classmate
Date
Page

Chapter - 2

Established in 1947, International standards Organization (ISO) is a multinational body dedicated to worldwide agreement on international standards.

An ISO standard that covers all aspect of network communications is Open System Interconnection (OSI) model.

The OSI model is not a protocol, it is a model for understanding hardware and software, designing a network architecture that is flexible, robust and interoperable.

Note: ISO is an organization & OSI is a model.

The MODEL -

OSI model is a layered framework for the design of network system that allows for communication across all types of computer systems.

It consists of seven separate but related layers, each of which defines a segment of process of moving information across the network.

Layered Architecture

7	Application layer	Away
6	Presentation layer	Pizza
5	Session layer	Sausage
4	Transport layer	Throw
3	Network Layer	Not
2	Data link layer	Do
1	Physical layer.	Please

Functions of the layers :-

1. Physical layer :-

- Physical characteristics of interfaces and media - defines the characteristics and type of transmission medium.

- Representation of bits :- The physical layer data consists of stream of bits (sequence of 0 and 1)

To be transmitted, bits must be encoded into signals (electrical or optical)

The physical layer also defines the type of encoding (How 0s and 1s are changed to signals)

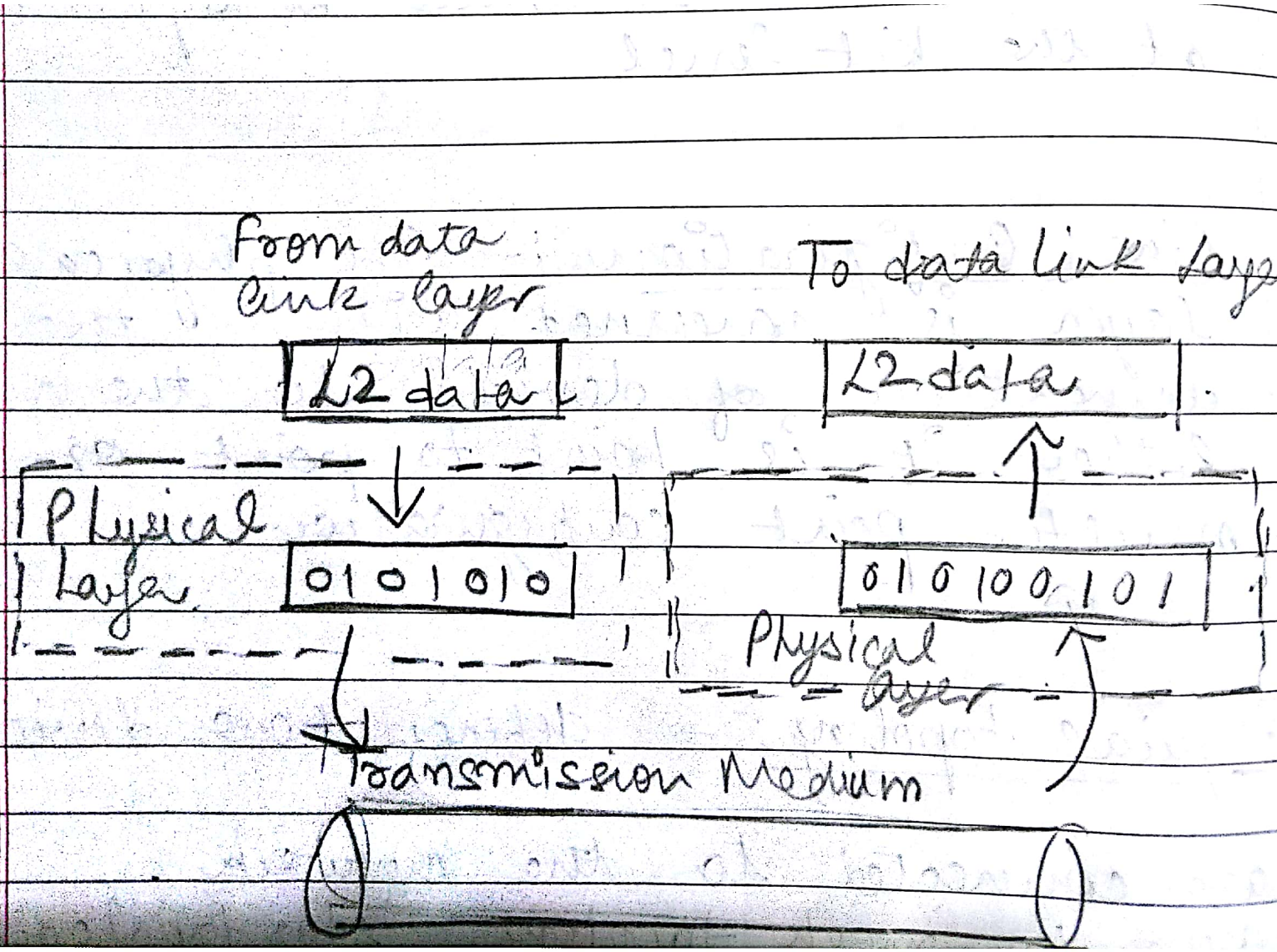
- Data rate :- That is transmission rate, the number of bits sent each second is also defined by the physical layer.

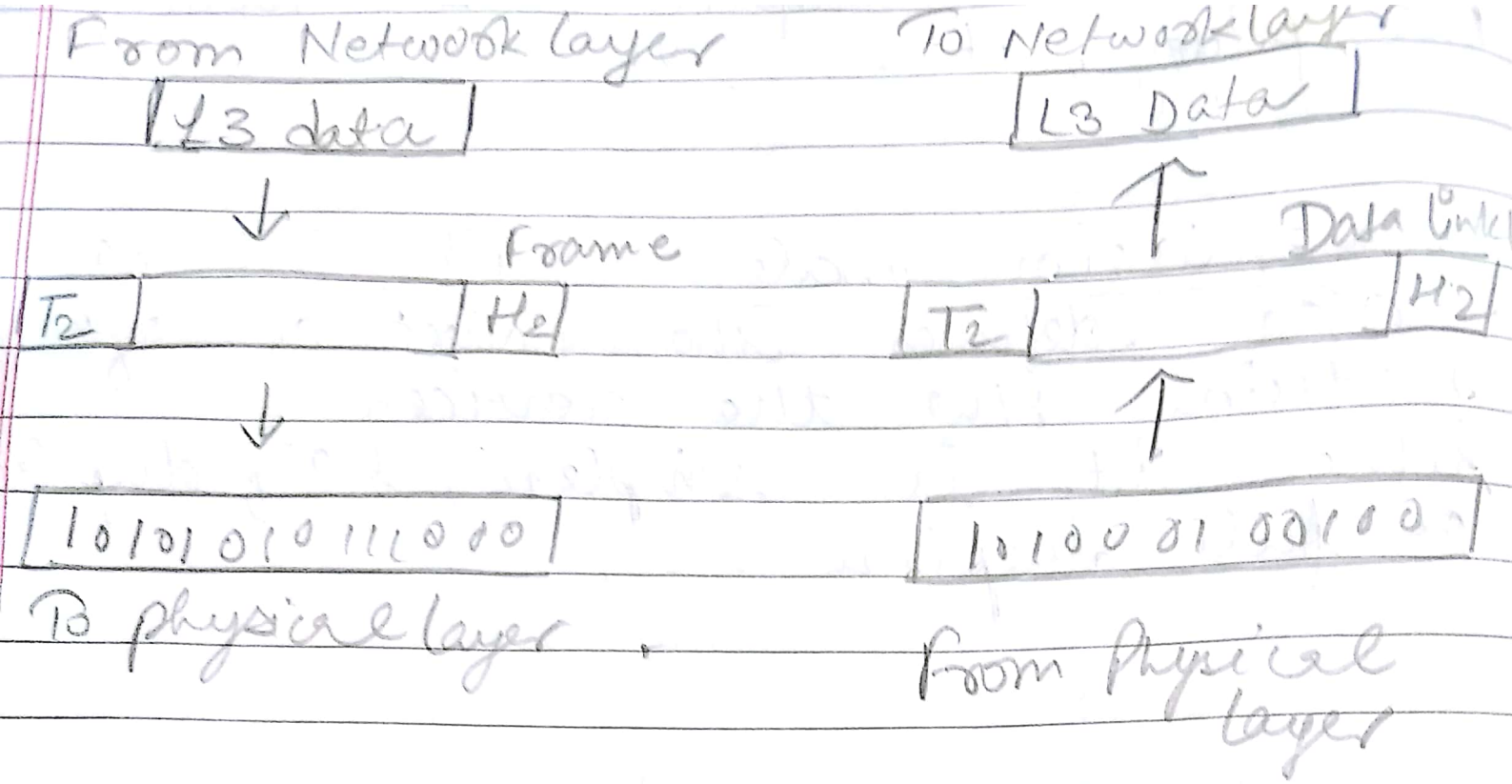
- Synchronization of bits :- The sender and receiver must be synchronized at the bit level.

- Line Configuration :- The physical layer is concerned with the connection of devices to the medium either it is point to point or multi-point configuration

- Physical topology :- defines how devices are connected to the network. either by mesh topology, star topology, bus topology, etc.....

Transmission mode :- Physical layer also defines the direction of medium b/w the devices either it is simplex, half duplex or full duplex...


From data link layer
L2 data
To data link layer
L2 data
Physical layer
0 1 0 1 0 1 0
0 1 0 1 0 0 1 0 1
Physical layer
Transmission Medium


From Network layer
L3 data
Frame
T2
H2
10101010111000
To physical layer
To Network layer
L3 Data
Data Link
T2
H2
10100101001000
From Physical layer

2. Data Link layer :-

The data link layer is responsible for —

" Node to Node Delivery "

1. Framing - The data link layer divides the stream of bits received from the network layer into manageable data units called frames.

2. Physical Addressing - If frames are to be distributed to different systems on the network, the data link layer adds a header to the frame to define the physical address of the sender (Source address) and/or receiver (desination address) of the frame.

If the frame is intended for the system outside the sender's network the receiver address is the address of the device that connects one network to the next.

- Flow Control - If the rate at which data are absorbed by the receiver is less than the rate produced by the sender, the data link layer imposes a flow control mechanism to prevent overwhelming the receiver.

- Error Control :-

The data link layer adds reliability to the physical layer by adding mechanism to detect and retransmit damaged or lost frames.

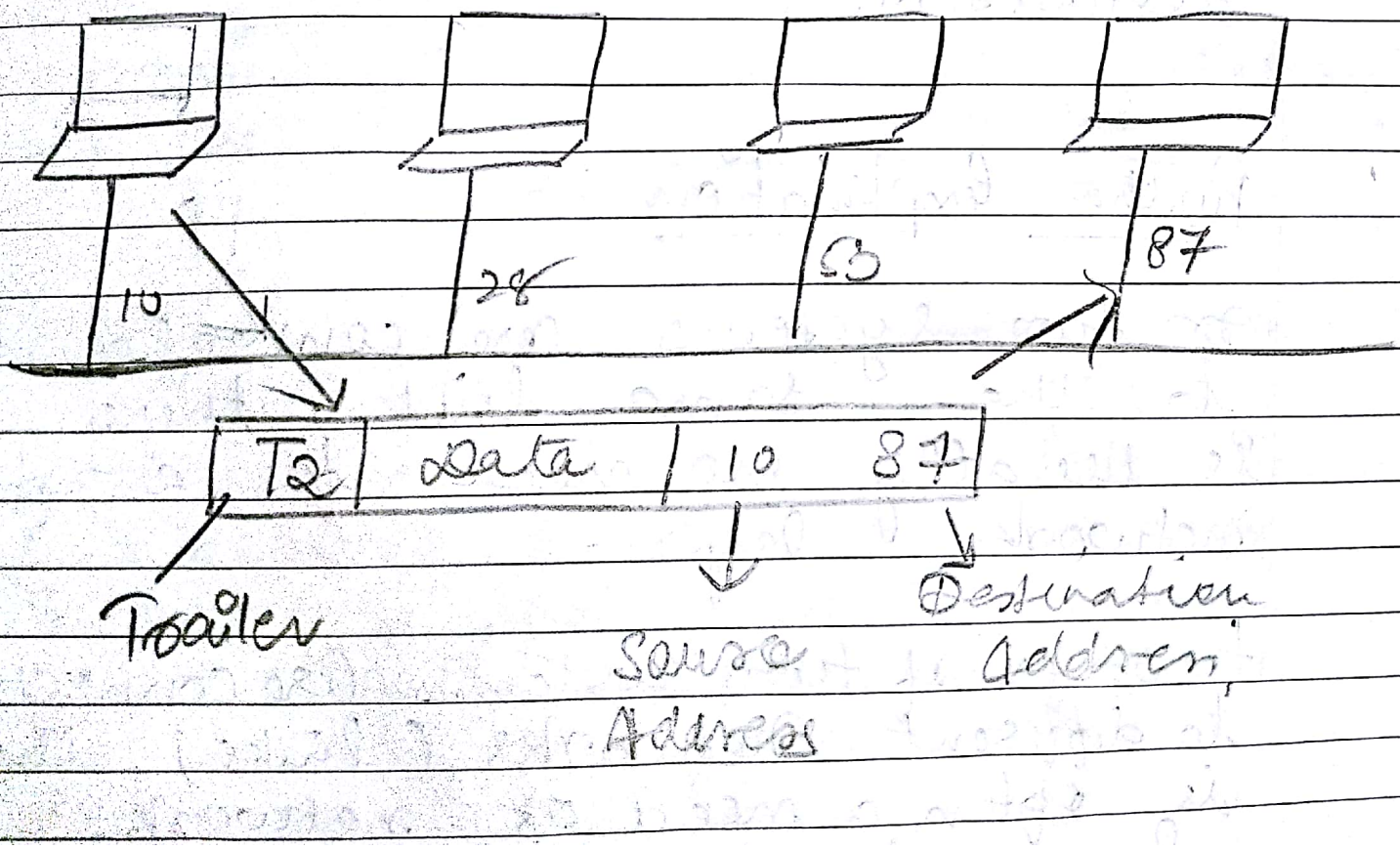
Error control is normally achieved through a trailor added to the end of the frame.

- Access Control :- when two or more devices are connected to the same link, data link layer protocols are necessary to determine which device has control over the link at any given time.

eg: In the figure below, a node with physical address 10 sends a frame to the node with physical address 87. The two nodes are connected by the link.

At data link level, this frame contains (link) addresses in the header.

These are the only addresses needed. The trailer actually contains extra bits for error detection.



3. Network layer :- The network layer is responsible for the source to destination delivery of a packet across multiple networks.

Whereas the data link layer oversees the delivery of the packet between two systems on the same network (link).

The network layer ensures that each packet gets from its point of origin to its final destination.

Further Explanation :-

If two systems are connected to the same link, there is usually no need for a network layer.

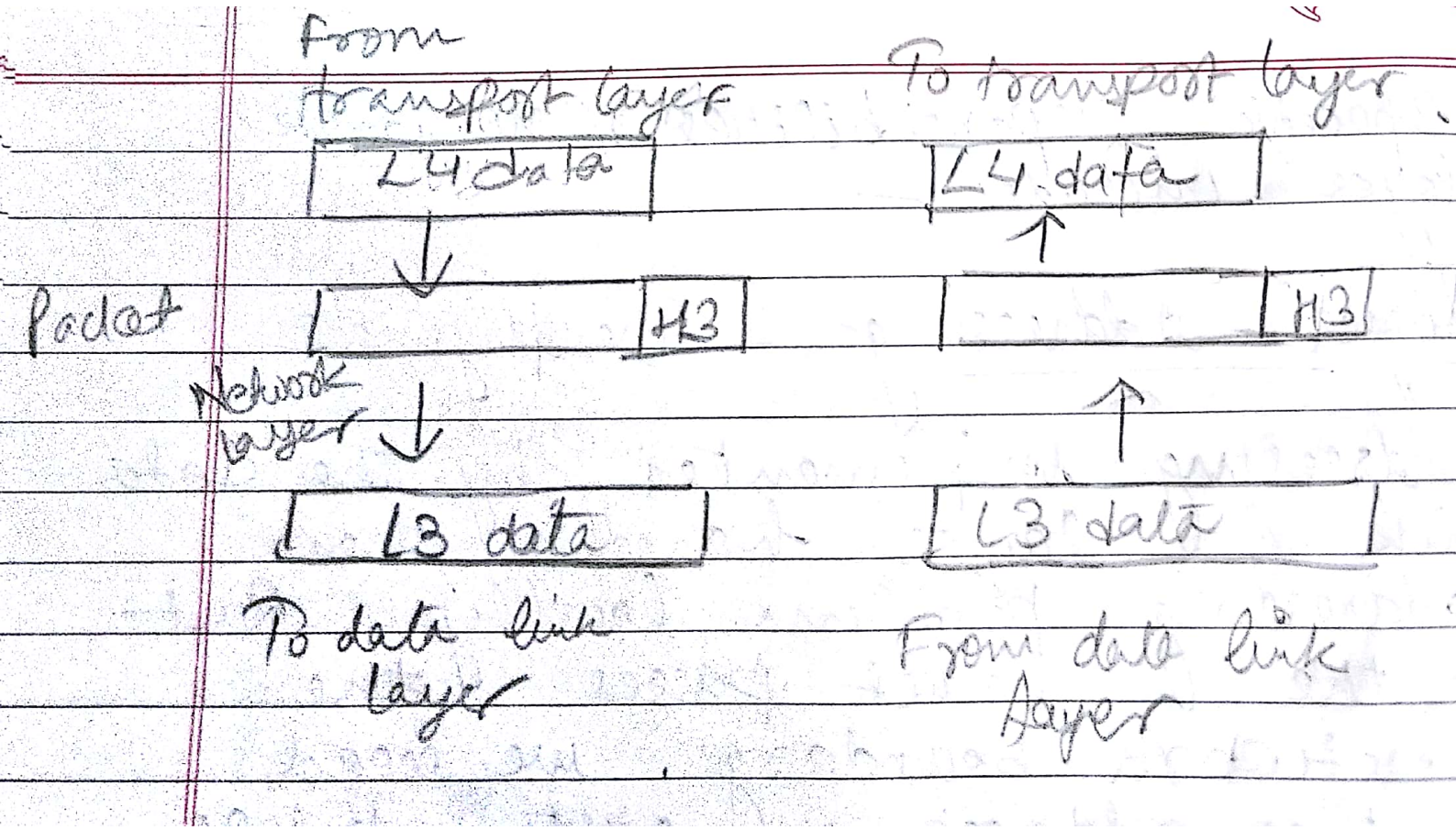
However if two systems are connected to different networks (links), there is often a need of network layer to accomplish source to destination delivery.

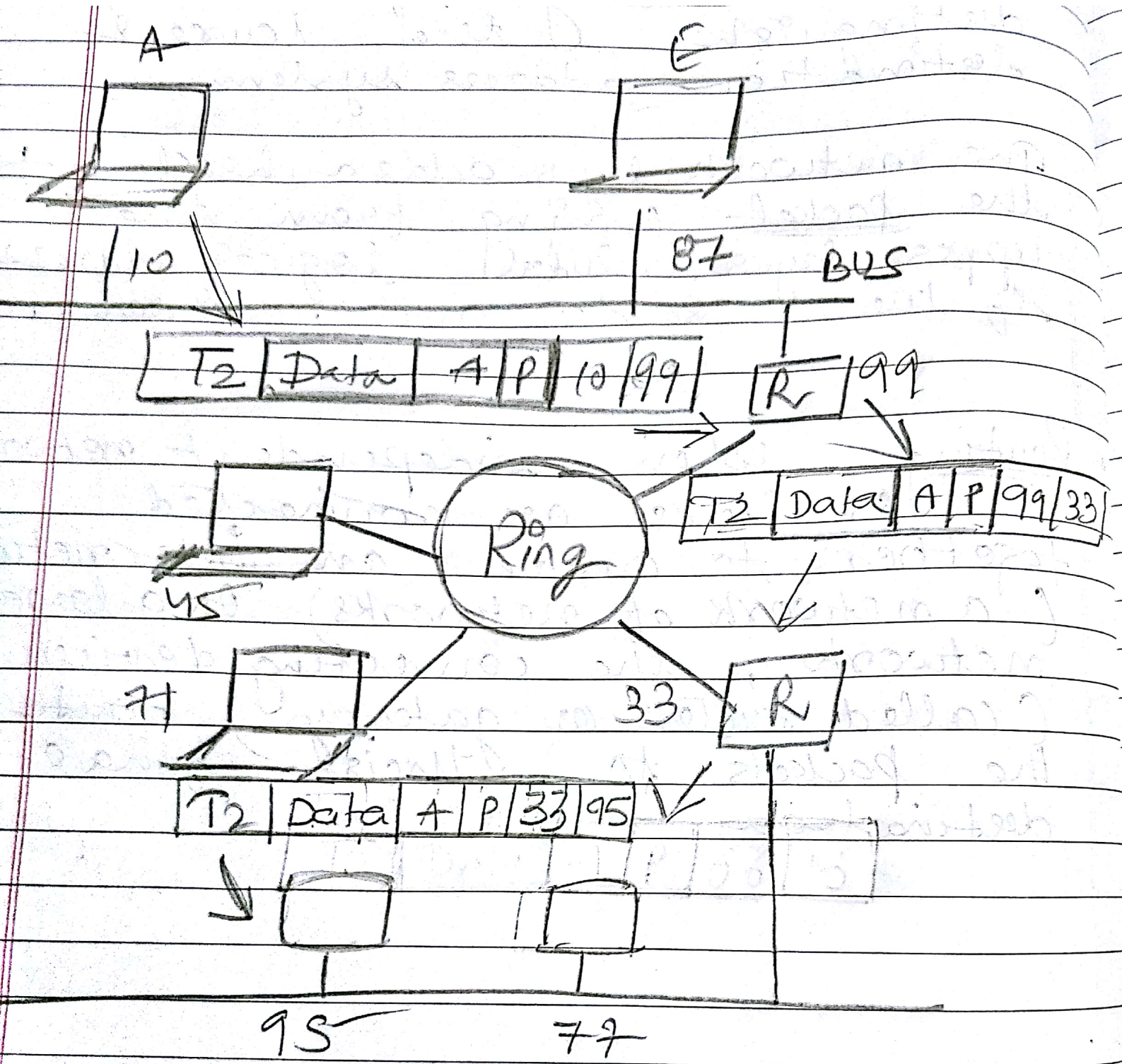
specific responsibilities of network layer includes —

- Logical Addressing — The physical addressing implemented by the data link layer handles the addressing problem locally. But if the packet passes the network boundary, we need another addressing system to help distinguish the source & destination address systems.

The network layer adds a header to the packet coming from the upper layer. includes logical addresses of the sender and receiver.

- Routing :- When independent networks or links are connected together to create an Internetwork (a network of networks) or a large network, the connecting devices (called routers or gateways) route the packets to their final destination.


From transport layer
L4 data
Packet
H3
Network layer
L3 data
To data link layer
To transport layer
L4 data
H3
L3 data
From data link layer


A
C
10
87
BUS
T2 | Data | A | P | 10 | 99
R
99
T2 | Data | A | P | 99 | 33
Ring
45
71
33
R
T2 | Data | A | P | 33 | 95
95
77

Example :- Imagine if we want to send the data from a node with network address A and physical address 10, located on one area network, to the node with a network address P and physical address 95, located on another local area network.

Because the two devices are located on different networks, we can not use physical addresses only. What we need here are universal addresses that can pass through the boundaries of local area network.

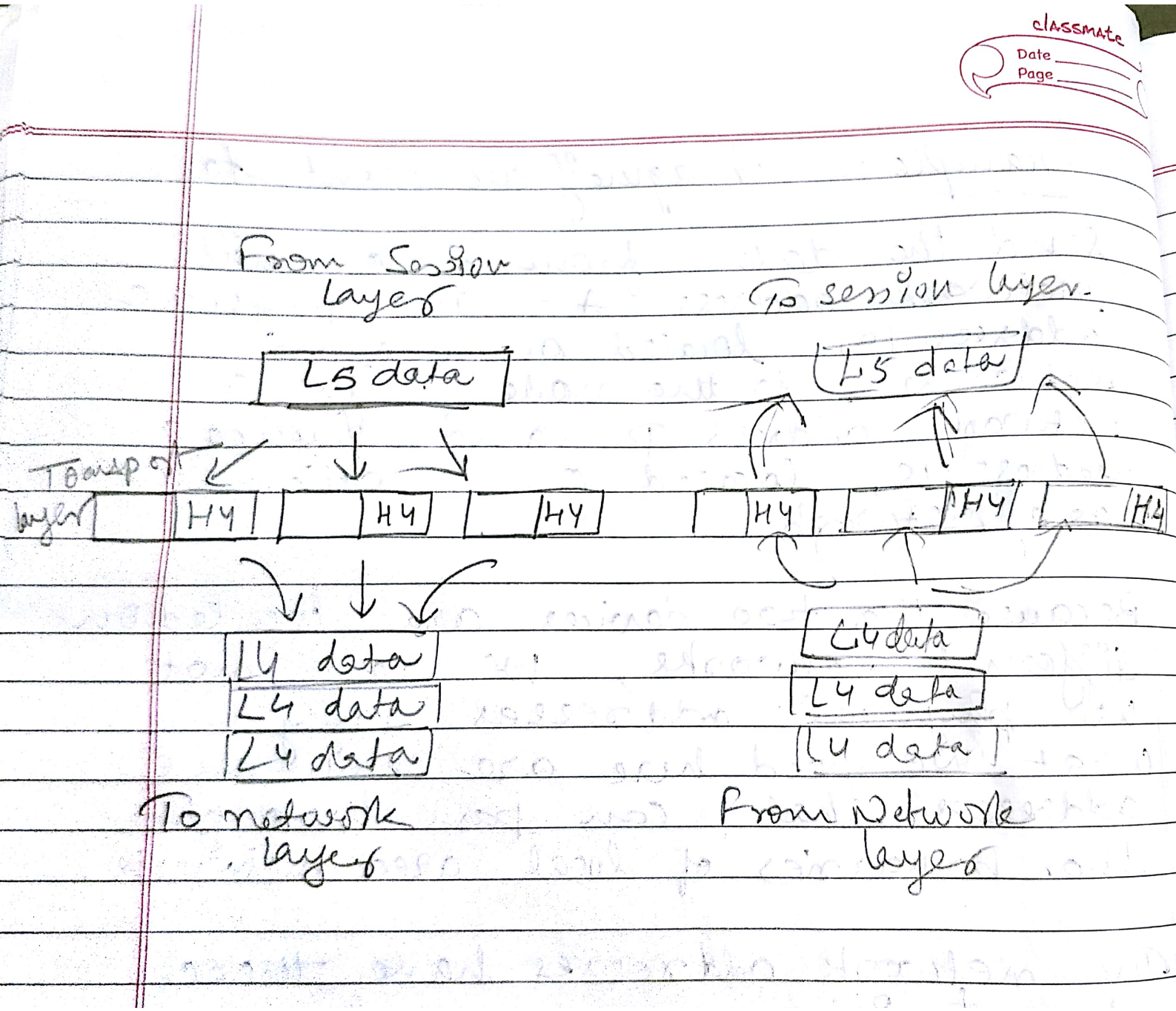
The network addresses have these characteristics.

The packet at network layer contains the logical addresses which remain the same from original source to final destination (A and P respectively in the figure).

They will not change when we go from network to network.

However the physical addresses will change when packet moves from one network to another.

The box with [R] is a Router.


From Session layer
L5 data
Transport layer
H4
H4
H4
L4 data
L4 data
L4 data
To network layer
To session layer.
L5 data
H4
H4
H4
L4 data
L4 data
L4 data
From Network layer

4. Transport Layer :- is responsible for source to destination (end to end) delivery of entire message.

whereas the network layer oversees end to end delivery of individual packets. It does not recognize relationship between those packets.

It treats each one independently, as though each piece belong to a separate message, whether or not it does.

The transport layer on the other hand ensures that the whole message arrives intact and in order, overseeing both error control & flow control at source to destination level.

- Service point addressing :- Computers often run several programs at the same time. for this reason, source to destination delivery means delivery not only from one computer to the next but also from a specific process (running program) on one computer to the specific process (running program)

on the another.

The transport layer header must include a type of address called a service point address (or port address)

The network layer gets each packet to the correct computer, the transport layer gets the entire message to the correct process on that computer.

Segmentation & Reassembly:-

A message is divided into transmitable segments, each segment containing a sequence number.

These numbers enable the transport layer to reassemble the message correctly upon arriving at the destination and to identify and replace packets that were lost in transmission.

- Connection Control:- The transport layer can either be connectionless or connection oriented.

A connectionless transport layer treats each segment as an independent packet and delivers it to a transport layer at the destination machine.

A connection-oriented transport layer makes a connection with the transport layer at destination machine first before delivering the packets. After all the data is transferred, the connection is terminated.

- Flow Control:- like data link layer, transport layer is also responsible for flow control.

However flow control at this layer is performed (end to end) rather than across the link.

- Errors Control :- Error control is performed here (end to end) rather than accross a single link. The sending transport layer makes sure that the entire message arrives at the receiving transport layer without error (damage, lost, duplication).

Error Correction is usually achieved through retransmission.

- For added security - transport layer may create a connection between two end points. A connection is a single logical path b/w the source and destination that is associated with the packets in the message.

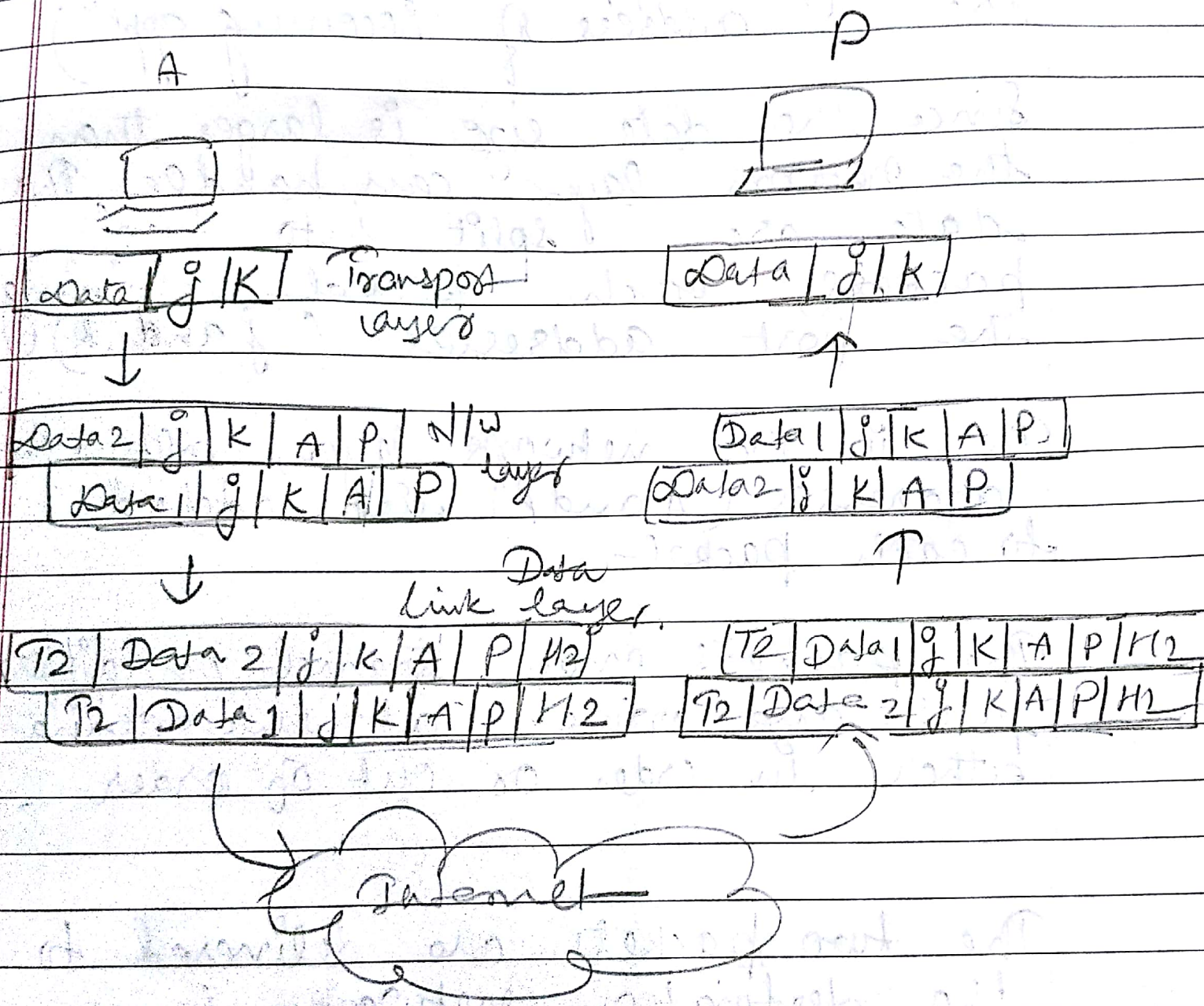
Creating a connection involves 3 steps —

Connection establishment
Data Transfer
Connection Release.

By confirming transmission of all the packets to a single pathway, the transport layer

has more control over sequencing, flow & error detection & correction.

Example



Data coming from the upper layers have service point (port) addresses j and k (j is the address of sending application and k is the address of receiving appl")

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.

The packets may travel on different paths and arrive at the destination either in order or out of order.

The two packets are delivered to the destination network layer, which is responsible for removing the network layer headers.

The two packets are now passed to the transport layer, where they are combined for delivery

to upper layers.

5) Session Layer:-

The services provided by first 3 layers (physical, data & network) are not sufficient for some processes

The session layer is the network dialog controller.

It establishes, maintains and synchronizes the interaction between communicating systems.

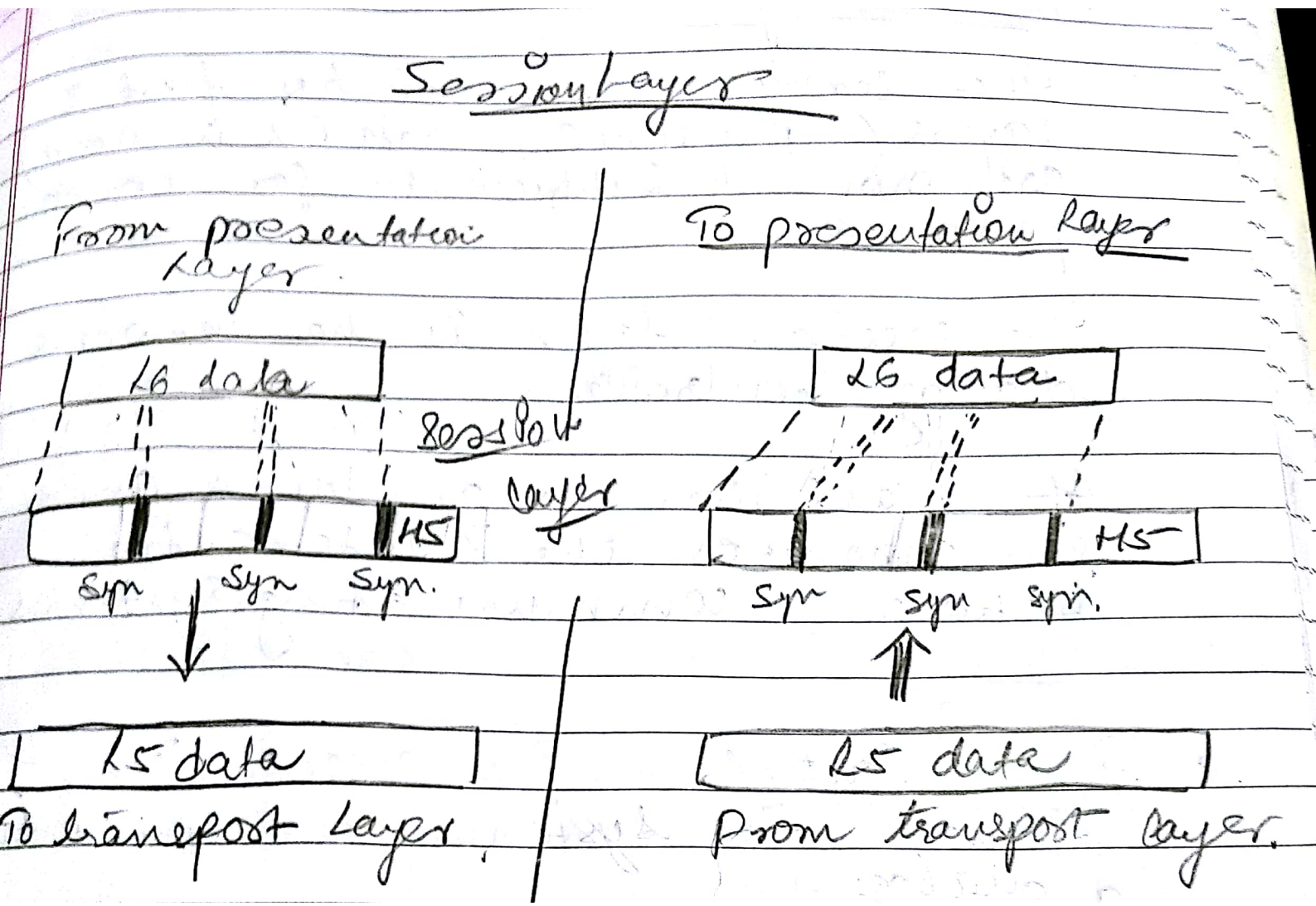
- Dialog Control :- The session layer allows two systems to enter into a dialog.

- Synchronization - The session layer allows a process to add checkpoints into a stream of data. For Example if a system is sending a file of 2000 pages, it is advisable to insert and acknowledged ~~in between~~

to insert checkpoints after every 100 pages to ensure that each 100 page unit is received and acknowledged independently.

In this case, that if crash occurs during the transmission of page 523, retransmission begins at page 501, page 1 to 500 are not re-transmitted.

Session layer



Presentation Layer

From application Layer

L7 data

↓

Encoded, Encrypted & compressed data | H6

↓ Presentation Layer

L6 data

To session Layer

To application Layer

L7 data

↑ Presentation Layer

Decoded, decrypted & decompressed data | H6

↑

L6 data

From session Layer.

6. Presentation layer:- It is concerned with syntax and semantics of the information exchanged between two systems.

- Translation - The processes (running programs) are usually exchanging information in the form of strings, numbers & so on.....

Because different computers use different encoding systems, the presentation layer is responsible for inter-operability between these different encoding methods.

The presentation layer at sender changes the information ~~from~~ from its sender dependent format into common format.

The presentation layer at receiving ~~machine~~ machine changes the common format into receiver dependent format.

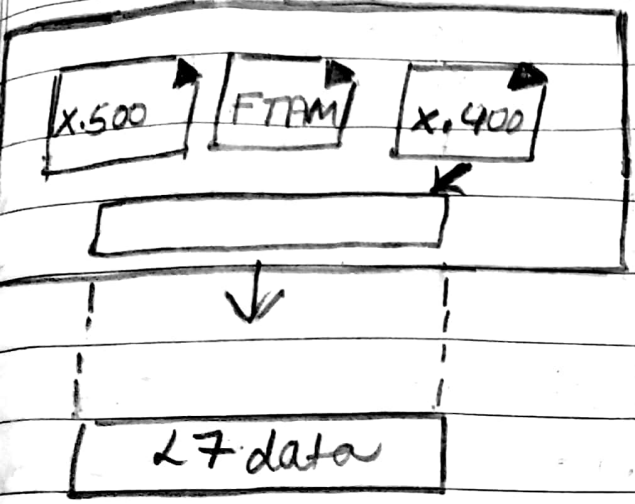
Encryption — To carry sensitive information, a system must be able to ensure privacy.

This layer provides the facility of Encryption & Decryption.

Compression - This layer handles data compression also. Data Compression becomes particularly important in the transmission of multi-media such as text, audio, video. etc

Application layer.

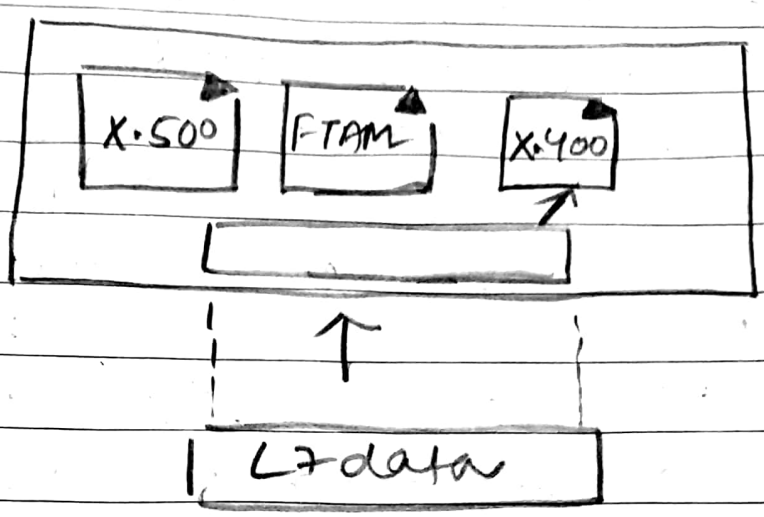
User



To presentation layer.

Application layer.

User



From Presentation Layer

7. Application layer - It provides user interfaces and support for services such as electronic mail, remote file access & transfer, shared database management & other types of distribution services

Figure below shows three services of application layer (out of many services)

1. X.400 - message handling service
2. X.500 - directory handling service.
3. FTAM - File transfer, access & management.

- Network Virtual terminal :- A network virtual terminal is a software version of a physical terminal and allows a user to log on to a remote host.

To do so, the application creates a software emulation of a terminal at the remote host.
The user's computer talks to

the software terminal which in turn talks to the host, & vice versa.

FTAM :→
This application allows users to access files in remote computer, to retrieve & manage files from remote computer.

Mail Services - The application provides the basis for email forwarding & storage.

Directory Services - The application provides distributed database sources and access for Global information about various objects & services.

Summary of layer functions -

Application	To allow access to H/W resources
presentation	To translate, encrypt & compress data
Session	To establish, manage & terminate sessions
Transport	To provide reliable end to end message delivery & error recovery
Network	To move the packets from source to destination
Data Link	To organize bits into frames, To provide node to node delivery
physical	To transmit bits over a medium, to provide mechanical & electrical specifications

Application layer
Type of communication: email, file transfer, client/server

Transaction Services

Presentation layer
Encryption, Data Conversion: ASCII to EBCDIC, BCD to Binary etc.

Presentation Services

Session layer
Starts, stops session
Maintains order

Data Flow control

Transport layer
ensures Delivery of entire file or Message

Transmission control

Network layer
Routes data to different LANs & WANs based on network address

Path control

Data Link (MAC) layer
Transmits packet from Node to Node based on station address

Data Link control

Physical layer
Electrical Signals & Cabling

Physical control

OSI MODEL

Data	Application	Network process to Application
Data	Presentation	Data Representation & Encryption
Data	Session	Inter - Host communication
Segments	Transport	End to end connection
Packets	Network	path Determination & IP
Frames	Data Link	MAC (Physical addressing)
Bits	Physical	Medium, Signal & Binary Transmission