OSI MODEL

By Amit Patel

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WLAN

- Known as Wireless LAN

- A WLAN allows you to connect your computers without wires or cables.

- With a wireless LAN, employees can have easy, convenient access to documents, emails, applications, and other network resources, so they can roam anywhere.

- A wireless LAN makes this easy by using radio waves or infrared signal to let mobile devices connect and communicate within a certain area.

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Continue….

- Typically used in area where computers are move quite often.

- Security remain an main issue in WLAN.

- Implemented using Access point in existing LAN or new WLAN.

- WEP (Wired Equivalent Privacy) protocol used for WLAN that encrypt data.

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Wi-Fi

- **Full Form: Wireless Fidility**

- Wi-Fi describes the implementation of WLAN.

- Wi-Fi is a technology and set of standards that allows for the implementation of WLANs.

- WiFi (Wi-Fi) is a term used for a family of products that work in WLAN networks.

- WIFI is a service & WLAN is application which uses the wifi/wimax service.

- **Wi-Fi Alliance** is a network of companies that bring WiFi technology.

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Advantages

- **Convenience:** All notebook computers and many mobile phones are equipped with the WiFi technology to connect directly to a wireless LAN. Employees can use a wireless LAN to securely access your network resources from any location within your facility.

- **Mobility:** Employees can stay connected to the network through a wireless LAN, even when they are not at their desks.

- People in meetings can access documents and applications with a wireless LAN. Salespeople can use a wireless LAN to check the network for important details from any location.

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- **Ease of Setup:** Since a wireless LAN does not require running physical cables through a location, installation can be quick and cost-effective.

- **Scalability:** A wireless LAN can typically expand with existing equipment, while a wired network might require additional cables and other materials.

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- **Security:** Controlling and managing access to your wireless LAN is important to its success. Advances in WiFi technology provide robust security protection, so your data is easily available through the wireless LAN only to the people you allow access.

- **Cost:** It can cost less to operate a wireless LAN, which eliminates or reduces wiring costs during office moves, reconfigurations, or expansions.

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Wired Lan Vs WLAN

| Wired LAN	Wireless LAN
Require cable to connect your computers	Allows you to connect your computers without wires or cables
Use guided media to transfer data.	Use unguided media to transfer data.
Commonly used in fixed network.	Commonly used in area where computers are moved often.
Faster than WLAN.	Slower than LAN.
Provide better security than WLAN.	Less secure than LAN.
Less convenient to user because it is fixed network.	More convenient to user because user access it from anywhere.
Hard to install than WLAN.	Easier to install than LAN.

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Bluetooth

- It is open wireless technology standard for exchanging data over short distance.

- It is a IEEE 802.15.1 specification for the use of low-power radio communication to link phones, computers and other network devices for short distance.

- Name borrowed from Herald Bluetooth - A king in Denmark.

- Designed primarily to support wireless networking devices .

- Typically cover upto 10 meter area.

- Communicate at less than 1mbps speed.

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- Bluetooth network feature dynamic topology called PICONET or PAN.

- It contain min. two or max. 8 Bluetooth devices.

- Compare with Wi-Fi it is slower, used in limited range and support fewer devices.

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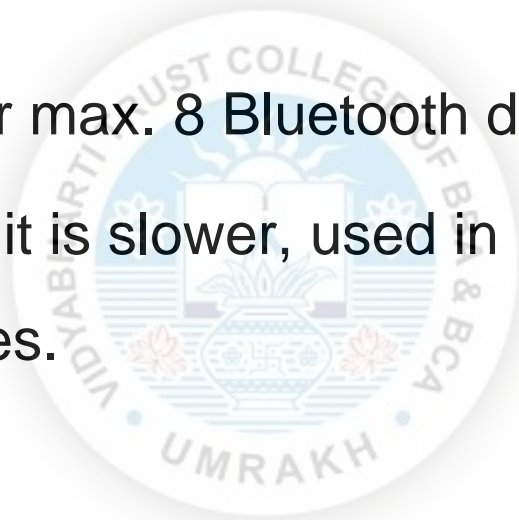
Protocol

- **Definition:** Set of rules that govern the exchange of information within a network.

- It is an Official procedure for given activity.

- Define the manner in which peer process communicating among various devices.

- Organized into layers.
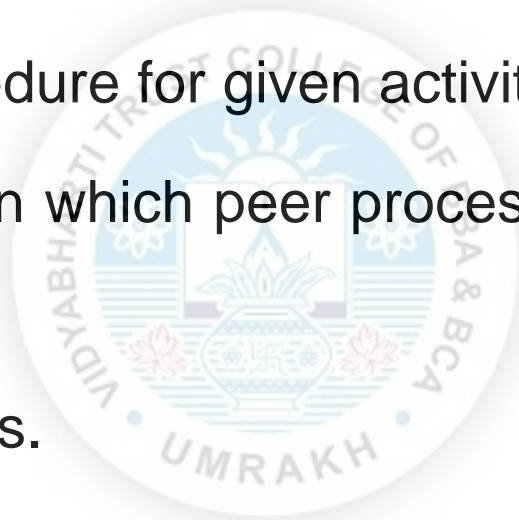
OSI Reference Model

- OSI referred as **O**pen **S**ystem **I**nterconnection.

- Why Invented? :   When network first came into use, computer could typically communicate only with computer from the same manufactures.

- For example: Companies ran either a complete IBM solution or Linksys Solution. But not together.

- To overcome this problem ISO created OSI model.

- ISO : **I**nternational **O**rganization for **S**tandardization

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Continue..

- ISO helps to manage and create many international standards in many technical areas to insure the same quality of a product or process regardless of location or company.

- Applying the logic of the ISO standards to computer networking, a computer component, or computer software needs to comply to set of standards so that the product or process will work no matter where in the world we are, and no matter who is the world is producing it.

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- To help vendors create interoperable network devices and software in form of protocols so that different vendor network could work with each other.

- Describe how data and network information are communicated from an application on one computer through the network media, to an application on another computer.

- It breaks this approach into layers.

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- It is the set of guideline that application developer can use to create and implement application that run on network.

- Provide framework for creating and implementing standard, devices.

Why It is Called Open System?

- Open System is a system in which its architecture is not secret and its open for anyone, who is interested in using, changing and reworking on it.

- Reference Model: Conceptual blueprint of how communication should take place.

- Layers: Reference Model Address all the process required for effective communication and divides these process into logical grouping called layers.

OSI Layers

All

People

See

The

New

Dance

Program

7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data link
1	Physical
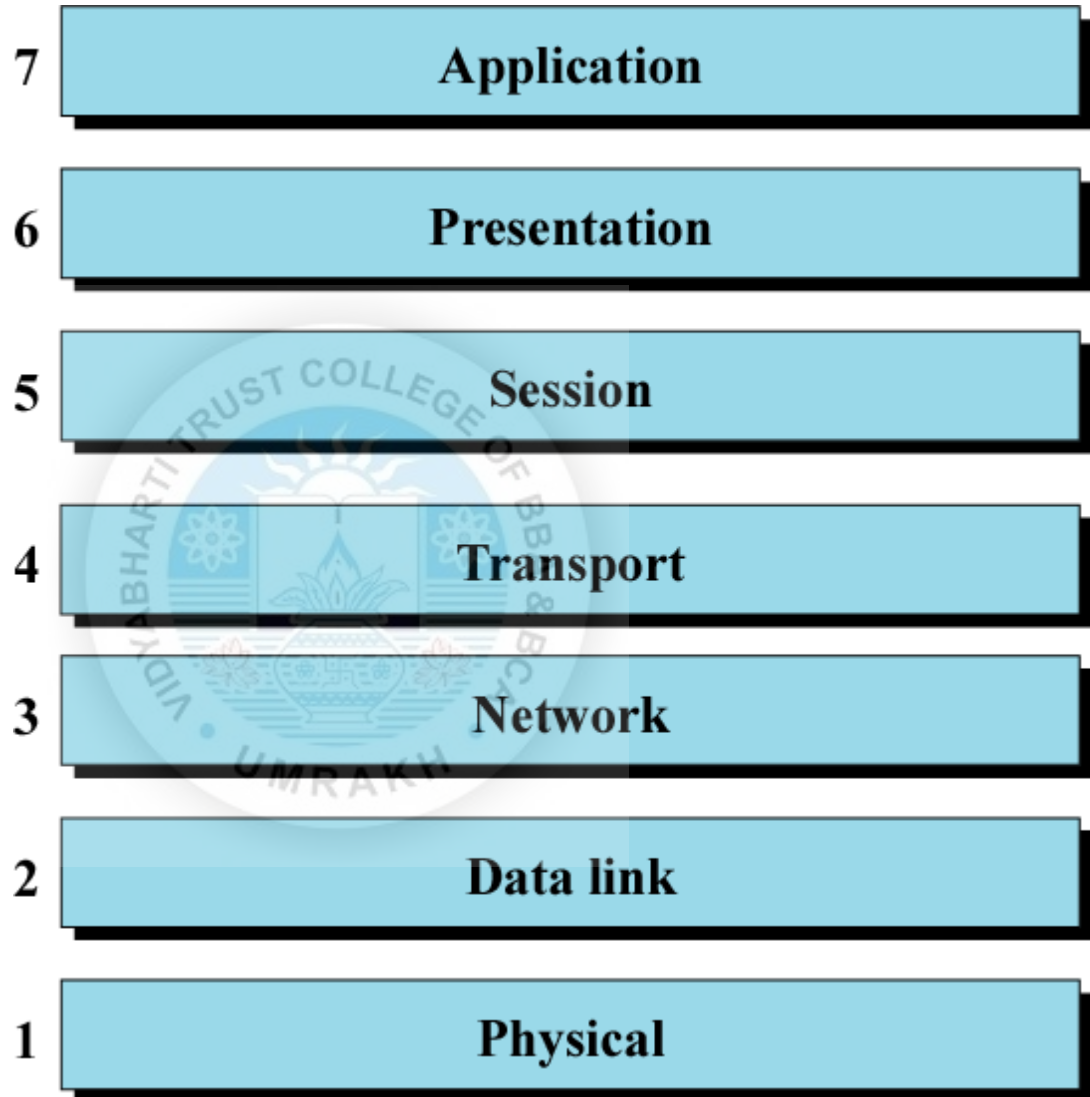
Why organized into layer?

- Many types of problem arise when data in the form of "Packets" gets communicated within network.

  - Host Failure

  - Link Failure

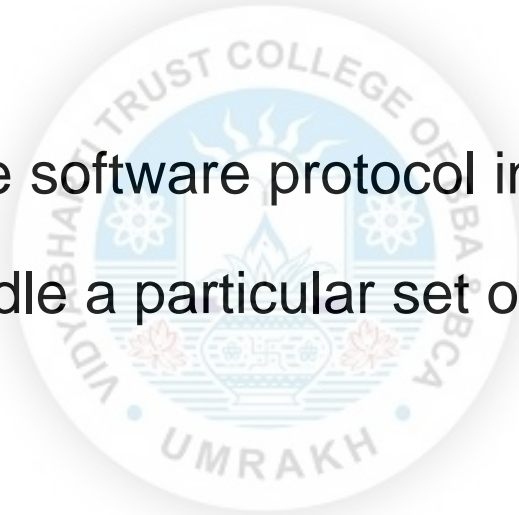 - Data Corruption

  - Packet Loss
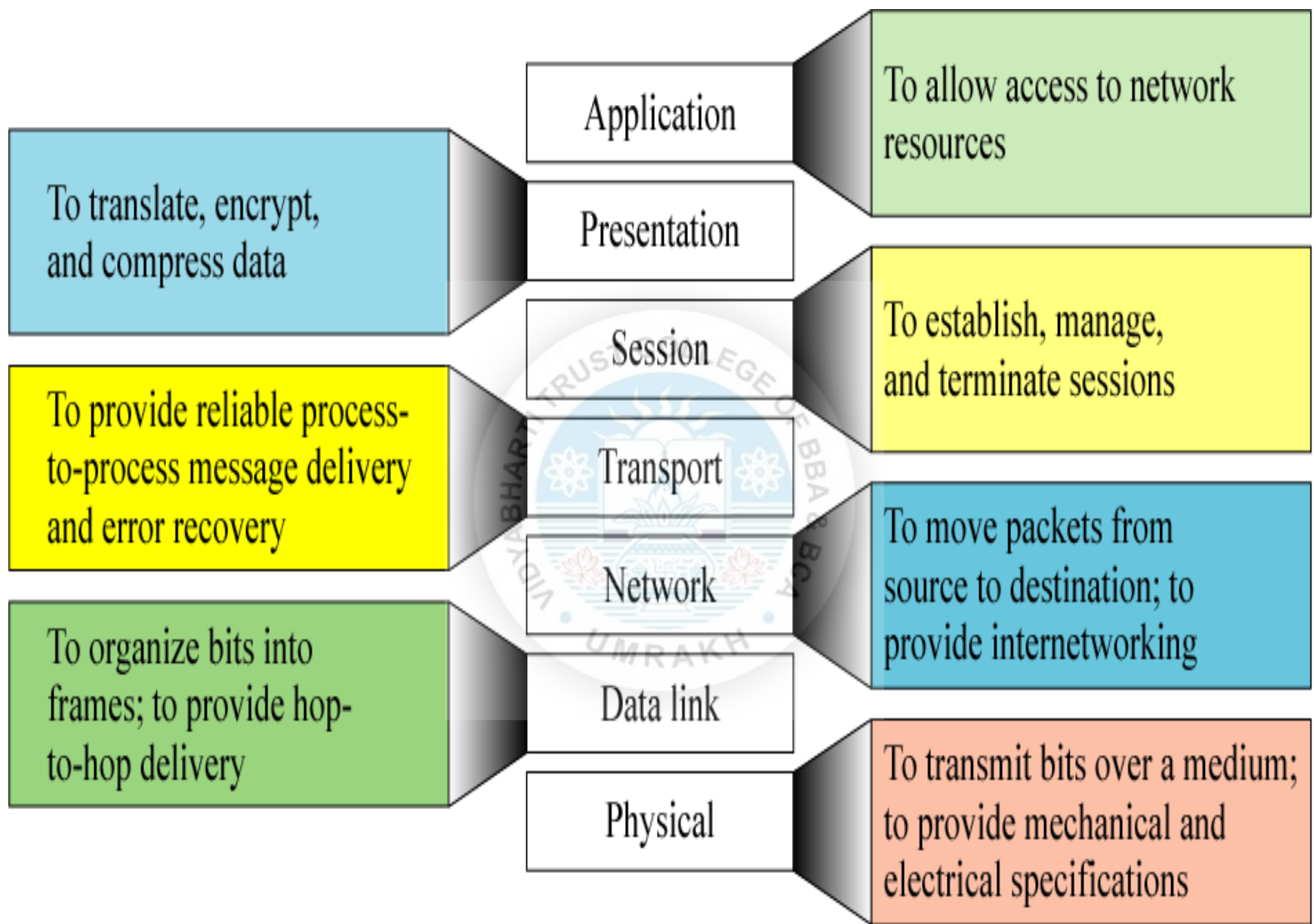
  - Data Duplication.

Continue…

- The OSI model is a seven-layer model, designed to help explain the flow of information from layer to layer.

Continue….

- It is impractical to set single protocol to handle all of above problem.

- Therefore, Organize software protocol into different layers.

- Each layer can handle a particular set of problem.

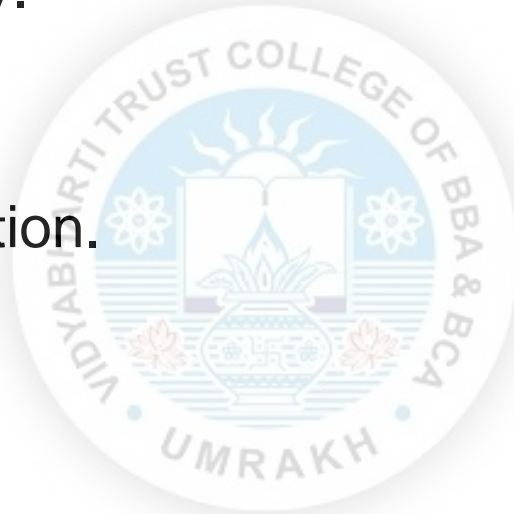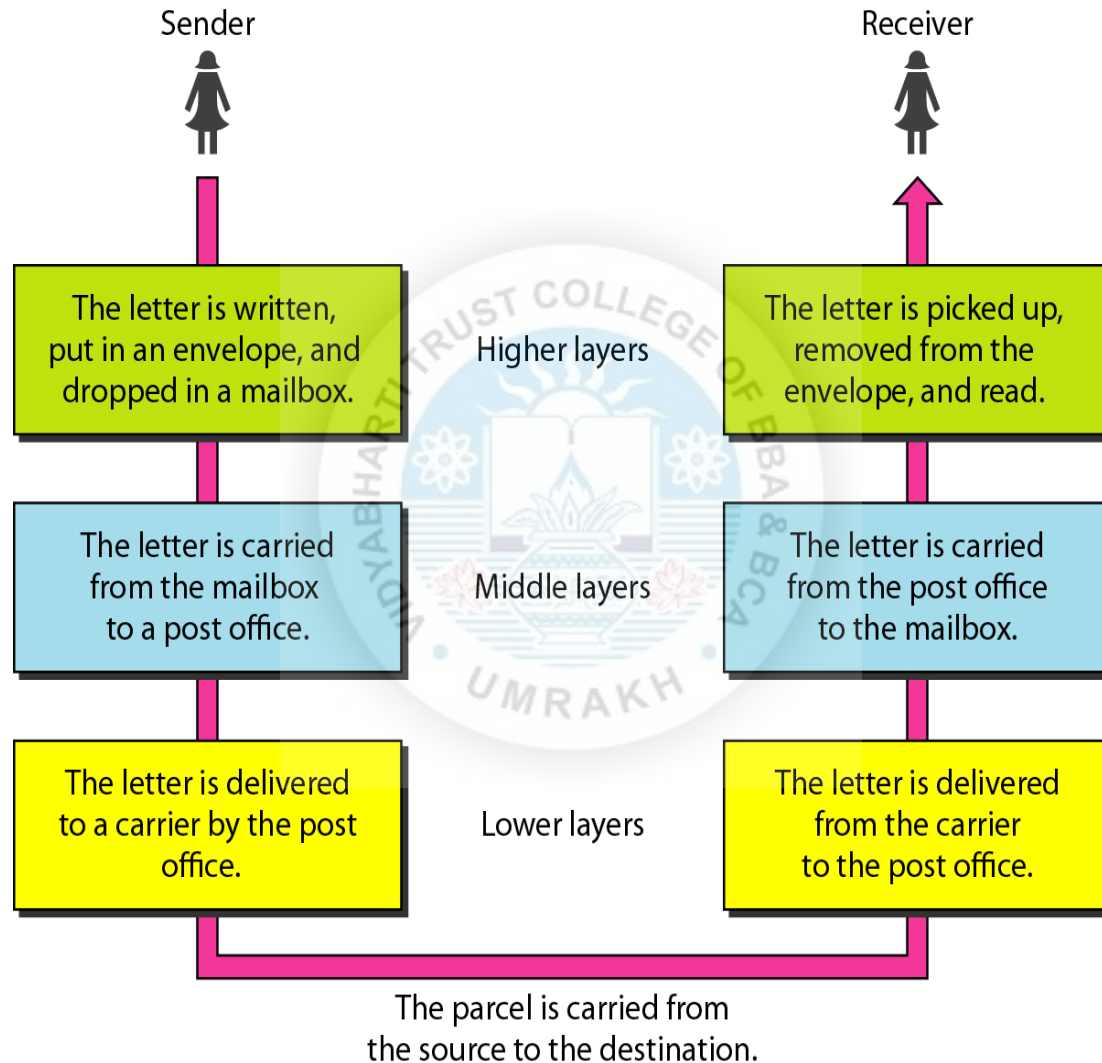|		
To translate, encrypt, and compress data	Application	To allow access to network resources
	Presentation	
To provide reliable process-to-process message delivery and error recovery	Session	To establish, manage, and terminate sessions
	Transport	
To organize bits into frames; to provide hop-to-hop delivery	Network	To move packets from source to destination; to provide internetworking
	Data link	
	Physical	To transmit bits over a medium; to provide mechanical and electrical specifications

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Protocol Characteristics.

- Each layer has predefined set of functions.

- Layer provide service to their immediate upper layers and hiding details of the services.

- It define process on either end of the processs.

- Define syntax and type of message.

- Define meaning of each field in syntax.

- Define how message are sent and expected result.

Advantages of Layering

- Data hiding and Encapsulation.

- Reduced Complexity.

- Easy Extension.

- Multi vendor Integration.

- Easy Testing.

Task Involved To Send Letter

Sender

Receiver

The letter is written, put in an envelope, and dropped in a mailbox.

Higher layers

The letter is picked up, removed from the envelope, and read.

The letter is carried from the mailbox to a post office.

Middle layers

The letter is carried from the post office to the mailbox.

The letter is delivered to a carrier by the post office.

Lower layers

The letter is delivered from the carrier to the post office.

The parcel is carried from the source to the destination.

Continue….

- OSI Layer divided into three groups

  1. Upper Layer (Application, Presentation, Session)

  2. Middle Layer (Transport)

  3. Lower Layer (Network, Data link, Physical)

- Lower Layer define how data is transmitted end to end.

Upper Layers

- Implemented in Software.

- Define how the application within the end station will communicate with each other and with user.

- Represent software that implements network services like encryption, Decryption, conversion and connection management.

- They don't know about lower layer function.

Lower Layer

- Lower Layer define how data is transmitted end to end.

- Implement more primitive, hardware-oriented functions like routing, addressing, and flow control.

Define : PDU (Protocol Data Unit)

- Data exist at each layer in units called Protocol Data Unit.

- Table show the name of PDU at each layer.

Data Units	Layers
data	**application** — Network Process to Application
data	**presentation** — Data Representation & Encryption
data	**session** — Interhost Communication
segments	**transport** — End-to-End Connections and Reliability
packets	**network** — Path Determination & Logical Addressing (IP)
frames	**data link** — Physical Addressing (MAC & LLC)
bits	**physical** — Media, Signal and Binary Transmission

Encapsulation

- **AMIT want to send parcel to VATSAL from india to TORONTO.**

1. AMIT tells VATSAL in Toronto that he is going to send her a package through the OSI Courier Service. VATSAL in Toronto responds, "Great - I'll be looking for it."

2. AMIT go to parcel shop , Prepares the weigh bill for the courier service and calls for pickup.

3. The OSI Courier Service picks up the AMIT's package from PARCEL OFFICE at Bardoli and takes off in a truck.

4. The package gets transferred to an airplane for shipment to Toronto.

Encapsulation

5. The airplane arrives in Toronto where it is offloaded, sorted and placed on a truck bound for VATSAL's office.

6. The package is delivered to VATSAL via the truck.

7. VATSAL acknowledges to AMIT that she received the package.

Encapsulation

- The example of the courier service, each layer required a separate process to ensure reliable delivery and transport of the package from India to Toronto. In order for this to happen, the package needed to:

  - Have a destination address and tracking number attached

  - Be sorted with the other package pickups for Toronto

  - Placed on a truck bound for a specific plane carrying the packages to Toronto

  - Picked up by a truck and taken to be sorted by Toronto destination

 - Delivered to the Toronto office.

Encapsulation

- Along the way, the original destination address served as a reference, however, other information was attached as well, such as the identification numbers for which truck or which plane it is delivered.

- These additions information did not change the package contents or the destination address information, they merely provided additional routing information needed at the time.

Transmission medium

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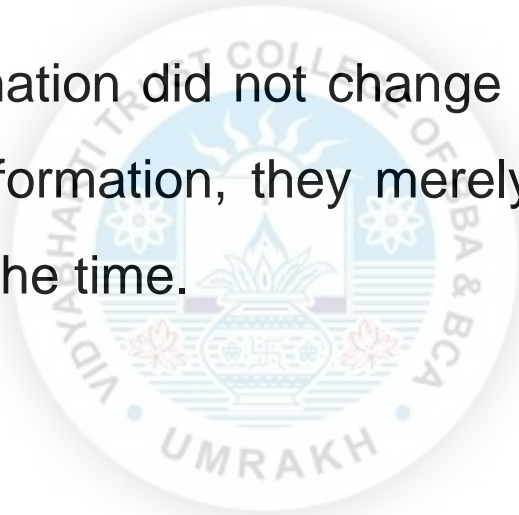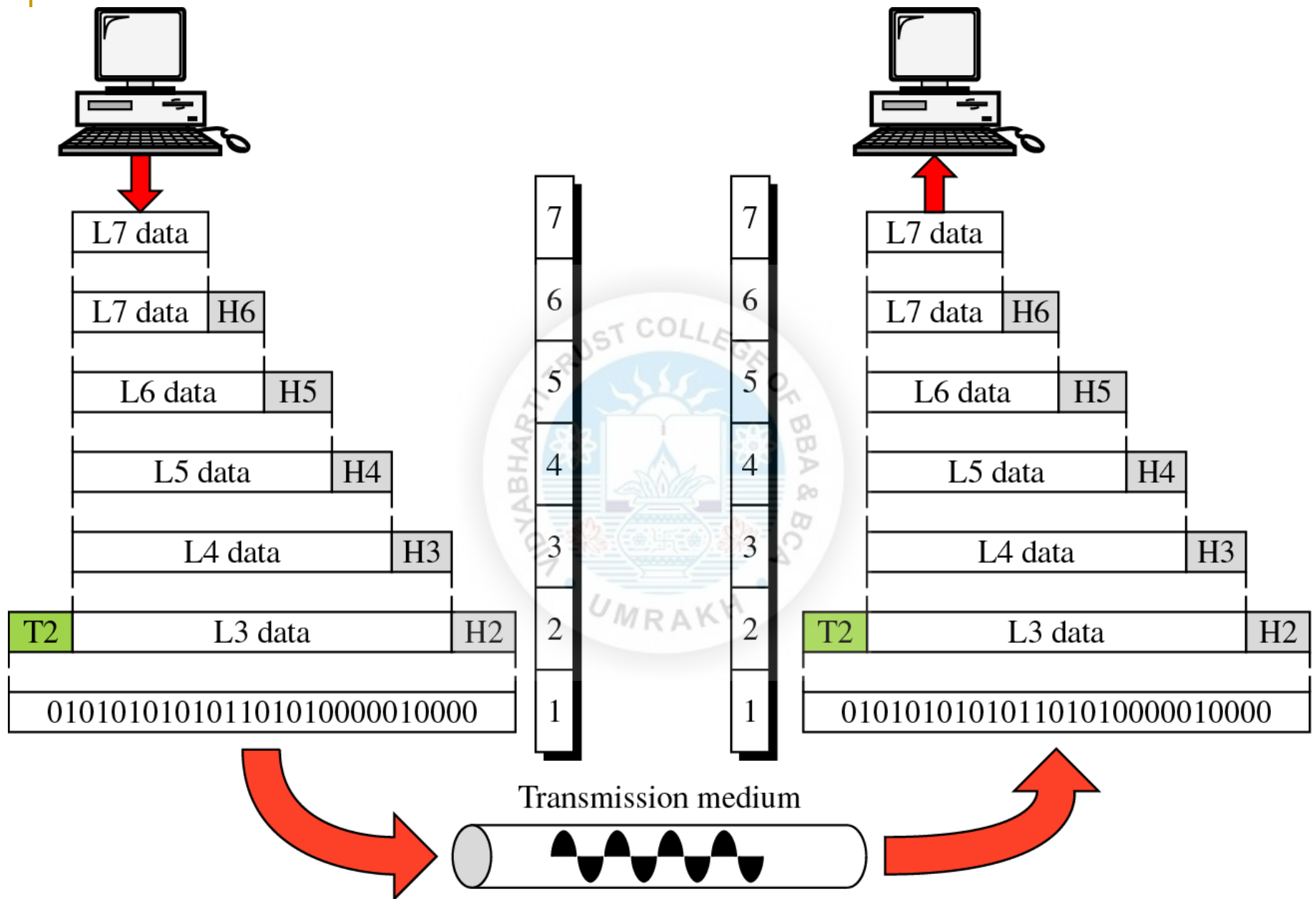
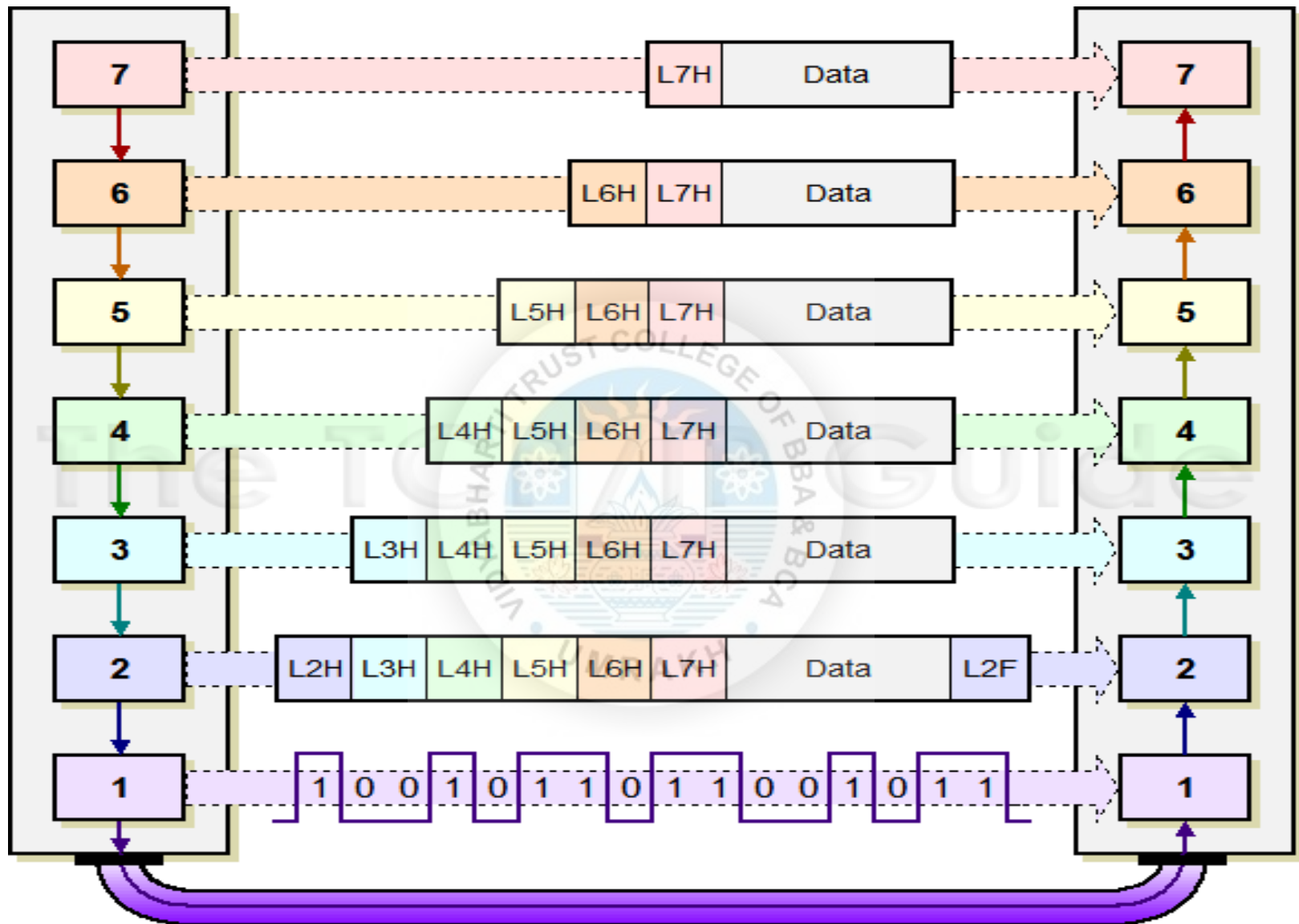# Define : Encapsulation

- Encapsulation is a term used to describe adding information to PDU as they are pass down the each layer.

- When data moves from upper layer to lower level of OSI protocol stack (outgoing transmission) each layer includes a bundle of relevant information called a header along with the actual data.

- The data package containing the header and the data from the upper layer then becomes the data that is repackaged at the next lower level with lower layer's header.

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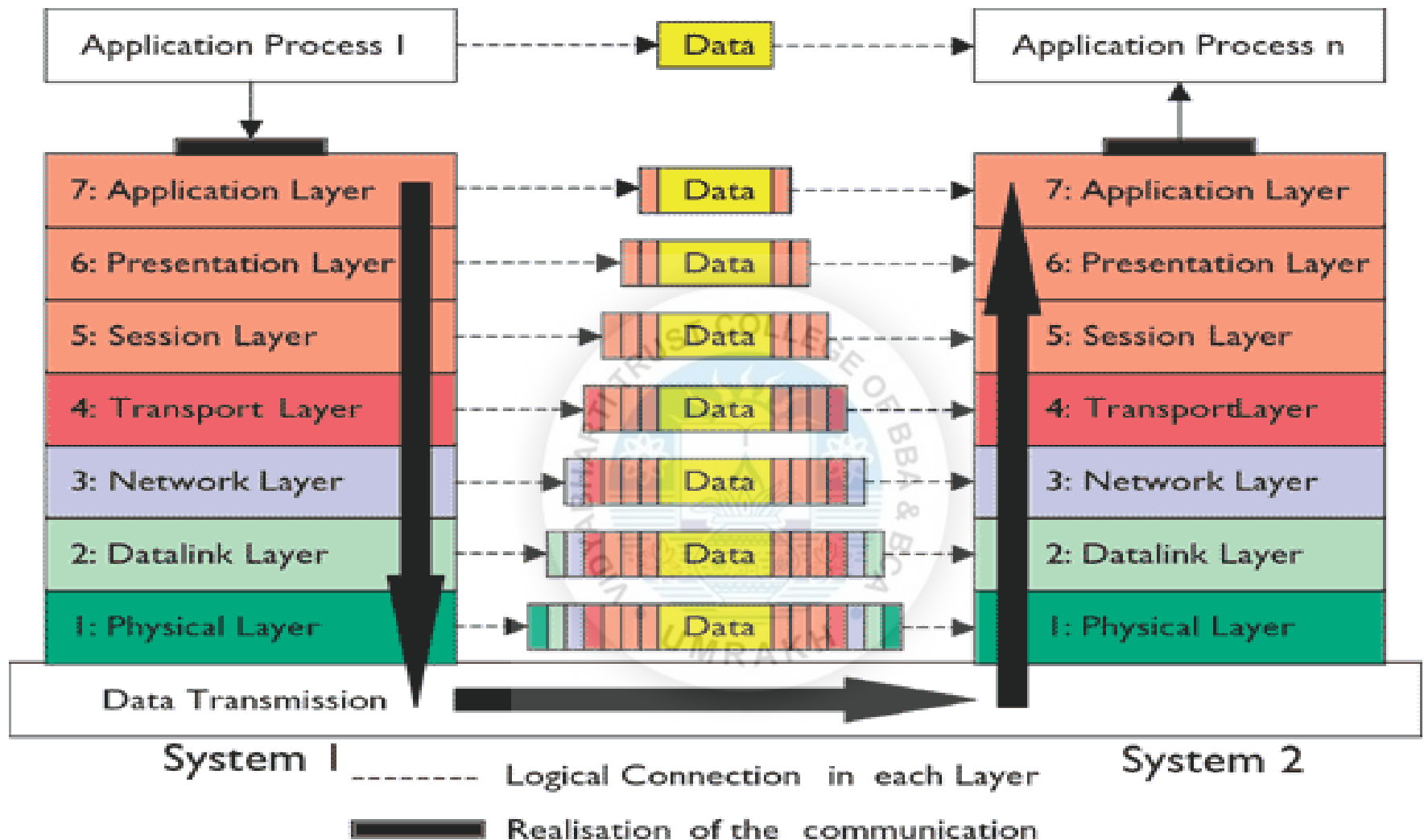
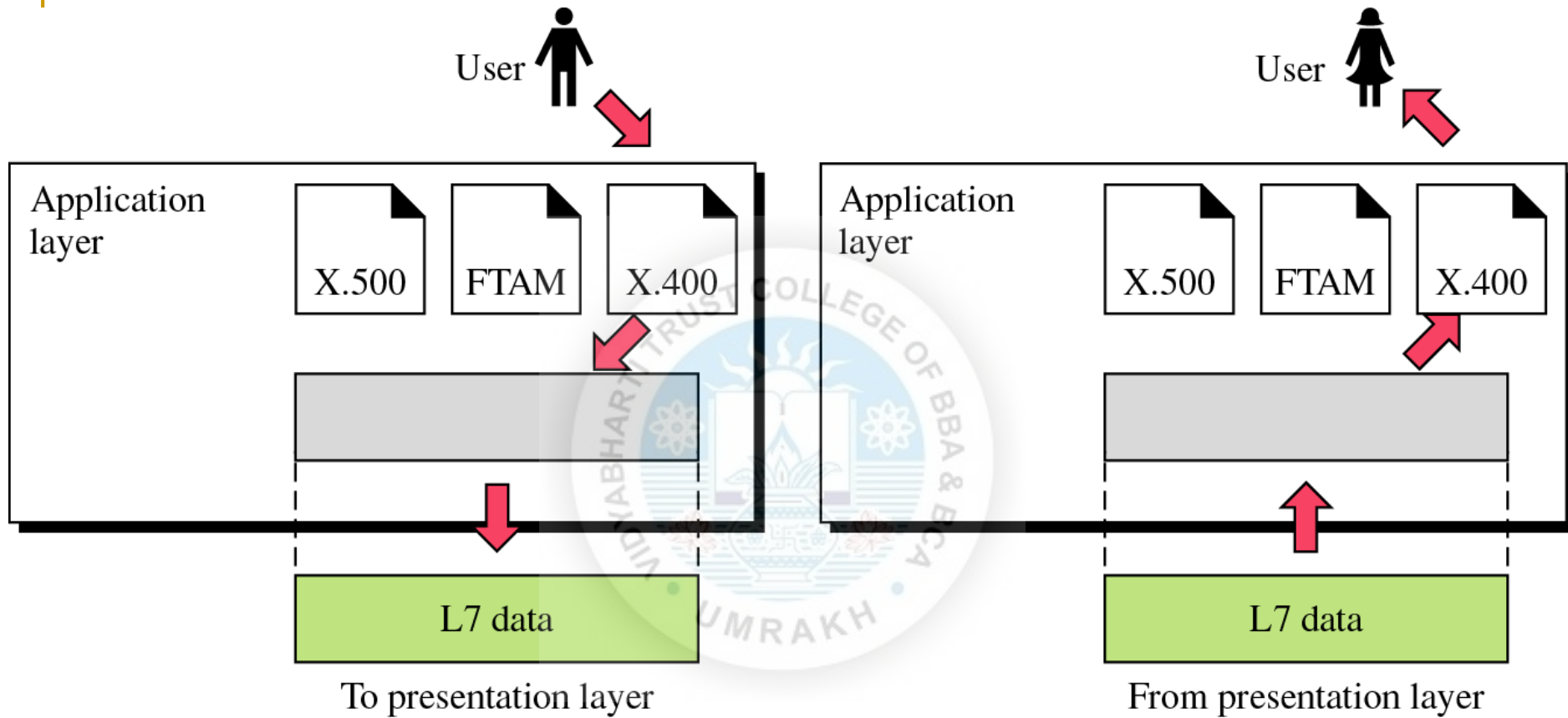# Peer-to-Peer Communications

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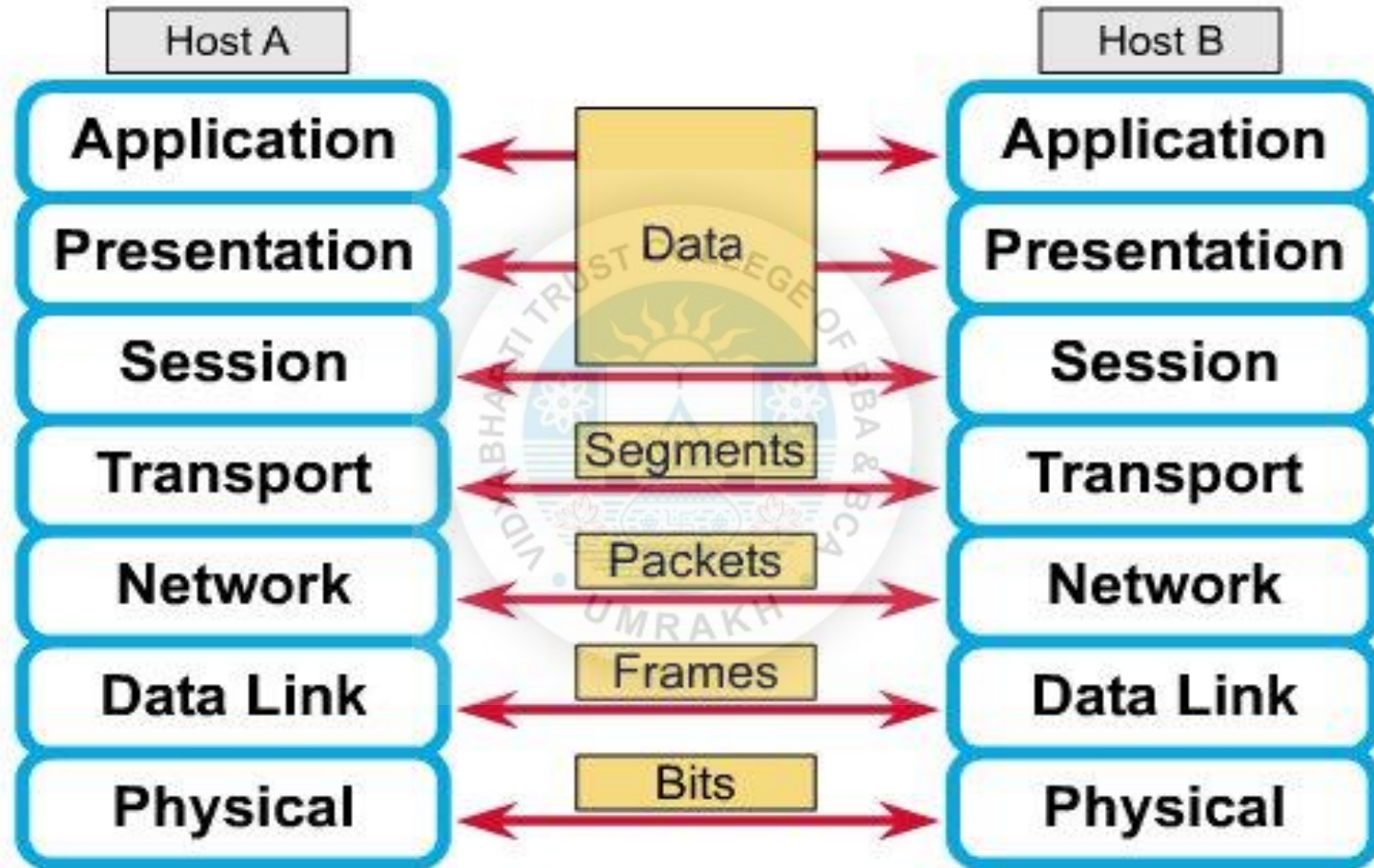
Continue..

- **Header** is the supplemental data placed at the beginning of a block of data when it is transmitted. This supplemental data is used at the receiving side to extract the data from the encapsulated data packet.

- This packing of data at each layer is known as data encapsulation.

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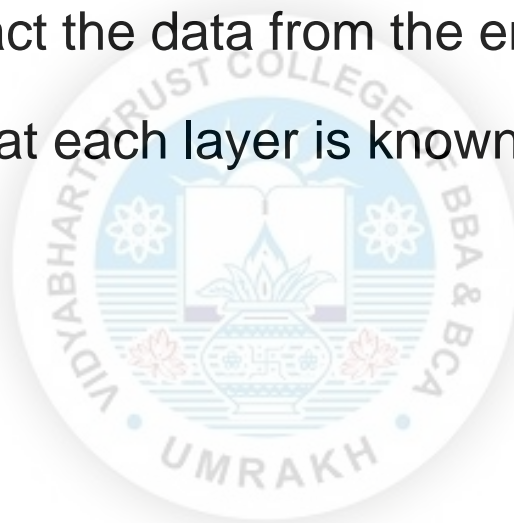
Application Layer.

- The Application layer is the top layer of the OSI model.

- It is the layer that provides the interface between the applications we use to communicate and the underlying network over which our messages are transmitted.

- Main interface for the user to interact with application and other layers for network services.

- Provide platform to send and receive data over the network.

- **Application layer** protocols are used to exchange data between programs running on the source and destination hosts.

User

Application layer

X.500 FTAM X.400

L7 data

To presentation layer

User

Application layer

X.500 FTAM X.400

L7 data

From presentation layer

Application Layer Services

- For example, when you use your Web browser, that actual software is an application running on your PC. It doesn't really "reside" at the application layer. Rather, it makes use of the services offered by a protocol that operates at the application layer, which is called the Hypertext Transfer Protocol (HTTP). The distinction between the browser and HTTP is important. Here browser is a application and HTTP is a application layer protocol.

Application Layer Services

- **Application layer** uses protocols that are implemented within applications and services.

- The Application layer relies on the functions of the lower layers in order to complete the communication process.

- Within the **Application layer**, protocols specify what messages are exchanged between the source and destination hosts, the syntax of the control commands, the type and format of the data being transmitted, and the appropriate methods for error notification and recovery.

Application Layer Services

- Whenever you interact with a program on your computer that is designed specifically for use on a network, you are dealing directly with the application layer.

- For example, sending an e-mail, firing up a Web browser, or using an IRC chat program—all of these involve protocols that reside at the application layer.
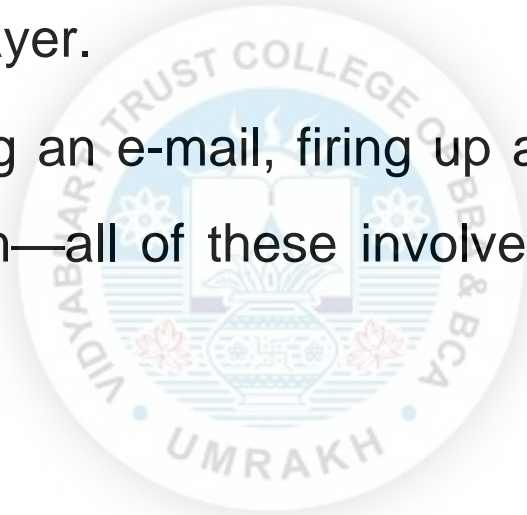
Application Layer Services

- File transfer, access and management

- Mail services

- Directory services.

- Print Services

- Support for network standard virtual terminal.

Protocol and Device Use

- Protocol : HTTP, FTP, SMTP, SNMP, TELNET, POP3, DHCP, SSL

- Data Unit (PDU) : Data

- Device : Gateway.

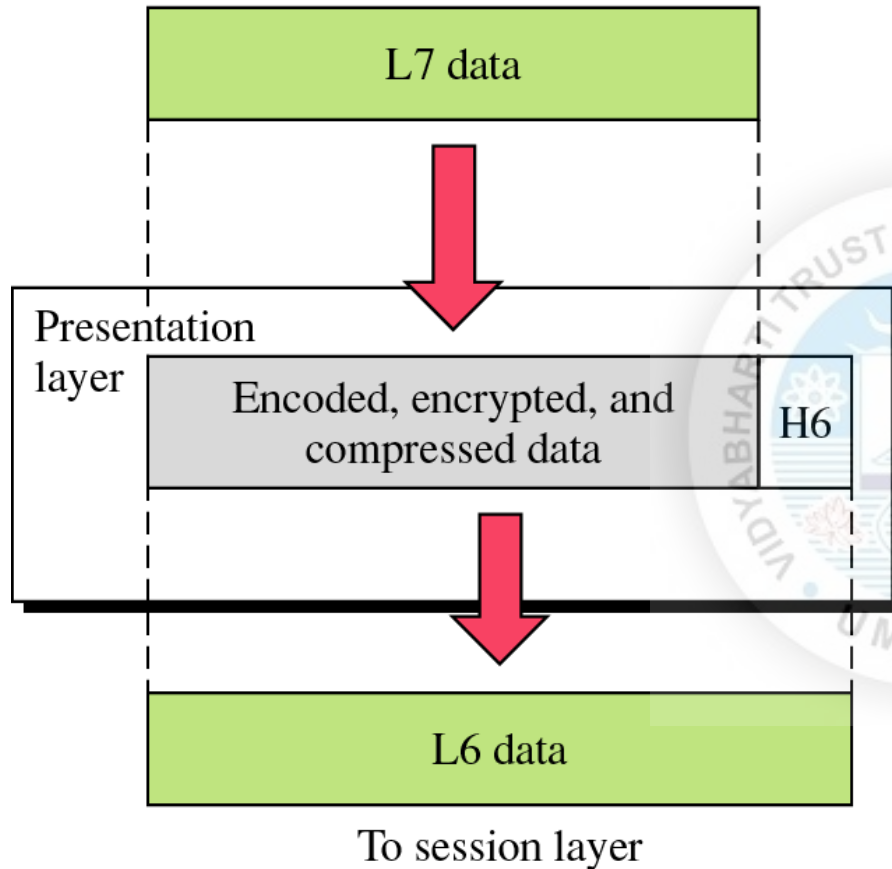- Utility used at this layer: ipconfig, telnet, lookup, hostname.

Presentation Layer.

- It responds to service requests from the application layer and issues service request to the session layer.

- Present data to application layer.

- Concerned with syntax and semantics of the information exchanged between two devices.

- Responsible for Translation, compression and encryption/decryption of information.
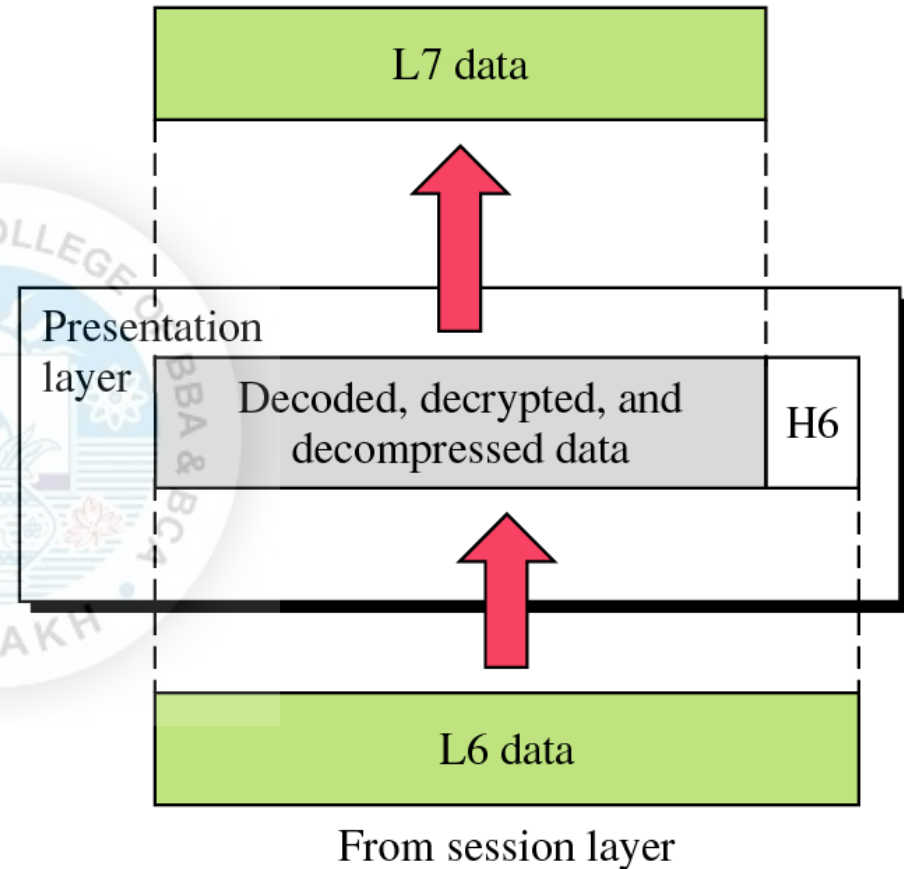
Presentation Layer.

- When the presentation layer receives data from the application layer, to be sent over the network, it makes sure that the data is in the proper format.

- If it is not, the presentation layer converts the data to the proper format.

- On the other side of communication, when the presentation layer receives network data from the session layer, it makes sure that the data is in the proper format and once again converts it if it is not.

From application layer

L7 data

Presentation layer

Encoded, encrypted, and compressed data | H6

To session layer

L6 data

To application layer

L7 data

Presentation layer

Decoded, decrypted, and decompressed data | H6

From session layer

L6 data

Services.

- Networks can connect very different types of computers together: PCs, Macintoshes, UNIX systems, AS/400 servers and mainframes can all exist on the same network.

- These systems have many distinct characteristics and represent data in different ways; they may use different character sets for example. The presentation layer handles the job of hiding these differences between machines.

- Presentation layer at the sender changes the information from its sender dependent form to common format. The presentation layer at receiver end changes the common format to its receiver dependent format.

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Services.

- Encryption: Encryption means sender transforms the original message to another form and send resulting message out over the network.

- Compression: Reduce the number of bit contained in the information.

Protocol and Device Use

- Protocol :

    S-MIME- Secure Multi Purpose Internet Mail Extension

    ASCII – American Standard code for Information Interchange

    EBCDIC – Extended Binary Coded Decimal Interchange Code

    NCP – Network Control Program

- Data Unit : Data

- Device   : Gateway.

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Session Layer

- Provides the mechanism for opening, closing and managing a session or connection between end-user application processes. So it Control communication between application on hosts.

- It is dialog controller because it establish, maintain and synchronize the interaction among communicating devices.

- Keeps one application data separate from other application data.

Session Layer.

- In the connection establishment phase, the service and the rules (who transmits and when, how much data can be sent at a time etc.) for communication between the two devices are proposed.

- The participating devices must agree on the rules. Once the rules are established, the data transfer phase begins.

- Connection termination occurs when the session is complete, and communication ends gracefully.

Services.

- **Dialog control** : Allow two system to enter into dialog. Allow communication between two processes in either half or full duplex mode.

- **Synchronization:** Allow process to add checkpoint or synchronization point.

  <u>For example:</u> if a system is sending a file of 2000 pages and system add checkpoint after 100 pages. So after each 100 page to ensure that each 100-page unit is received and acknowledge. During the transmission of page 523 if crash happen, the only page need to be resent after system recovery are pages 501 to 523.
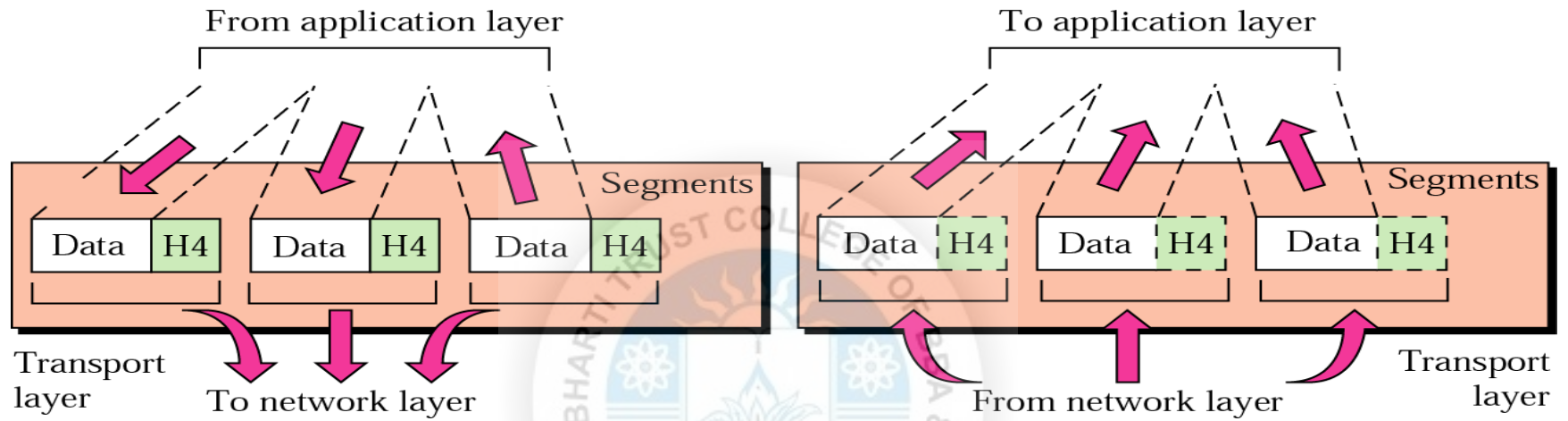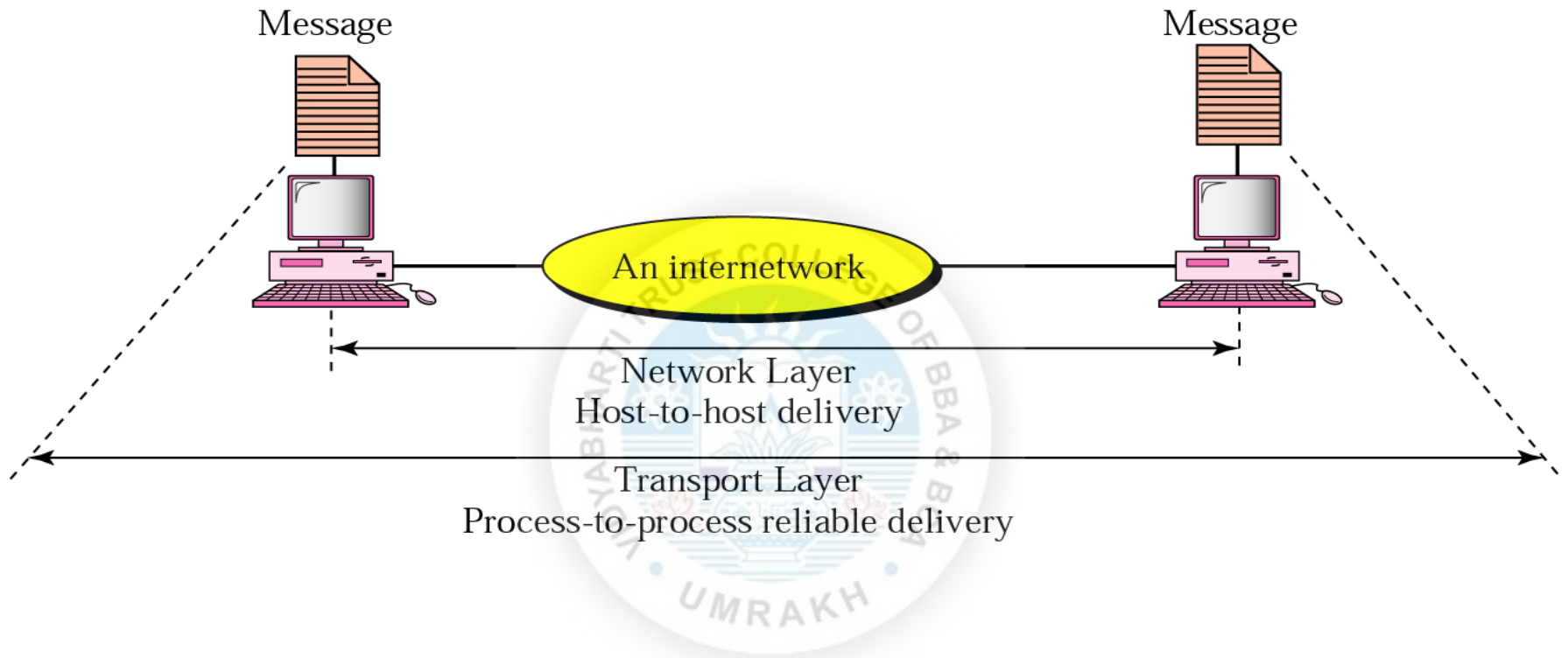
Protocol and Device Used

- Protocol   : NFS, SMB (Server Message Block), SQL, RPC

- Device   : Gateway.

- Data Unit : Data

- Utility Used at this layer: nbtstat

Transport Layer

- Responsible for process to process delivery of the entire message.

- Ensure that whole message arrives intact .

- Also seeing error control and flow control at the source to destination level. Means it Ensure that messages are delivered error-free, in sequence and with no losses or duplications.

- It relieves the higher layer protocol from any concern with the transfer of data between them and their peers.

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Message

Message

An internetwork

Network Layer
Host-to-host delivery

Transport Layer
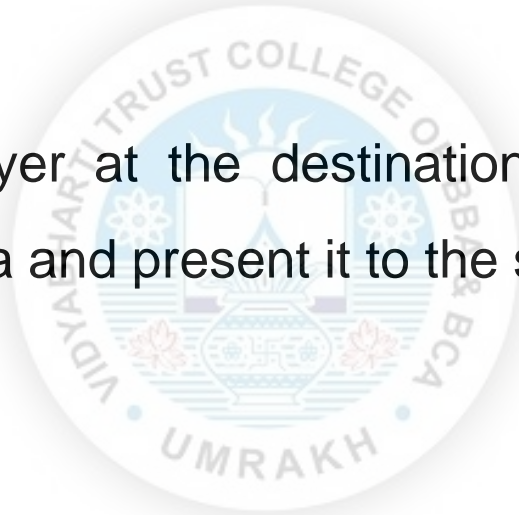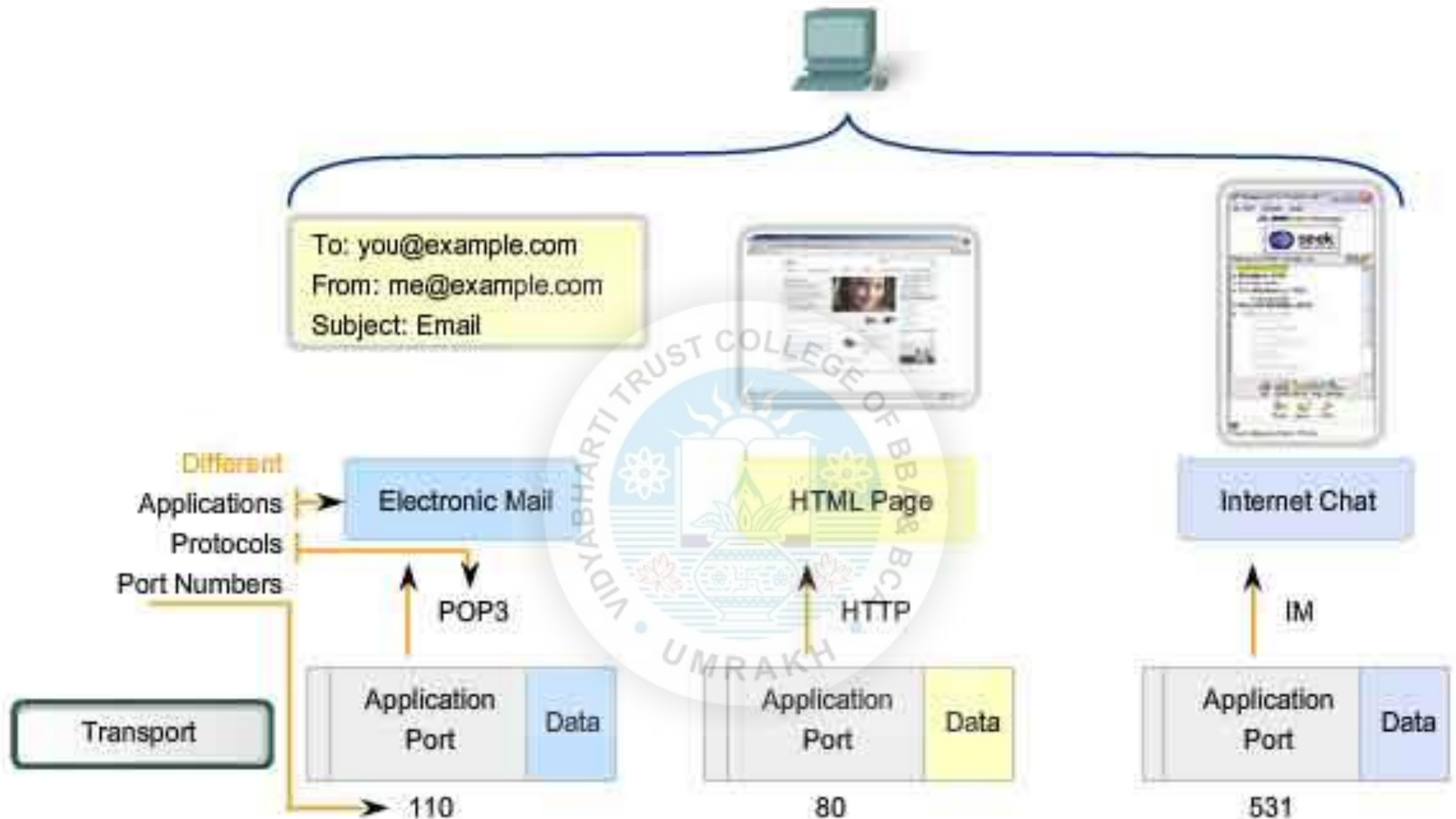Process-to-process reliable delivery

Transport Layer

- The transport layer receive data from the session layer on the source computer, which need to be send across to the other computer.

- For this , transport layer on the source computer breaks the data into smaller packets and give them to the network layer from which it goes to still lower layers and finally get transmitted to the destination machine.

- If the original data is to be recreated at the session layer of the destination computer we would need some mechanism for identifying the sequence in which the data was fragmented into packets by the transport layer of source computer.

Transport Layer

- For this purpose, when it breaks the session layer data into segments, the transport layer of the source computer adds sequence number to the segments.

- Now the transport layer at the destination can reassemble them to create the original data and present it to the session layer.
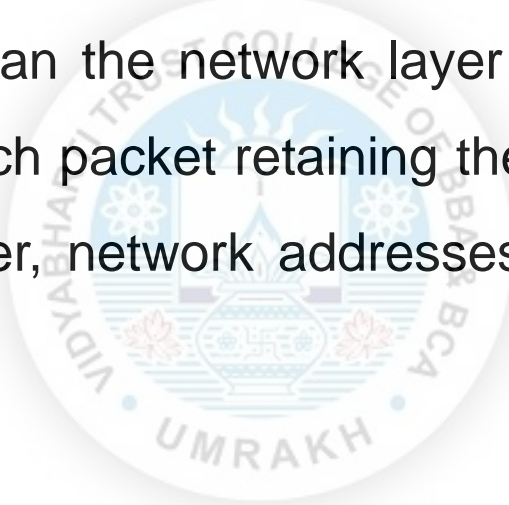
Port Addressing

To: you@example.com
From: me@example.com
Subject: Email

Different
Applications
Protocols
Port Numbers

Electronic Mail   HTML Page   Internet Chat

POP3   HTTP   IM

Transport

Application Port | Data
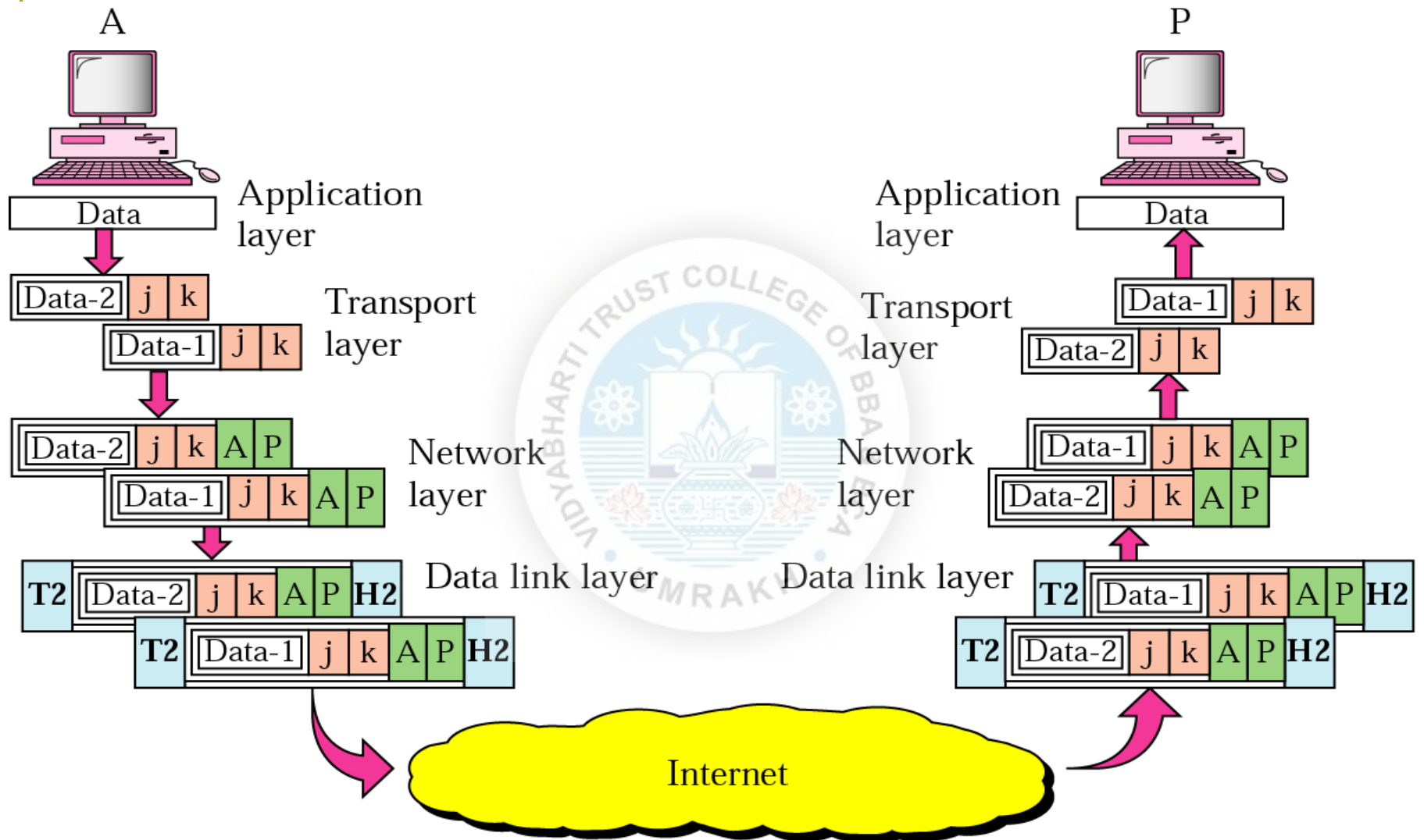110

Application Port | Data
80

Application Port | Data
531

Data for different applications is directed to the correct application because each application has a unique port number.

Figure shows an example of transport layer communication. Data coming from the upper layers have port addresses j and k (j is the address of the sending process, and k is the address of the receiving process). Since the data size is larger than the network layer can handle, the data are split into two packets, each packet retaining the port addresses (j and k). Then in the network layer, network addresses (A and P) are added to each packet.

A

Data — Application layer

Data-2 | j | k — Transport layer

Data-1 | j | k

Data-2 | j | k | A | P — Network layer

Data-1 | j | k | A | P

T2 | Data-2 | j | k | A | P | H2 — Data link layer

T2 | Data-1 | j | k | A | P | H2

Internet

P

Data — Application layer

Data-1 | j | k — Transport layer

Data-2 | j | k

Data-1 | j | k | A | P — Network layer

Data-2 | j | k | A | P

T2 | Data-1 | j | k | A | P | H2 — Data link layer

T2 | Data-2 | j | k | A | P | H2

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Services.

- Two types of service provided by transport layer: Reliable and Unreliable.

  Reliable service is one that make sure that data is not lost during transmission and to provide data error free. It ensure that the receiver acknowledge the receipt of each packet .

  Unreliable Service doesn't make mechanism to ensure that the receiver did receive the data sent.

Services

- Connection control: Transport layer can be either connection less or connection oriented.

  Connection Oriented :

  - First establish logical connection with receiver.

  - Send all packet through the connection.

  - Receiver send acknowledge after receiver packet.

  - Terminate connection.

  - Receiver receive packet in sequence.

Services

Connection Less :

- The sender doesn't establish a contact with receiver.

- Each packet route to different path.

- Receiver doesn't send acknowledgement.

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Continue…..

- **Segmentation and Reassembly**

  A message is divided into transmitted segments, known as packet, with sequence number. These number enable to the transport layer at other end to identify and reassemble packet.

- **Service Point Addressing (Port Address)**

  To deliver message from one computer's specific process to other computer's specific process Transport layer add Port address or service point address.

Continue…

- Flow Control

- Error Control

  Error control performed process to process. Sending transport layer make sure that entire message arrive at the receiving transport layer without error. Error control achieve through retransmission.
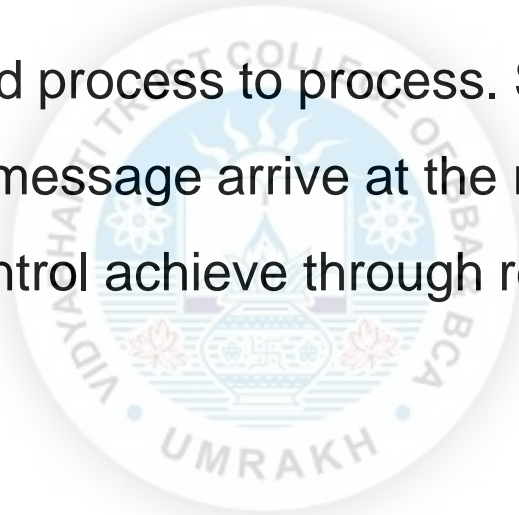
Protocol and Device.

- **Protocol :**

    TCP : Transmission Control Protocol

    UDP : User Datagram Protocol

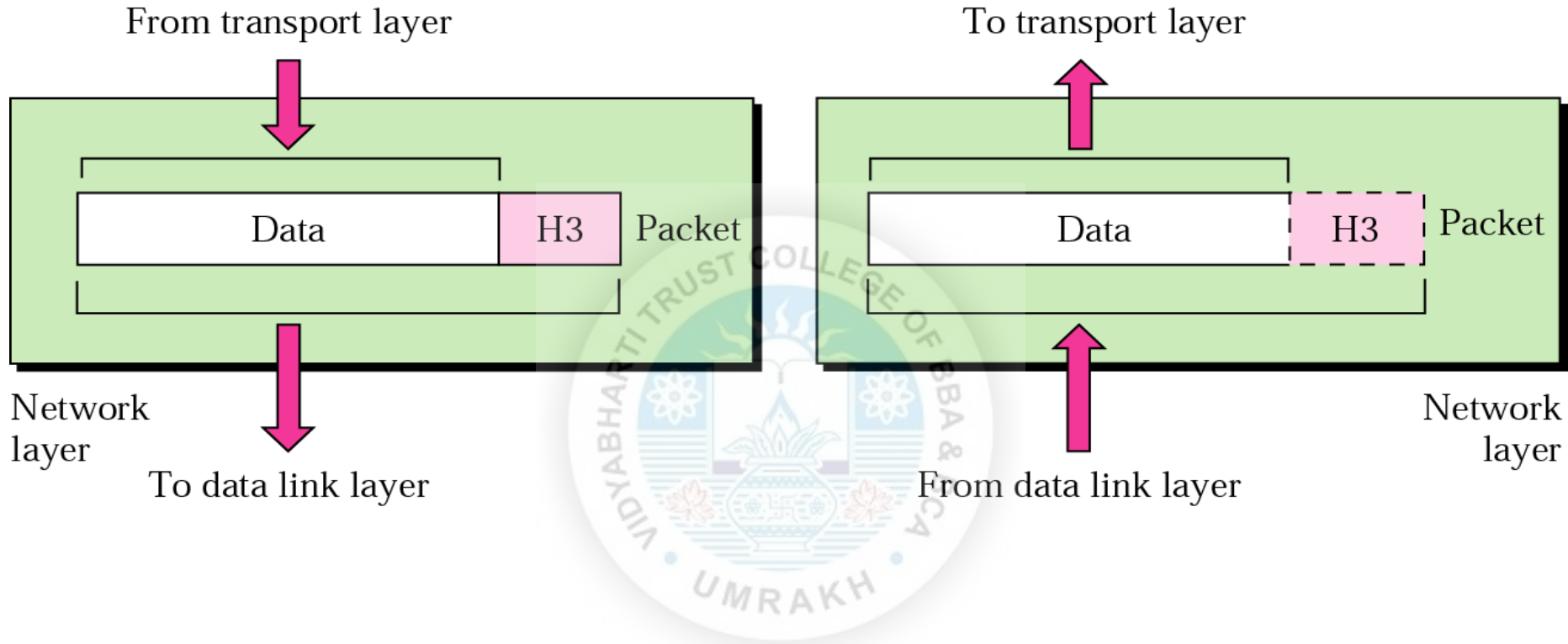   SCTP: Stream control Transmission Protocol

    SPX : Sequence Packet Exchange

    DCCP: Datagram Congestion Control Protocol

- **Device :** Gateway

Network Layer

- Responsible for the delivery of individual packets from the source host to destination host.

- Deliver packet across multiple network.

- If two system are connected to the same link, there is no need for network layer.

- If two system are attached to different network with connecting device, there is need for network layer .

From transport layer

To transport layer

Data | H3 | Packet

Data | H3 | Packet

Network layer

Network layer

To data link layer

From data link layer

Services.

- Logical Addressing (IP Address)

  If the packet pass the network boundary, we need another addressing system to help distinguish the source and destination system. The network layer add header to the packet coming from the upper layer and add logical address of source and destination.
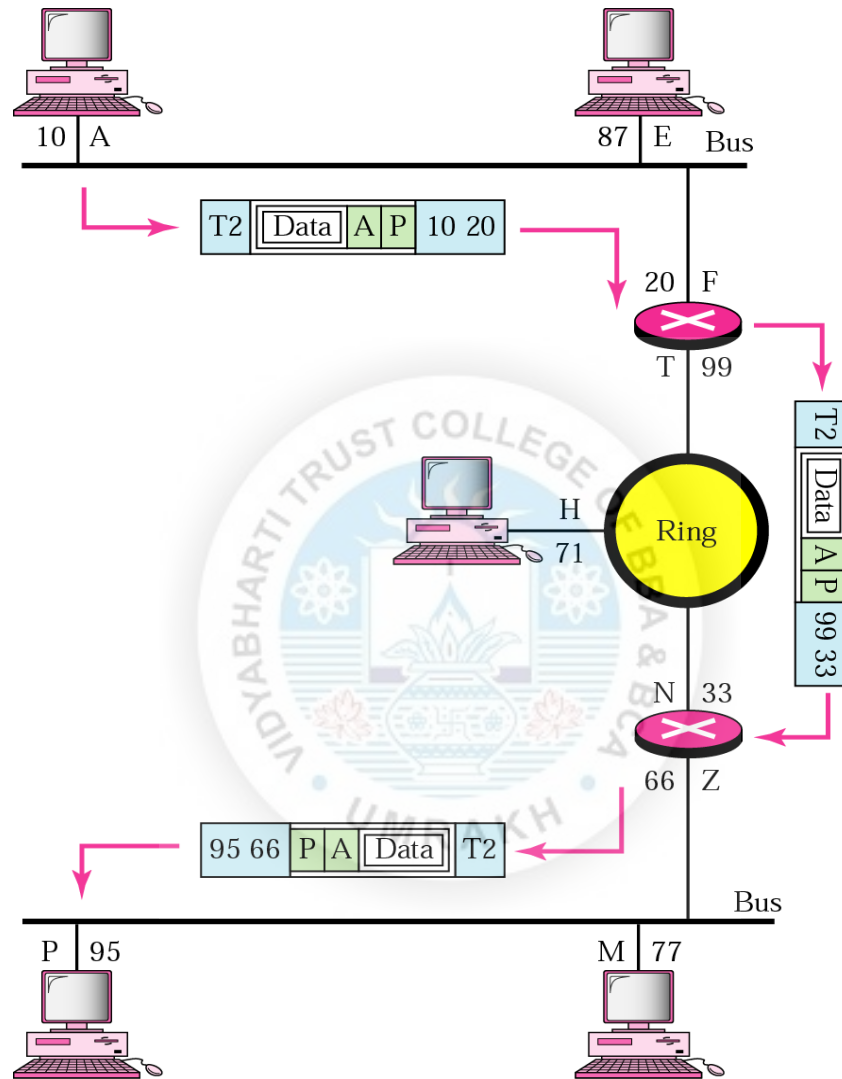
Continue…

- Routing

"Routing is the process of determining where to send data packets that are destined for addresses outside the local network. "

When independent network are connected to the large network , the connecting device route the packet to their final destination

Protocol and Device.

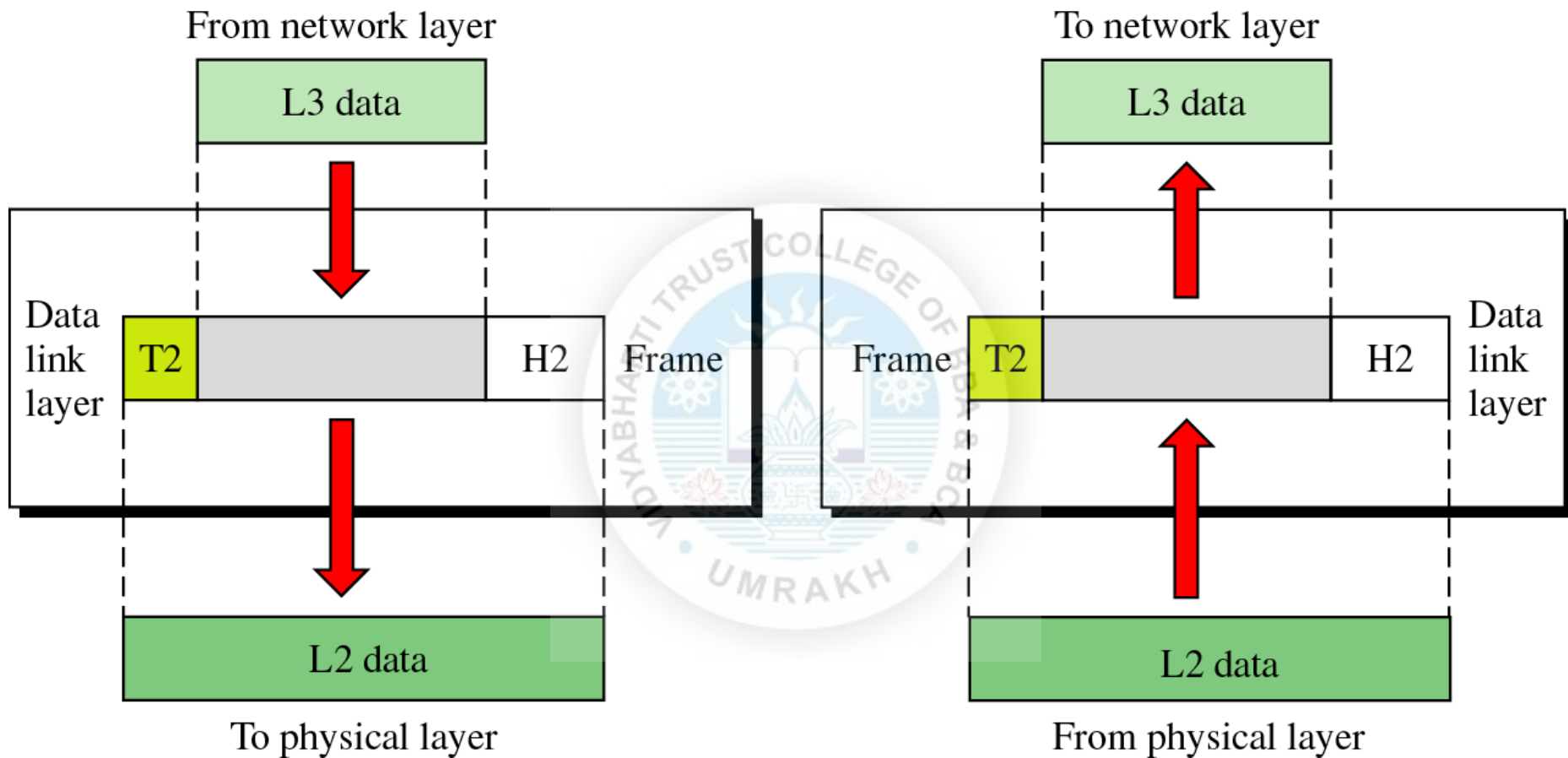| Protocol	Full Name
IP	Internet Protocol
RARP	Reverser Address Resolution Protocol
OSPF	Open Shortest Path First
ICMP	Internet Control Message Protocol
IPX	Internetwork Packet eXchange
IGRP	Interior Gateway Routing Protocol
EIGRP	Enhanced Interior Gateway Routing Protocol
BGP	Border Gateway Protocol

- **Device** : Router

- **Utility Used at this layer:** Ping, Tracert, Arp

10 A   87 E   Bus

T2 | Data | A | P | 10 20

20 F
T 99

T2 | Data | A | P | 99 33

H   Ring   71

N 33
66 Z

95 66 | P | A | Data | T2

Bus
P 95   M 77

In diagram we want to send data from a node with network address A and physical address 10, located on one LAN, to a node with a network address P and physical address 95, located on another LAN. Because the two devices are located on different networks, we cannot use physical addresses only; the physical addresses only have local jurisdiction. What we need here are universal addresses that can pass through the LAN boundaries. The network (logical) addresses have this characteristic.

Data Link Layer

- Responsible for moving data or frame over a common local media.

- Transform physical layer bit stream to reliable link at destination side.

- Makes Physical layer error free to upper layer.

- Data link layer has two sub layer

  - **LLC (Logical Link Control) :**

    - Upper most part of Data link layer

    - Responsible for error checking, flow control and synchronization.

  - **MAC (Media Access Control)**

    - Responsible for addressing in LAN, determine when nodes on LAN are allowed to transmit.

PROF. AMIT PATEL

From network layer

L3 data

Data link layer

| T2 | | H2 | Frame

To physical layer

To network layer

L3 data

Frame | T2 | | H2 |

Data link layer

From physical layer

L2 data

L2 data

PROF. AMIT PATEL

Responsibilities

- **Framing.**

  Divide the stream of bit receive from network layer into manageable data units called Framing.

- **Flow Control.**

  If the rate at which the data are absorb by receiver is less than the rate at which data are produced in sender, data link layer impose the flow control mechanism to avoid overwhelming.

Continue…

- Physical Addressing.

  If the frame are to be distributed to different system on the same network, the data link layer add the header to the frame to define the sender or receiver of the frame , if the frame is related to the system which is outsider of the local network, receiver address is the address of the device that connect the network to the next network.

Continue…

- **Error Control.**

  Adding mechanism to detect and retransmit damaged or lost frame. Also recognize duplicate frame. Error control achieve through trailer added to the end of frame.

- **Access Control.**

  When multiple device are connected to the link , data link layer determine which device has control over the link.

Protocol and Device

| PROTOCOL	FULL NAME
SDLC	Synchronous Data Link Conrol
HDLC	High Level Data Link Control
PPP	Point to Point Protocol
ATM	Asynchronous Transfer Mode
LLC	Logical Link Control
SLIP	Serial Line Internet Protocol
IEEE 802.3	
Frame Relay	
ARP	Address Resolution Protocol

- Device   : Hub, Switch, Bridge
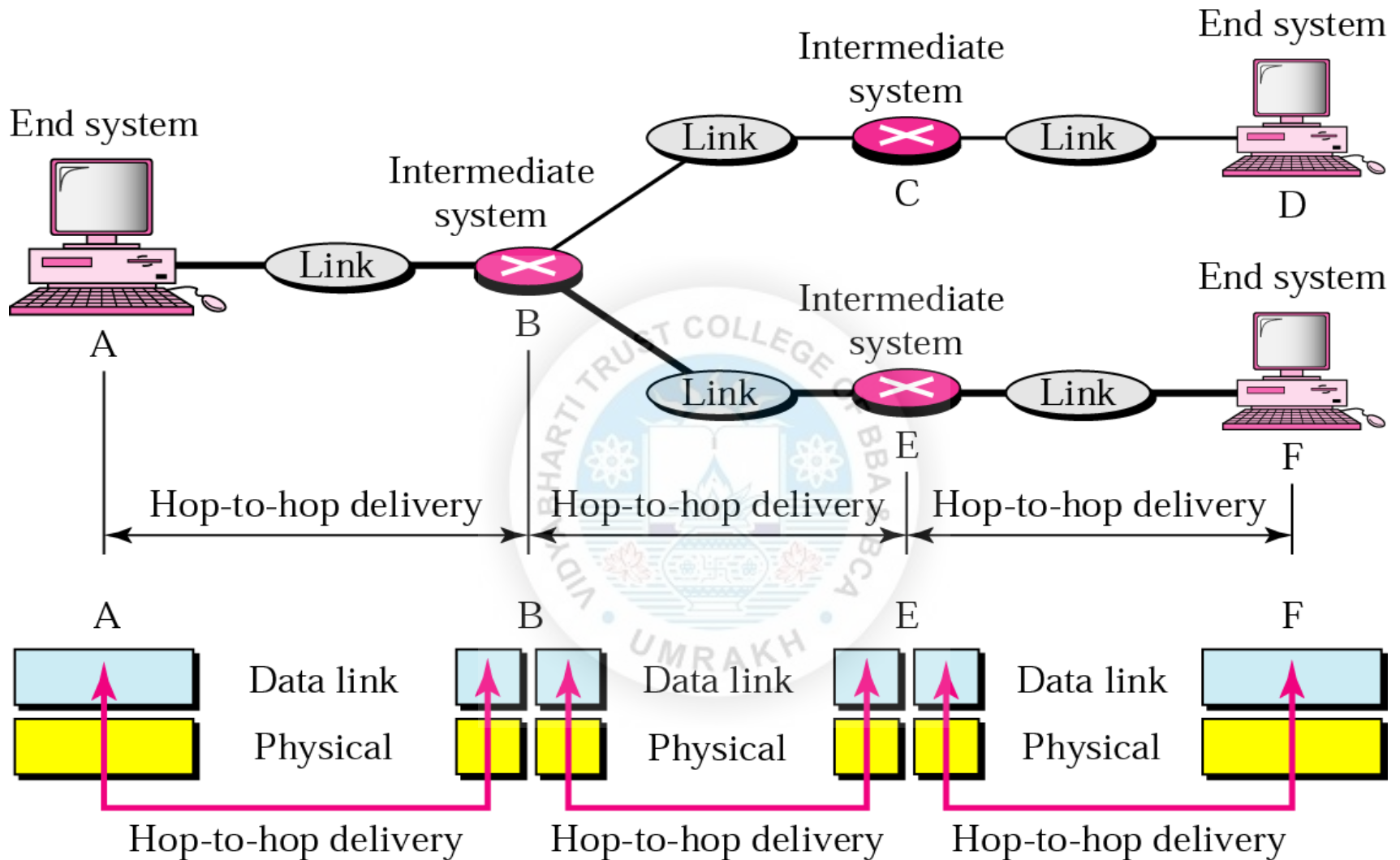
Continue…Send data from A to F

- 3 Partial Deliveries occurs.

- First, Data link layer at A send frame to data link layer at B.

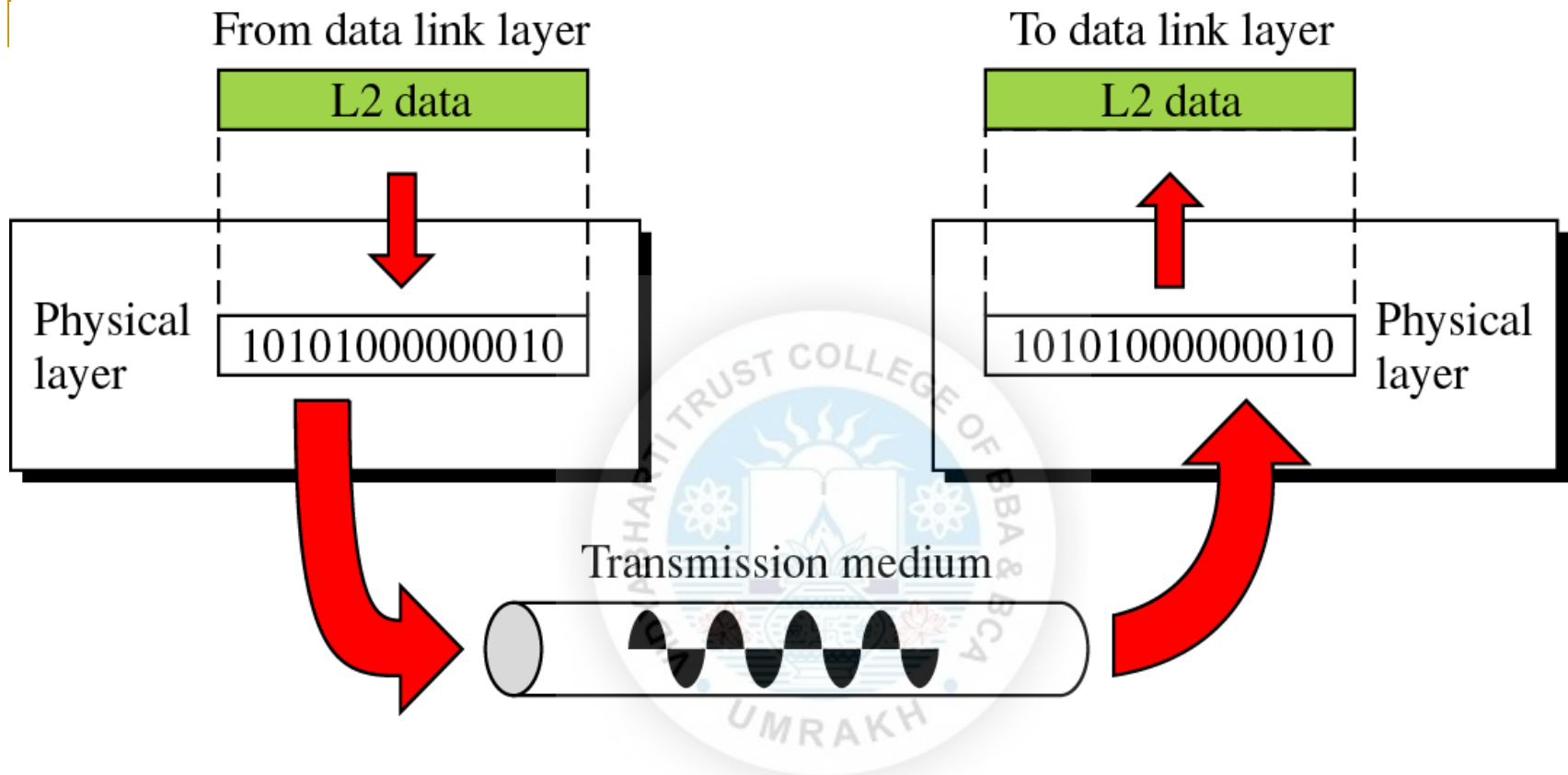- Second , Data link layer at B send frame to data link layer at E and E send to F.

In a node with physical address 10 sends a frame to a node with physical address 87. The two nodes are connected by a link. At the data link level this frame contains physical addresses in the header. These are the only addresses needed. The rest of the header contains other information needed at this level. The trailer usually contains extra bits needed for error detection

10	28	53	65	87

T2 Data 10 87

Trailer Source address Destination address
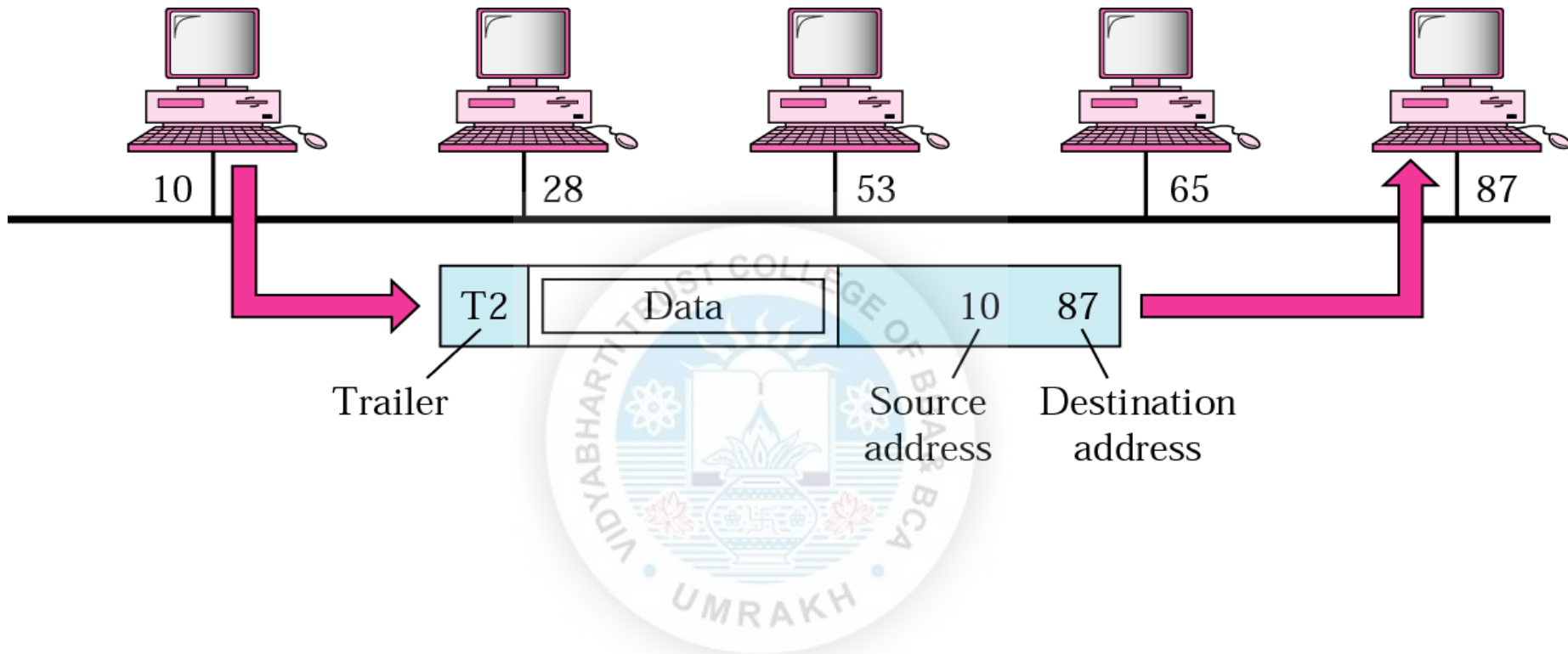
Physical Layer

- Concerned with sending raw bits between source and destination.

- To carry bit stream over a physical medium.

- Deal with electrical specification of transmission medium.

- Define procedure and function that physical device has to be perform for transmission.

- To send data, sender and receiver must agree on a number of factors such as what is the encoding of 0 and 1? Whether communication is half , full or simplex and so on.

From data link layer

L2 data

Physical layer

10101000000010

To data link layer

L2 data

10101000000010

Physical layer

Transmission medium

Responsibilities

- Physical characteristic of Medium.– Type of transmission media

- Representation of bits. – How 1 and 0 is encoded

- Data Rate (Transmission Rate) – speed

- Physical Topology.

- Transmission mode. --- data flow type

- Signal Type – Are analog or digital signal?

- Transmission type – Is the transmission parallel or serial?
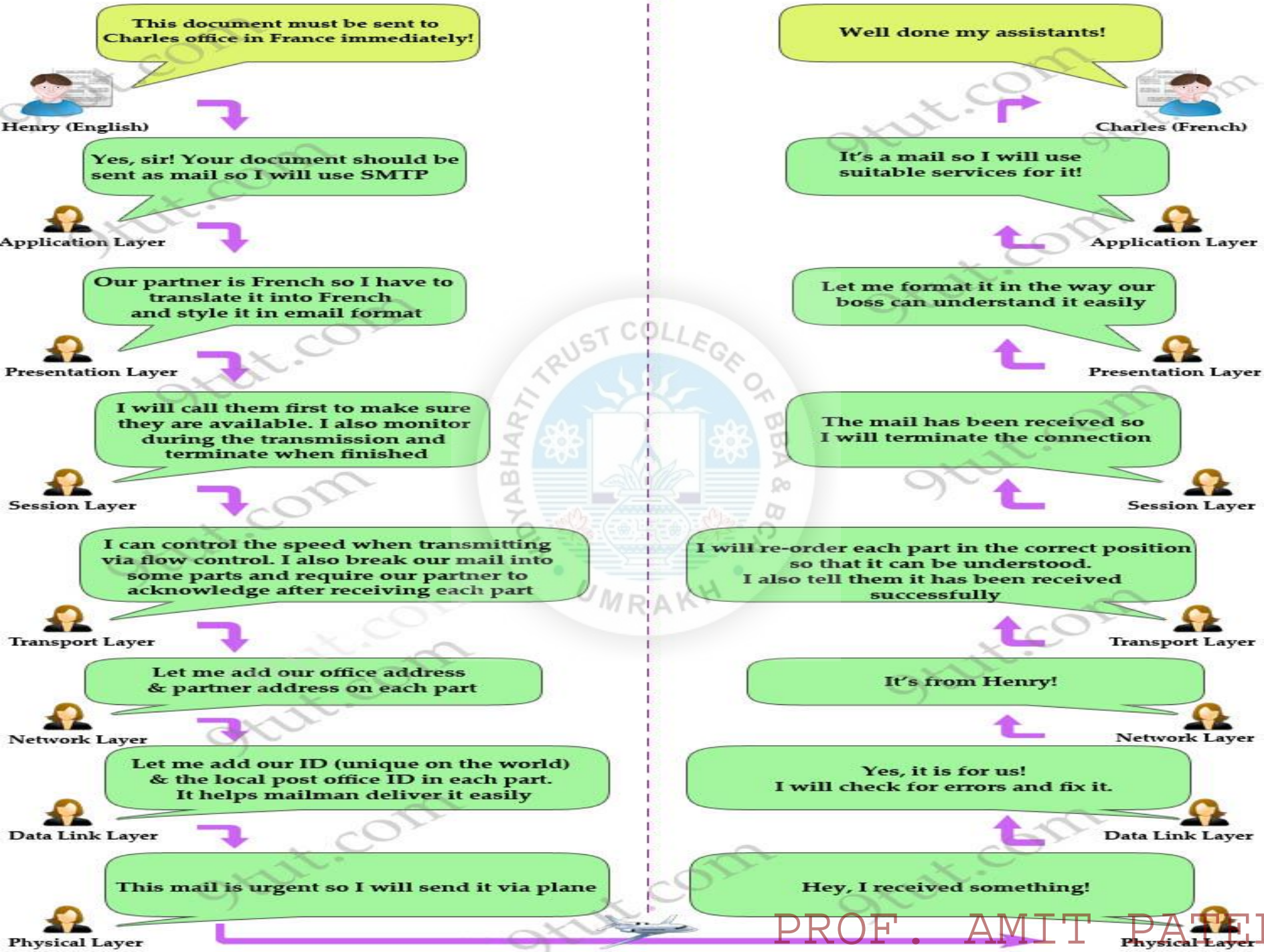
TCP/IP Model
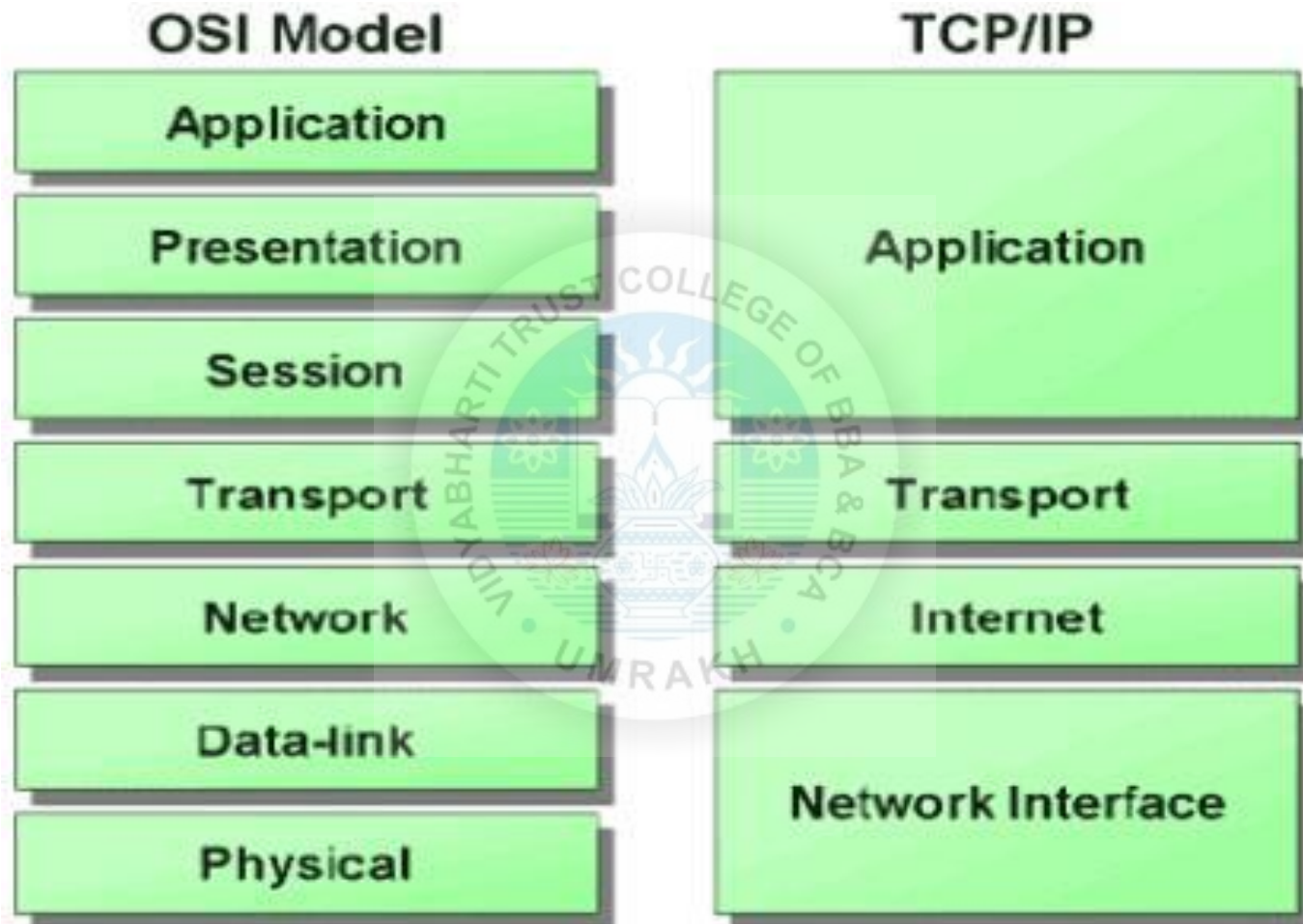
TCP/IP and the OSI model

OSI Vs TCP/IP Model

OSI	TCP/IP
OSI is reference model	Implementation of OSI model.
7 layer architecture	Only 4 layer architecture.
Generic protocol independent standard.	Standard around which internet has developed.
Concept of service, interface and protocol are well explained.	Not clear explanation of services, protocol and interface.
Provide connection oriented service at transport layer.	Provide connection less and connection oriented service.
Provide only connection less and connection oriented service at network layer	Provide only connection less service at network layer.
All layer are separate.	Combine presentation and session layer into application layer and data link and physical layer into network access layer.

PROF. AMIT PATEL

Broadcast, Unicast and Multicast

- Broadcast : Broadcast is a type of transmission in which information is sent from just one computer but is received by all the computers connected to the network.

- Unicast : Unicast is a type of transmission in which information is sent from only one sender to only one receiver. Unicast transmission is between one-to-one nodes (involving two nodes only).

- Multicast : **Multicast** is the delivery of a message or information to a group of destination computers simultaneously in a single transmission from the source