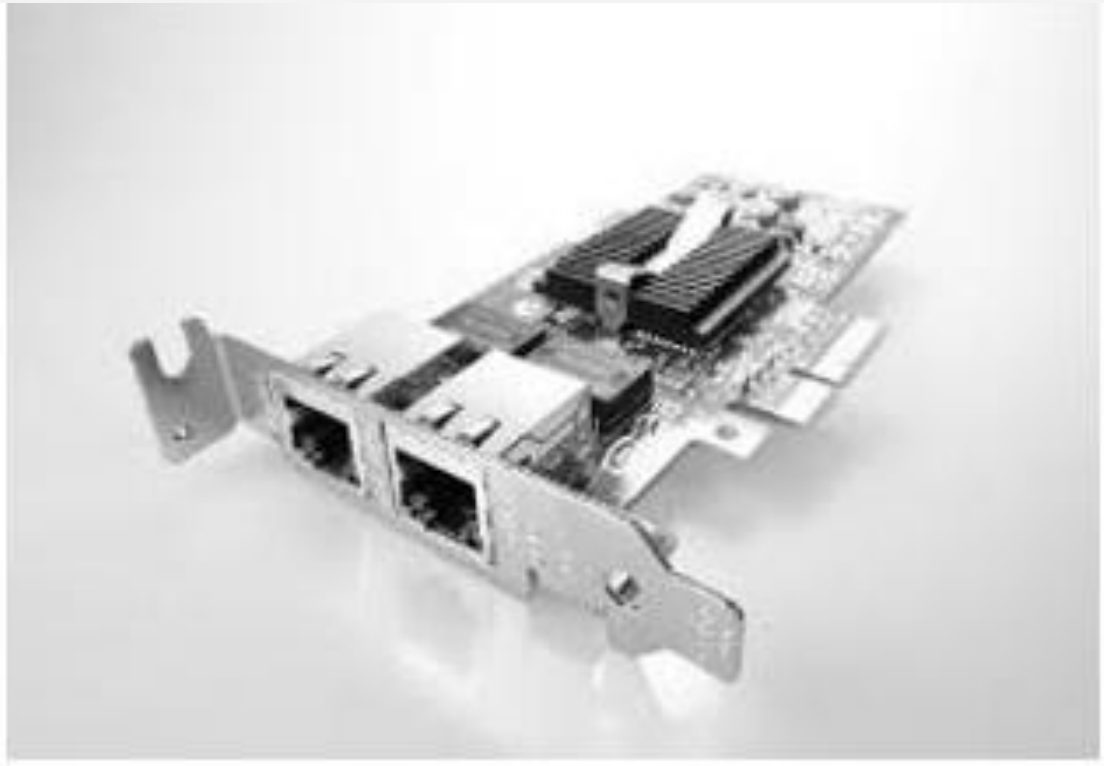
Types of Network Interface Cards

There are two types NIC they are,

i) Ethernet NIC

ii) Wireless Network NIC

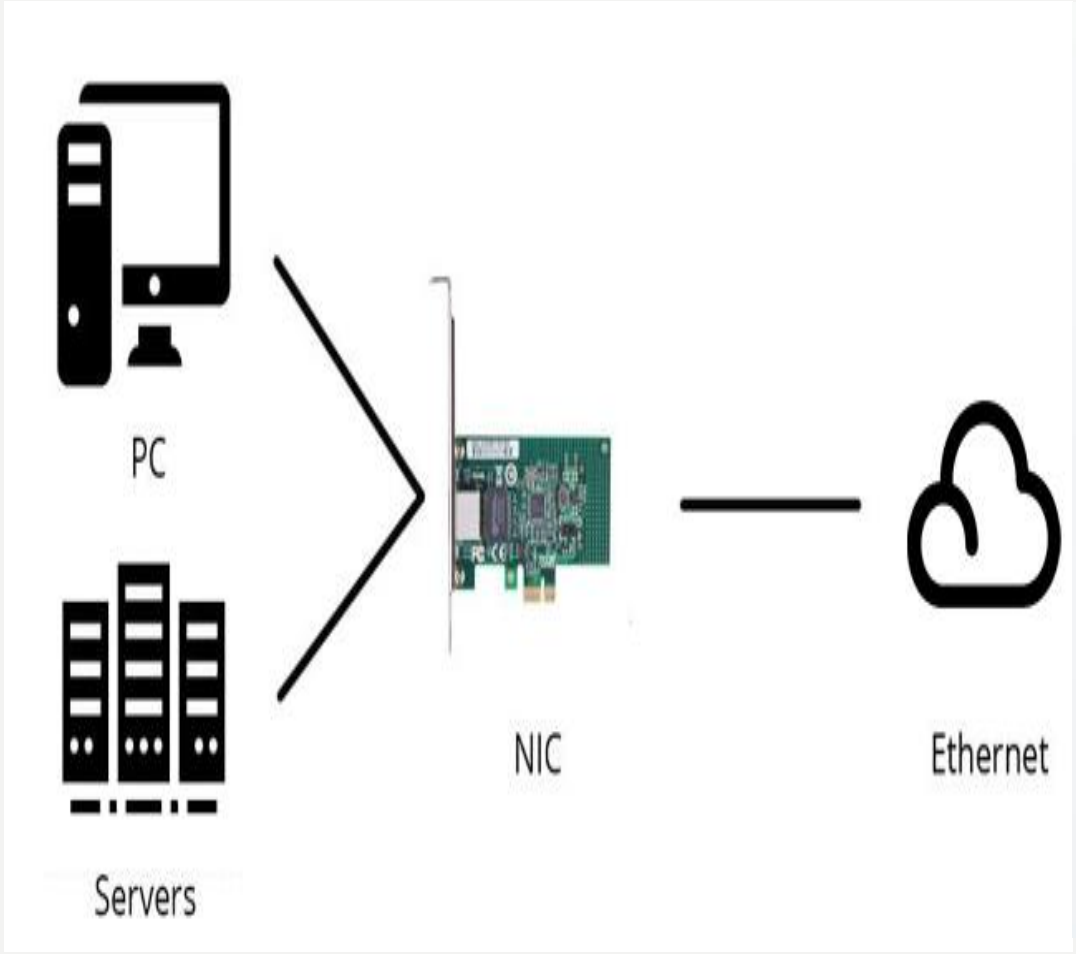
NETWORKING CONT'D



wired-network-interface-card

wireless-network-interface-card

NETWORKING CONT'D



NETWORKING CONT'D

ii) LAN Cabling

A LAN is data communication network, which connects many computers or client workstations and permits exchange of data and information among them within a localized area (2 to 5 Km).

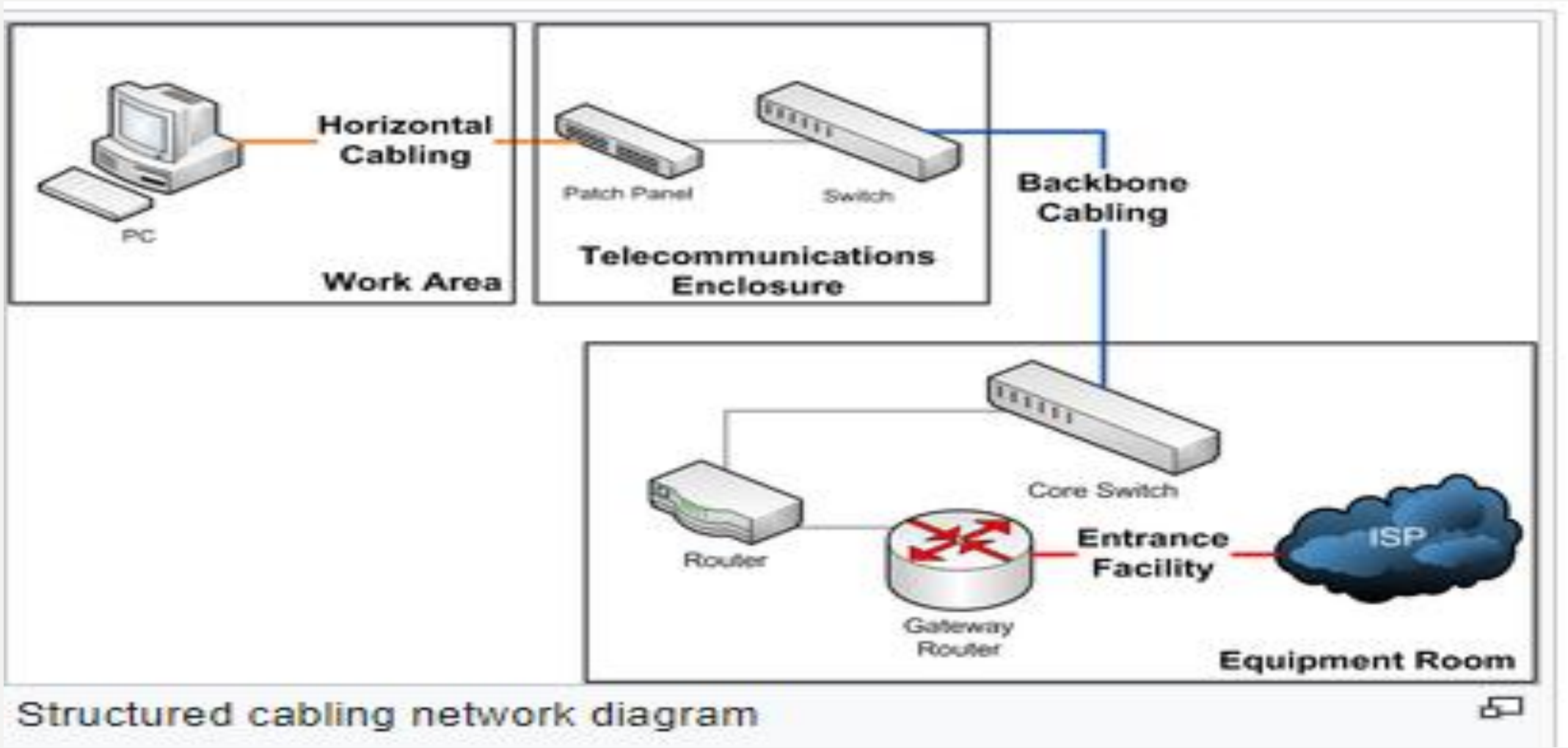
Where all connected devices share transmission media (cable) and also each connection device can work either as stand alone or in the network. Each device connected in the network can communicate with any other device with a very high data transmission rate that is of 1Mbps to 100Mbps.

NETWORKING CONT'D

Due to rapid change in technology, design and commercial applications for the LANs the number of approaches has emerged like High speed wireless LAN fast Ethernet.
As a result, in many applications the volume of data handled over the LAN has been increased. For example in case of centralized server farms there is need for higher speed LAN. There is a need for client system to be able to draw huge amount of data from multiple centralized servers

A structured cabling system is a complete system of cabling and associated hardware, which provides a comprehensive telecommunications infrastructure. This infrastructure serves a wide range of uses, such as to provide telephone service or transmit data through a computer network. It should not be device dependent.

NETWORKING CONT'D



Structured cabling network diagram

NETWORKING CONT'D

iii) WAN

A WAN (Wide area network) is a data communications network that covers a large geographical area such as cities, states or countries.

WAN technologies generally function at the lower three layers of the OSI reference model, the physical layer, the data-link layer, and the network layer.

WAN consists of a number of interconnected switching nodes via telephone line, satellite or microwaves links.

A transmission from any one device is routed through internal nodes to the specific destination device.

In WAN two computing device are not connected directly, a network of 'switching nodes' provides a transfer path and the process of transferring data block from one node to another is called data switching.

Further this switching technique utilizes the routing technology for data transfer.

NETWORKING CONT'D

Whereas the routing is responsible for searching a path between source and destination nodes. Earlier WAN have been implemented using circuit or packet switching technology, but now frame relay, ATM and wireless networks are dominating the technology.

WANs use numerous types of devices that are specific to WAN environments. WAN switches, access servers, bridge, gateway, repeater, brouter, modems, CSU/DSUs and ISDN terminal adapters.

Other devices found in WAN environments that are used in WAN implementations include routers, ATM switches, and multiplexers.

NETWORKING CONT'D

Types of WAN technologies

i) TCP/IP protocol suite. TCP/IP is a protocol suite of foundational communication protocols used to interconnect network devices on today's Internet and other computer/device networks.

ii) Router.

iii) Overlay network.

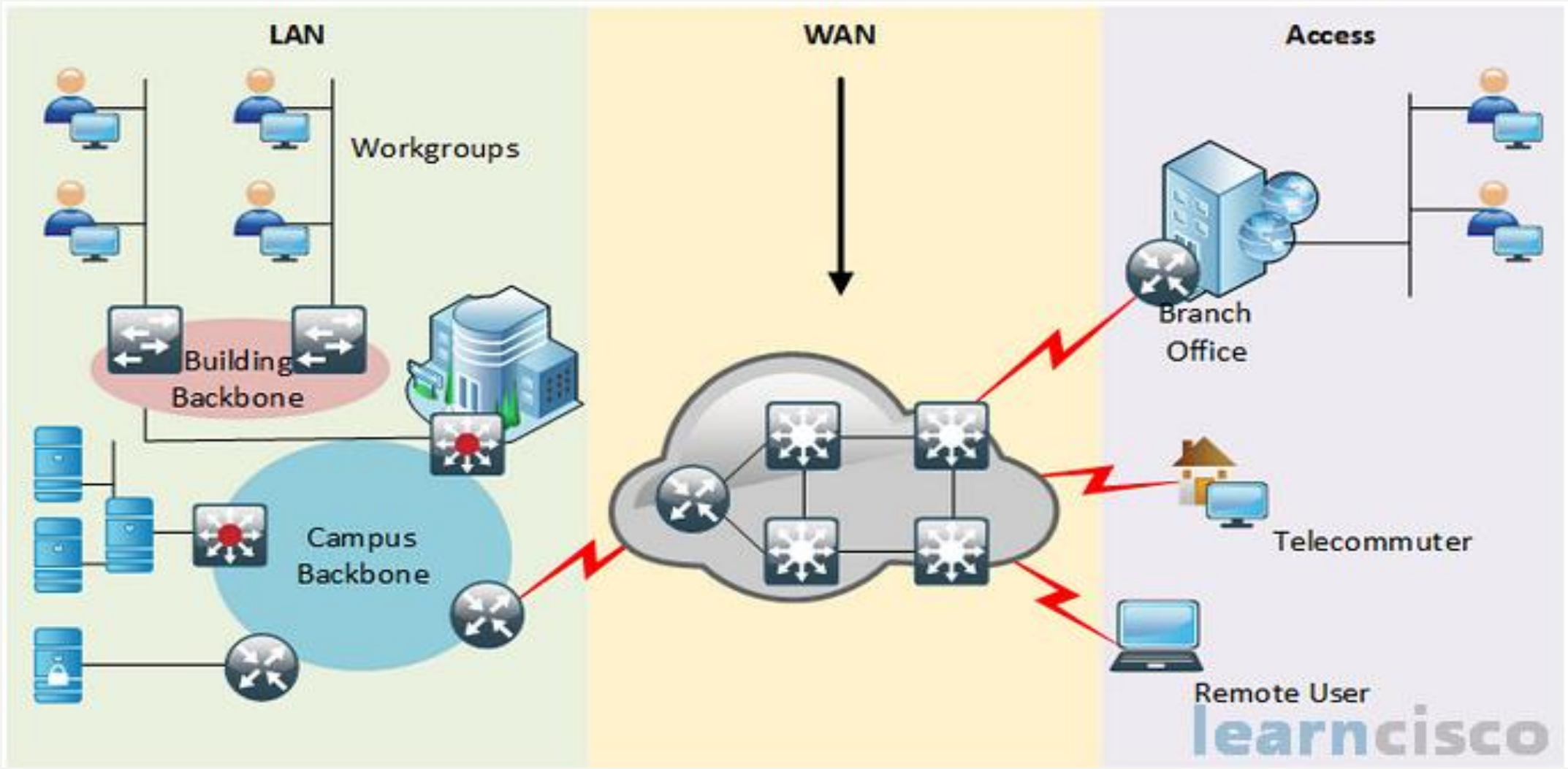
iv) Packet over SONET/SDH (PoS) (Synchronous Optical Network/ synchronous Digital Hierarchy)

v) Multiprotocol Label Switching (MPLS)

vi) ATM.

vii) Frame Relay.

NETWORKING CONT'D



NETWORKING CONT'D

iv) ATM

An Asynchronous Transfer Mode (ATM) is a connection-oriented technology, in which a logical connection is established between the two end points before the actual data exchange begins.

ATM has proved very successful in the WAN scenario and numerous telecommunication providers have implemented ATM in their wide-area network cores.

ATM is a cell relay, packet switching network and data link layer protocol which encodes data traffic into small (53 bytes; 48 bytes of data and 5 bytes of header information) fixed sized cells.

ATM provides data link layer services that run over Layer 1 links. This differs from other technologies based on packet-switched networks (such as the Internet Protocol or Ethernet), in which variable sized packets (known as frames when referencing layer 2) are used.

The motivation for the use of small data cells was the reduction of jitter (delay variance, in this case) in the multiplexing of data streams; reduction of this (and also end to-end round-trip delays) is particularly important when carrying voice traffic.

NETWORKING CONT'D

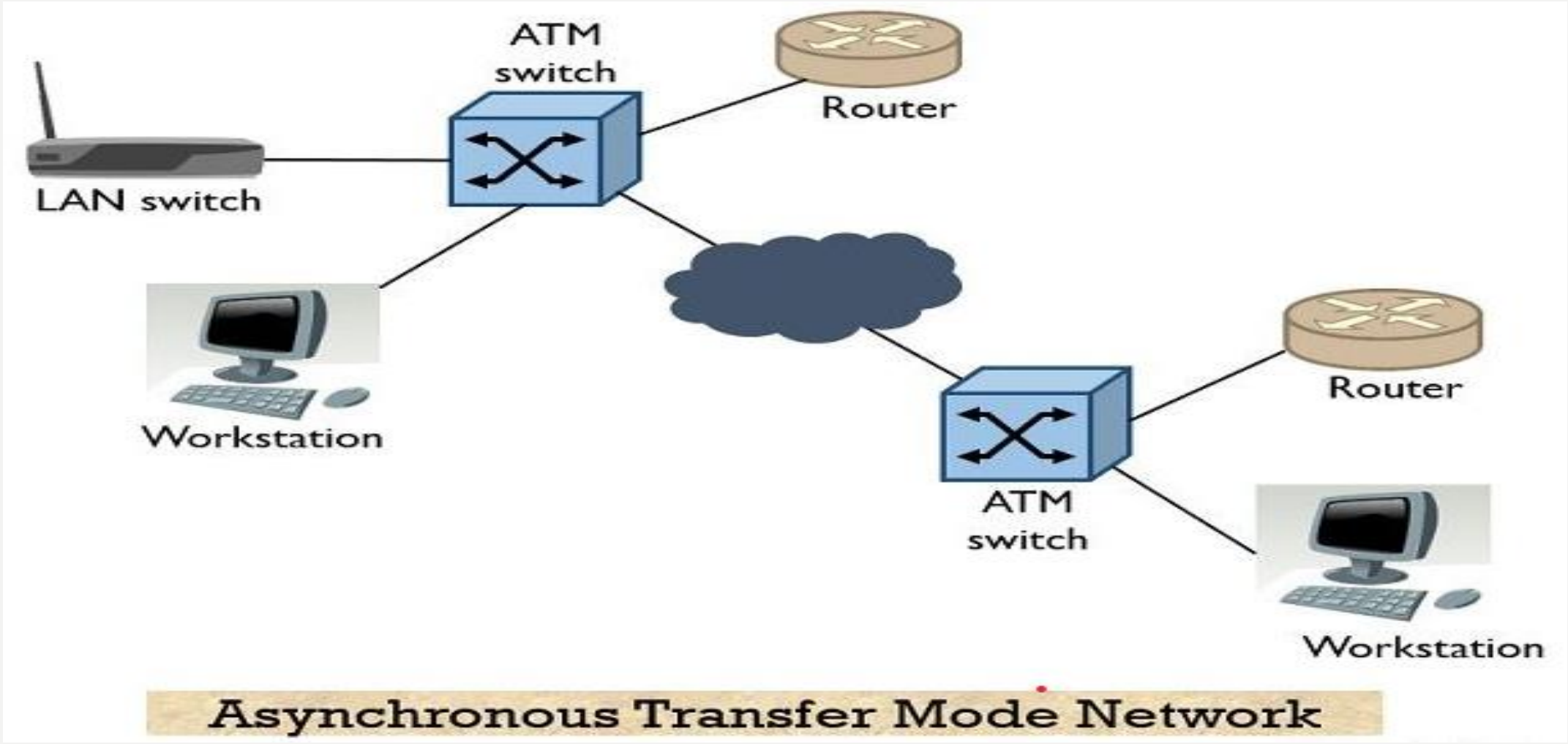
An ATM network is designed to be able to transfer many different types of traffic simultaneously, including real time flows such as video, voice and bursty TCP flows.

ATM services are categorized into Real-Time Services and Non real-Time Services which are used by an end system to identify the type of service required.

RTS concerns the delay and the variability of delay, referred to as jitter, that the application can tolerate.

Real time applications typically involve a flow of information to a user that is intended to reduce that flow at a source.

NETWORKING CONT'D



NETWORKING CONT'D

v) Ethernet

Ethernet is a family of frame-based computer networking technologies for Local Area Networks (LANs) that is also based on the idea of computers communicating over a shared coaxial cable acting as a broadcast transmission medium.

The name comes from the physical concept of the ether.

It defines a number of wiring and signaling standards for the physical layer, through means of network access.

The communication methods used shows some similarities to radio systems, although there are fundamental differences, such as the fact that it is much easier to detect collisions in a cable broadcast system than a radio broadcast.

The coaxial cable was replaced with point-to-point links connected by hubs and/or switches to reduce installation costs, increase reliability, and enable point-to-point management and troubleshooting

NETWORKING CONT'D

Star LAN was the first step in the evolution of Ethernet from a coaxial cable bus to a hub-managed, twisted-pair network.

Ethernet is most widely used LAN technology to get connected PCs and workstations, more than 84% world wide due to its protocol that has following characteristics:

=> Is easy to understand, implement, manage, and maintain.

=> Allows low-cost network implementations.

=> Provides extensive topological flexibility for network installation.

=> Guarantees successful interconnection and operation of standards.

=> Compliant products, regardless of manufacturer.

NETWORKING CONT'D

Ethernet LANs consist of network nodes and interconnecting media. The network nodes fall into two major classes:

=> Data Terminal Equipment (DTE)—Devices that are either the source or the destination of data frames. DTEs are typically devices such as PCs, workstations, file servers, or print servers that, as a group, are all often referred to as end stations.

=> Data Communication Equipment (DCE)—Intermediate network devices that receive and forward frames across the network. DCEs may be either standalone devices such as repeaters, network switches, and routers, or communications interface units such as interface cards and modems.

NETWORKING CONT'D

Network Diagram-Typical Simple Home Network

NETWORKING CONT'D

vi) Token Ring

Token-Ring was developed and promoted by IBM in the early 1980s and standardized as IEEE 802.5.

Physically, a token ring network is wired as a star, with 'hubs' and arms out to each station and the loop going out-and-back through each.

Stations on a token ring LAN are logically organized in a ring topology with data being transmitted sequentially from one ring station to the next with a control token circulating around the ring controlling access.

Token ring is a local area network protocol which resides at the Data Link Layer (DLL) of the OSI model.

It uses a special three-byte frame called a token that travels around the ring.

NETWORKING CONT'D

Token ring frames travel completely around the loop.
=>Token-passing networks move a small frame, called a token, around the network.
=> Possession of the token grants the right to transmit.
=> If a node receiving the token has no information to send, it passes the token to the next end station.
=> Each station can hold the token for a maximum period of time.
=> If a station possessing the token does have information to transmit, it seizes the token, alters 1 bit of the token (which turns the token into a start of-frame sequence), appends the information that it wants to transmit, and sends this information to the next station on the ring.

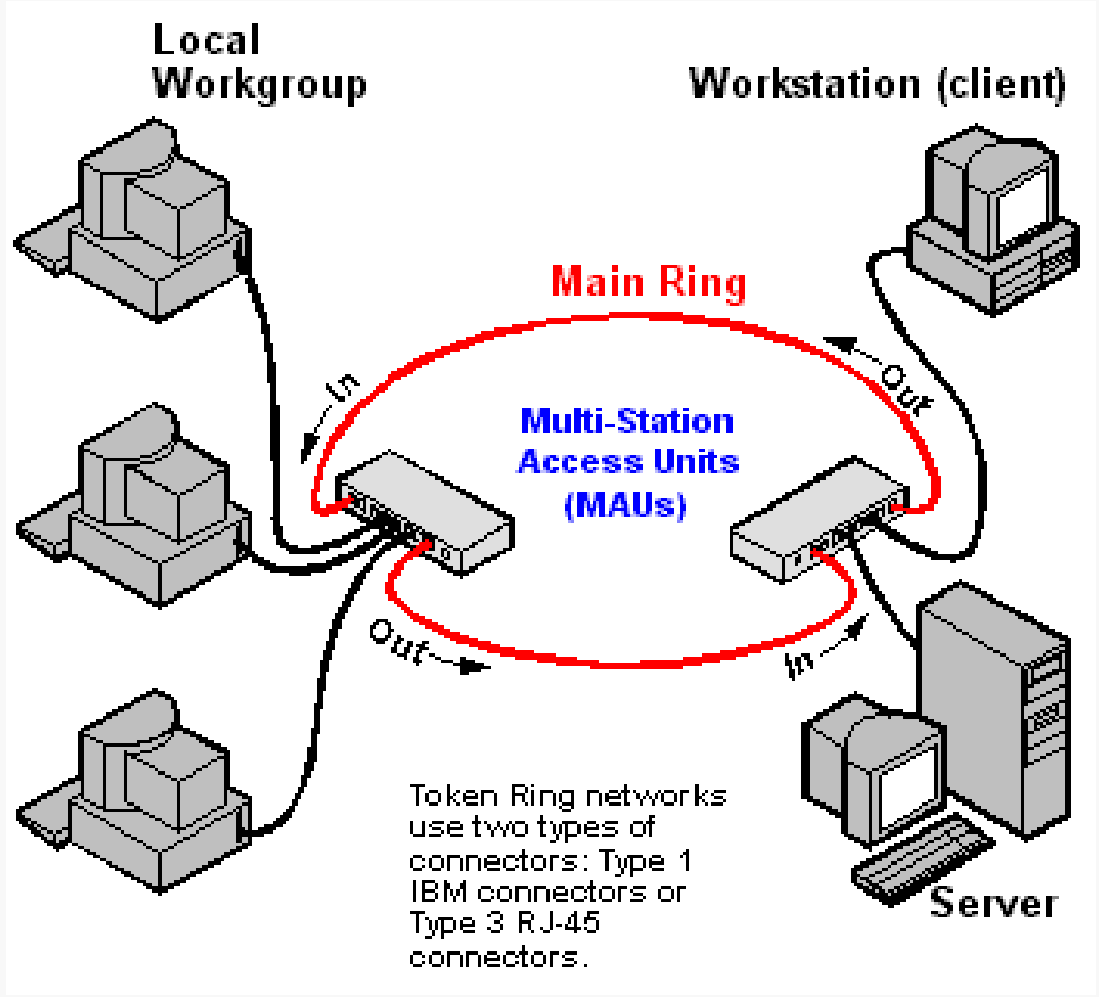
NETWORKING CONT'D

While the information frame is circling the ring, no token is on the network (unless the ring supports early token release), which means that other stations wanting to transmit must wait.

Therefore, collisions cannot occur in Token Ring networks.

Token ring networks had significantly superior performance and reliability compared to early shared-media implementations of Ethernet (IEEE 802.3), and were widely adopted as a higher-performance alternative to the shared-media Ethernet.

NETWORKING CONT'D



Token Ring Topology

All stations connect to a ce ntral wiring hub called the "Multistation Access Unit" (MAU) using twisted wire c able.

Today, most Token Ring bu siness networks have migra ted to Ethernet.

NETWORKING CONT'D

vii) FDDI

FDDI (Fiber Distributed Data Interface), as a product of American National Standards Institute X3T9.5 (now X3T12), conforms to the Open Systems Interconnection (OSI) model of functional layering of LANs using other protocols.

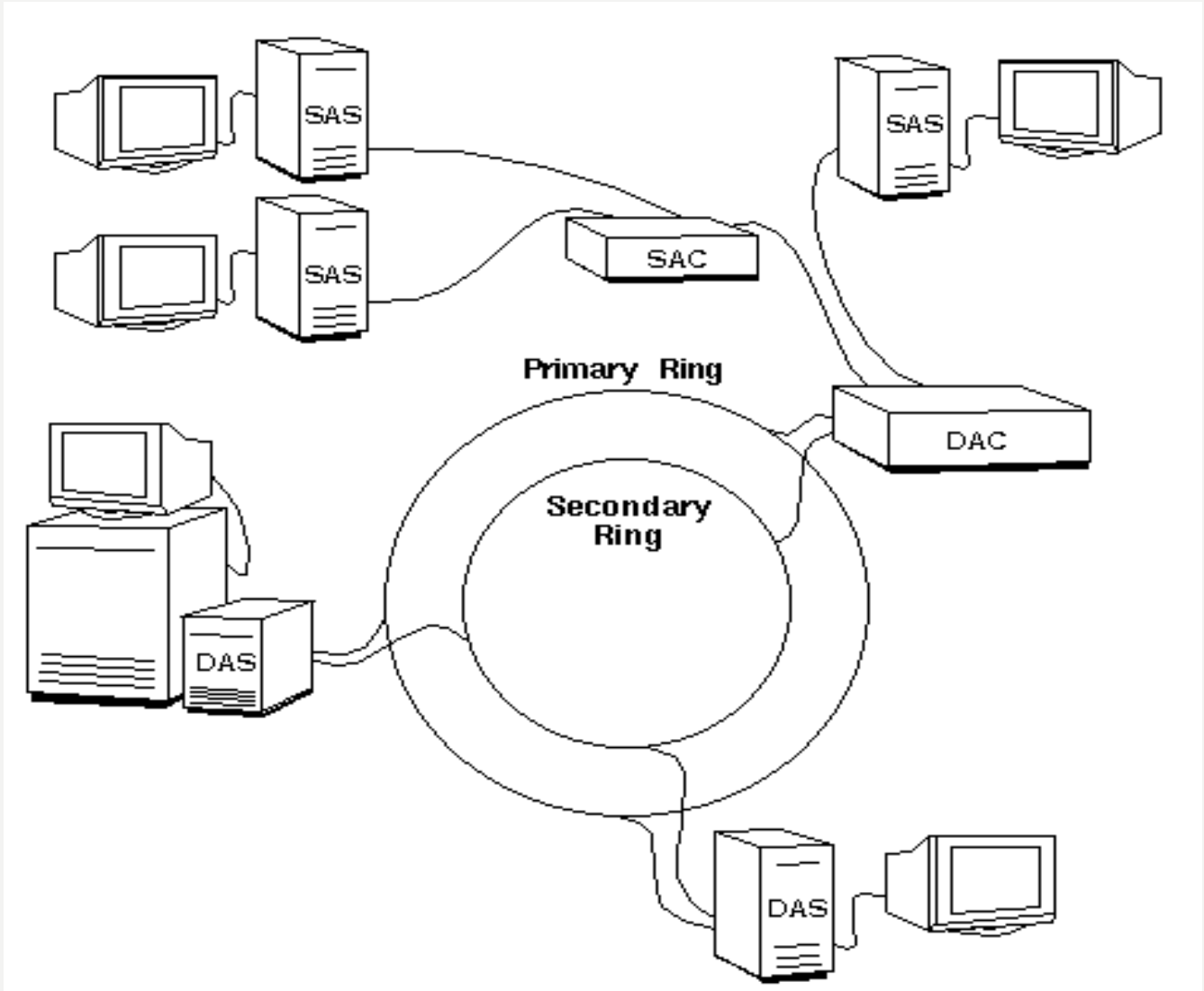
FDDI provides a standard for data transmission in a local area network that can extend in range up to 200 kilometers.

In addition to covering large geographical areas, FDDI local area networks can support thousands of users.
As a standard underlying medium, it uses optical fiber (though it can use copper cable, in which case one can refer to CDDI (copper cable distributed data interface)).

NETWORKING CONT'D

A FDDI network contains two token rings (dual-ring architecture) with traffic on each ring flowing in opposite directions (called counter-rotating). The dual rings consist of a primary and a secondary ring.
During normal operation, the primary ring is used for data transmission, and the secondary ring remains idle.
Secondary ring also provides possible backup in case the primary ring fails.
The primary ring offers up to 100 Mbit/s capacity.
When a network has no requirement for the secondary ring to do backup, it can also carry data, extending capacity to 200 Mbit/s.
The single ring can extend the maximum distance; a dual ring can extend 100 km.
FDDI has a larger maximum-frame size than standard 100 Mbit/s ethernet, allowing better throughput.
The primary purpose of the dual rings is to provide superior reliability and robustness.

NETWORKING CONT'D



The FDDI standard defines two types of concentrators: dual-attachment and single-attachment.

A dual attach concentrator (DAC) has two ports (A and B), each of which connects to both the primary and secondary rings, just like the DAS.

A single attach concentrator (SAC) connects to an FDDI ring through another concentrator, in the same manner as an SAS as illustrated in the figure

SUMMARY

During this session we have discussed

i) Client/server models

=> Fat client vs Thin client

=> Stateful vs Stateless

ii) Operating systems

=> Client operating system

=> Server operating System

=> Network operating system

iii) Networking

=> Network interface card

=> LAN

=> WAN

=> Ethernet

=> ATM

=> Token ring

=> FDDI

The End.

Q&A