



नेपाल सरकार

शिक्षा मन्त्रालय

परीक्षा नियन्त्रण कार्यालय, सानोठिमी एसएलसी थप उत्तरपुस्तिका

थप उत्तरपुस्तिकाको दुवैतर्फ यसै पेजदेखि लेखनहोला । यसमा सि.न. तथा अन्य कुनै सद्केत लेखेको पाइएमा परीक्षा रद्द हुनेछ ।

Telcom

LEG

RATIN MISHRA

(200128) BEIT

विषय..... मिति

मूल उत्तरपुस्तिका नं

निरीक्षकको सही:

Set_1

1) Draw a neat diagram of PSTN hierarchy and explain the role of local and tandem exchange. Also explain transmission impairment

→

Class 1

Regional
Center

International

Class 2

Sectional
center

Sectional
Center

National

Class 3

Primary
Center

Primary
Center

Call
Center

Call
Center

Inter-tan
trunks

Highway
trunks

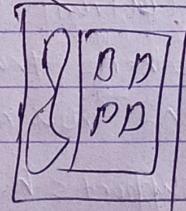
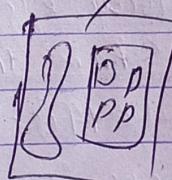
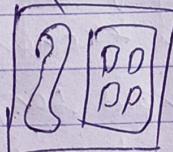
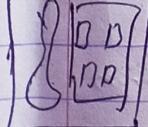
Class 4

Central
office

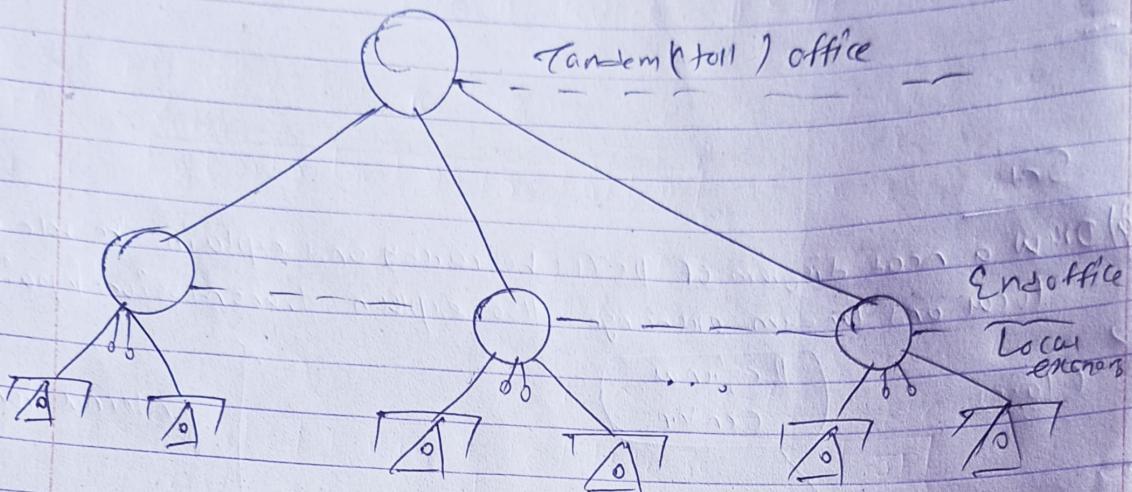
Central
office

Inter office
trunks

Local



④ Roles of local & tandem exchange :



1) Local Exchange (End office) :

- • It connects / links individual subscribers telephone (via local loops) to n/w
- Manages call routing for users in same geographical area
- forward non-local call to appropriate tandem exchange
- Routing based on telephone numbers
 - if 3 digits → To determine call as local or long distance
- Maintains subscriber record and connects from to telephone n/w.

2) Tandem Exchange (

- "An intermediate switching center that connects multiple local exchanges
- Routes long distance calls as it handles communication betn local exchanges for long distance
- Gathers traffic from multiple local exchanges and routes it efficiently to avoid congestion
- Supports high capacity transmission through optical fibers and can manage hundreds / thousands of connections



नेपाल सरकार

शिक्षा मन्त्रालय

परीक्षा नियन्त्रण कार्यालय, सानोठिमी
एसएलसी थप उत्तरपुस्तिका

विषय

मिनि

मूल उत्तरपुस्तिका नं

निरीक्षकको सही:

प उत्तरपुस्तिकाको दुवैतर्फ यसे पेजदेखि लेख्नुहोला । यसमा सि.ने. तथा अन्य कुनै सङ्केत लेखेको पाइएमा परीक्षा रद्द हुनेछ ।

④ Transmission Impairment :

→ Transmission impairments refers to disturbances that affect quality, clarity and integrity of transmitted data causing error delays or loss of information

a) Attenuation :

↳ Loss of signal strength as it travels over long distance.

b) Delay:

↳ Time taken to travel from sender to receiver.

c) Noise:

↳ Unwanted signals interfering with voice

d) Echo:

↳ Delayed and weakened reflection of transmitted signal

e) Jitter:

↳ variation in packet arrival time

1 b) Draw frame format of 30 voice channel PCM & explain T1 and E1. Compare the SONET & SDH in data rate

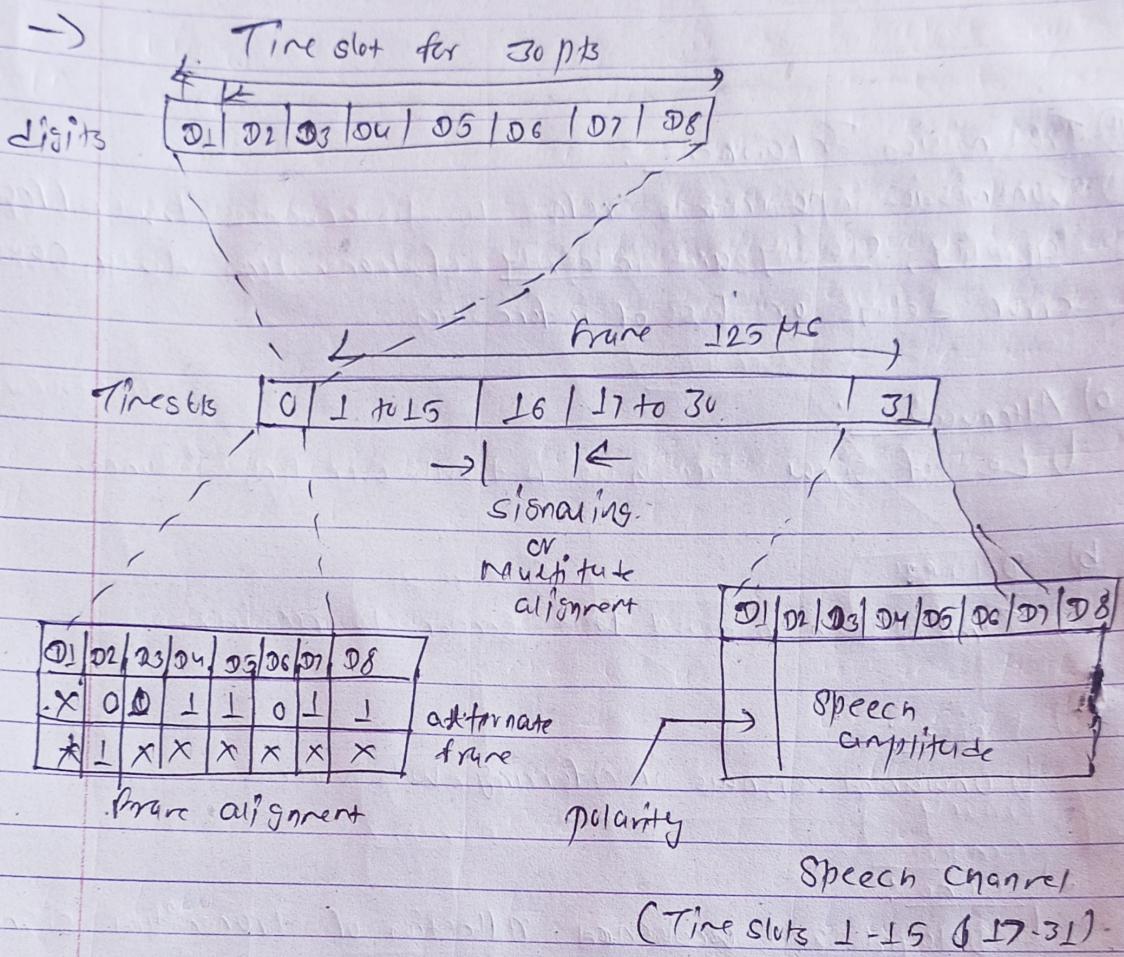
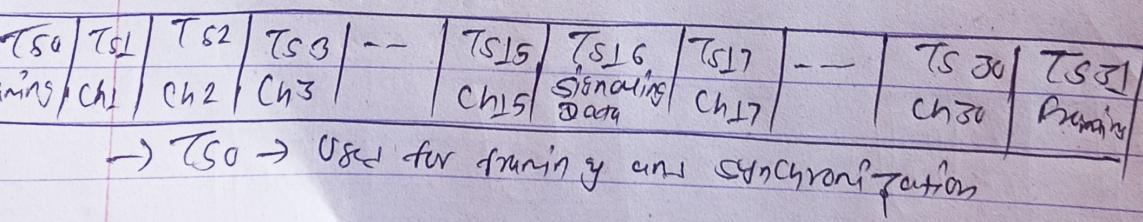


fig: 30 channel frame format

1) E1 (European standard) :

- Operates at 2.048 Mb/s
- Uses 32 time slots (TS0 - TS31) in a 125 μs frame





नेपाल सरकार

शिक्षा मन्त्रालय

परीक्षा नियन्त्रण कार्यालय, सानोठिमी
एसएलसी थप उत्तरपुस्तिका

विषय

मिति

मूल उत्तरपुस्तिका नं

निरीक्षकको मही:

प उत्तरपुस्तिको हुँदैतर्फ यसै पेजदेखि लेख्नुहोला। यसमा सिने तथा अन्य कुनै सद्केत लेखेको पाइएमा परीक्षा रद्द हुन्छ।

- TS1 - TS15, TS17 - TS31 → carry 30 voice or data channels
- TS16 → used for signalling or as an extra data channel (CCS) mode

2) T1 (North-American):

→ Operates at 1.544 Mbps

→ Uses 24 time slots (DS0 - DS23) in a 125 μs frame

F-bit	Ch1	ch2	ch3	-	ch23	ch24
Framing	8bit	8bits	8bits		8bits	8bits

→ 24 DS0 channels (DS0 - DS23) are used for voice or data

→ A framing bit is added at every 193rd bit

(#) SONET VS SDH Data Rates :

SONET → Synchronous Optical Network

SDH → Synchronous Digital Hierarchy

Parameter	SONET	SDH
Basic unit	STS (Synchronous Transport Signal)	STM (Synchronous Transport Module)
T		
Bandwidth	STS-1 = 51.84 Mbps	STM-1 = 155.52 Mbps
Data Rate	In multiple of STS-1	In multiple of STM-1
Region of	primarily North America	primarily Europe and rest of world.
use		
common rates	STS-3 = 155.52 Mbps (OC-3) STS-12 = 622.08 Mbps (OC-12)	STM-4 = 155.52 Mbps STM-16 = 622.08 Mbps

Q) Compare among Ckt switching, message switching and packet switching. Explain types of topologies of The switch and space switch.

→

Aspect	Ckt switching	Message switching	Packet switching
Defn	Establishes dedicated path b/w sender and receiver for entire communication session	Sends entire message to next node which is stored and forwarded to next node until it reaches destination	Breaks data into packets that are sent independently through the network and assembled at destination
Connection Type	connection oriented	connectionless	connection oriented
Data transmission	continuous without interruptions	entire message is sent as one unit with delays at each intermediate node	Data is divided into small packets which may take different routes
Delay	Low	High	Low to Moderate
Eg.:	PSDN	Post office system	Internet, TCP/IP

→ Ckt switching for real time communication

→ Message switching for when delay is acceptable but ~~reliability~~ reliability is needed

→ packet switching for efficient, scalable and fast communication



नेपाल सरकार

शिक्षा मन्त्रालय

परीक्षा नियन्त्रण कार्यालय, सानोठिमी
एसएलसी थप उत्तरपुस्तिका

विषय

मिति

मूल उत्तरपुस्तिका नं

निरीक्षकको सही

यप उत्तरपुस्तिकाको द्वैतफ यसै पेजदेखि लेख्नुहोला । यसमा सि.ने. तथा अन्य कुनै सङ्केत लेखको पाइएमा परीक्षा रद्द हुनेछ ।

Types of operation of Time switch and Space switch are :

Time switch

- ↳ It operates by rearranging time slots of incoming data streams. It is used in TDM when multiple signals share the same transmission medium by dividing the time into discrete slots.

Operations Involved :

a) TSI:

- ↳ Primary function of time switch is to interchange time slots. For eg: data arriving in time slot 3, can be switched to time slot 5 in o/p stream.

b) Buffering

- ↳ Incoming data is temporarily stored in buffer memory to allow for rearrangement of time slots.

c) Reading & Writing:

- ↳ Data is written into memory in one order and read out in different order based on switching requirement.

Space switch

- ↳ It operates by physically connecting P/I/O ports to o/p ports using a matrix of crosspoints. It's a flow based switching mechanism that routes data based on physical path.

Operations involved :

a) Crosspoint switching :

↳ Switch establishes a physical connection between an I/p and O/p port using a crosspoint in switching matrix.

b) Path establishment :

↳ Switch determines optimal path for data transmission based on destination address or routing table.

c) Non-blocking operations

↳ Any I/p can be connected to any O/p without interfering with other connection.

d) Blocking operations

↳ Some connections may be blocked if required path is already in use.

2b) Draw and explain drive mechanism of rotary switch in stronger switching system. How does a computer controlled "SCC" effectively manage the switching & signaling functions in an automatic switching system of Telecom links? Explain in detail with figure.

→ Drive mechanism of Rotary switch in stronger switching system is mentioned below:

It involves 2 types of Selectors which form the building blocks for switching system.

i) Uni-selector

ii) Two-wire selector



नेपाल सरकार

शिक्षा मन्त्रालय

परीक्षा नियन्त्रण कार्यालय, सानोठिमी
एसएलसी थप उत्तरपुस्तिका

विषय

मिति

मूल उत्तरपुस्तिका न

निरीक्षकाले गर्दा

थप उत्तरपुस्तिकाको दुवैतर्फ यसे पेजदेखि लेख्नुहोला । यसमा भिन. तथा अन्य कुनै महकेत लेखको पाहाएमा परीक्षा रह दृढ़ ।

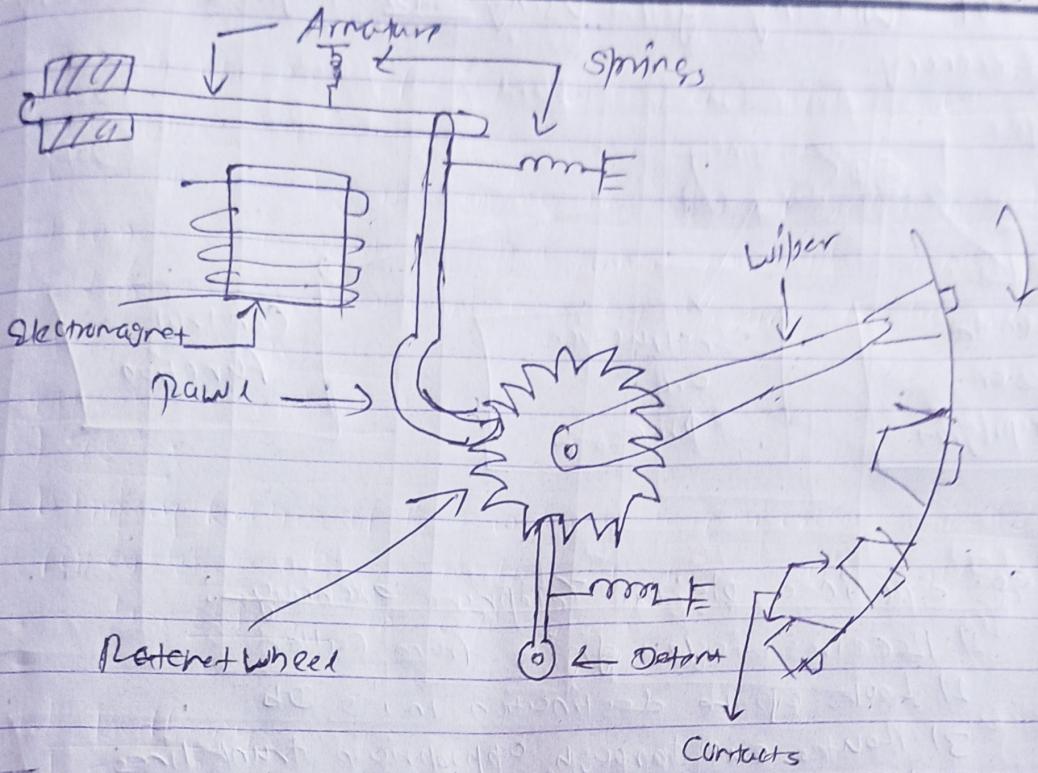


FIG: Drive mechanism of a Rotary switch

Working:

Step 1: Vertical motion (Selecting the Bank of contacts)

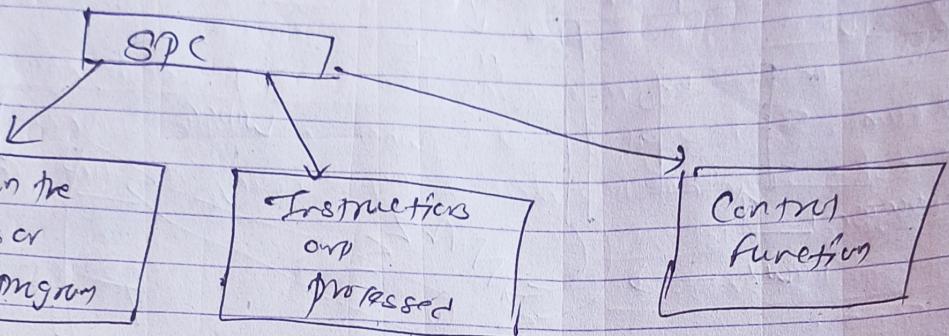
- When a telephone user dials a digit, electrical pulses are sent to selector switch
- Amplicular magnet energizes for each pulse moving switch upward step by step

Step 2: Rotary motion (Choosing contact within the level)

- After vertical movement steps, a rotary magnet is energized
- This rotates the wiper contacts clockwise in steps across different outgoing lines within selected level
- Switch stops when it finds a free connection

SPC is a key technology used in modern telecommunication networks to handle switching and signaling functions automatically.

In SPC-based system, a computer controls operation of switching system using SLC programs stored in memory.



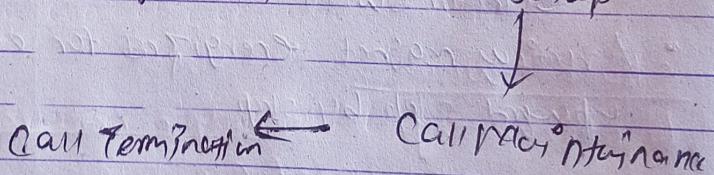
Ex: SPC in a Digital Telephone exchange:

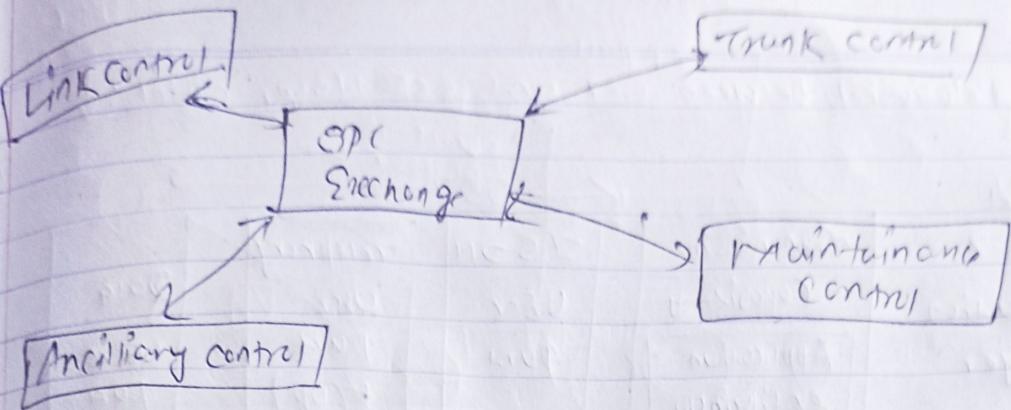
- 1) Receives dialed digits from caller
- 2) Looks up the destination in its DB
- 3) Routes call through appropriate trunk lines
- 4) Manages signaling and other exchange using SS7

5) Tracks call duration for billing purposes

Switching system,

Call Initiation → Routing Decision → Call Setup





34) Define Signaling system. Explain with block diagram the relationship between CCITT signaling system no 7. functional architecture, levels and OSI layer.

→ Signaling system:

A Signaling system refers to mechanism used to exchange control info. between network elements to establish, manage and terminate communication sessions.

It limits variety of switching systems, transmission systems, subscriber equipments in a telecommunication net to enable the net to function as a whole.

Functions:

- ① Supervision
- ② Information bearing

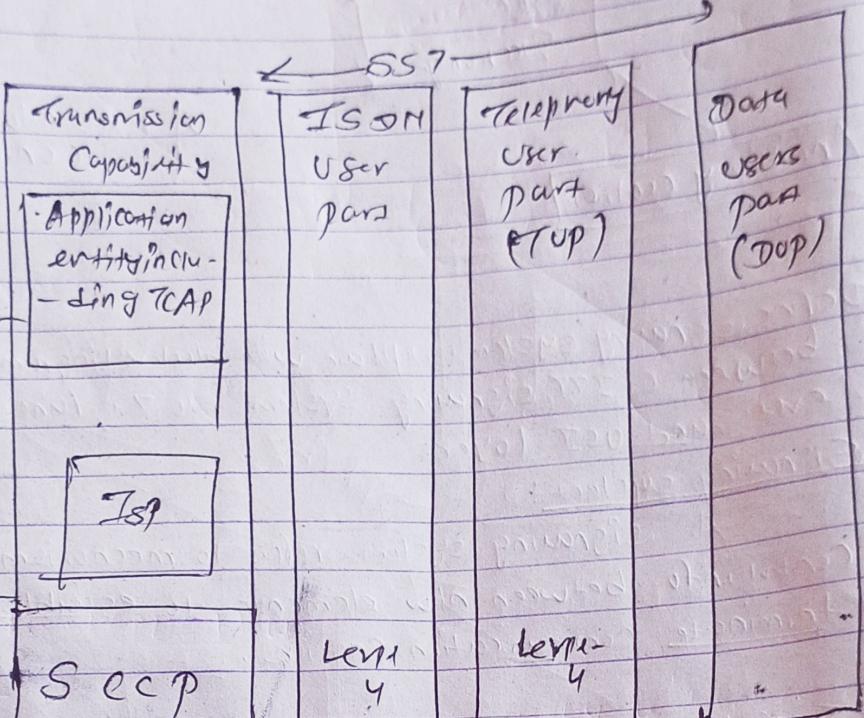
Relationship between SS7 and OSI layer model

OSI Model

Layer-7
Application Layer

Layer 4-6
→ presentation
→ session
→ transaction

Layer 1-3
HW Layer
→ DCE
→ physical



[Notes]

TCAP → Transaction capability Application part

ISP → Intermediate service part

MTP → Message Transfer part

SCCP → Signaling control connection part

Fig: Relationship between SS7 & OSI Layer

1) LEVEL 1: Means of sending bitstreams over a physical path.

2) LEVEL 2: Performs the function of Error-control, link initialization - setup, flow control.

3) LEVEL 3: Provides function required for signaling info.

Thus Levels (1-3) form MTP of SS7.

4) LEVEL 4: User part:

It consists of process for handling the service being supported by a signaling system.

5) Since SS7 was developed after OSI model its protocols were specified to conform with OSI.

6) SQCP has been added to level-3 to make it fully comparable with level-4 of OSI model.

7) The ISUP performs the function of Layer 4-6 of OSI

8) TCP/IP provides function of Layer-7.

→ (Multiprotocol Label switching)

3b) Why is MPLS popular? Explain it with neat diagram and its benefits of MPLS

→ MPLS is a networking technology that routes traffic using shortest path based on 'labels' rather than IP addresses or complex routing tables, to handle forwarding over WAN.

It operates between Layer 2 (OL) and Layer 3 (NW) of an OSI model often referred to as Layer 2.5.

Its widely used due to its performance, security and QoS.

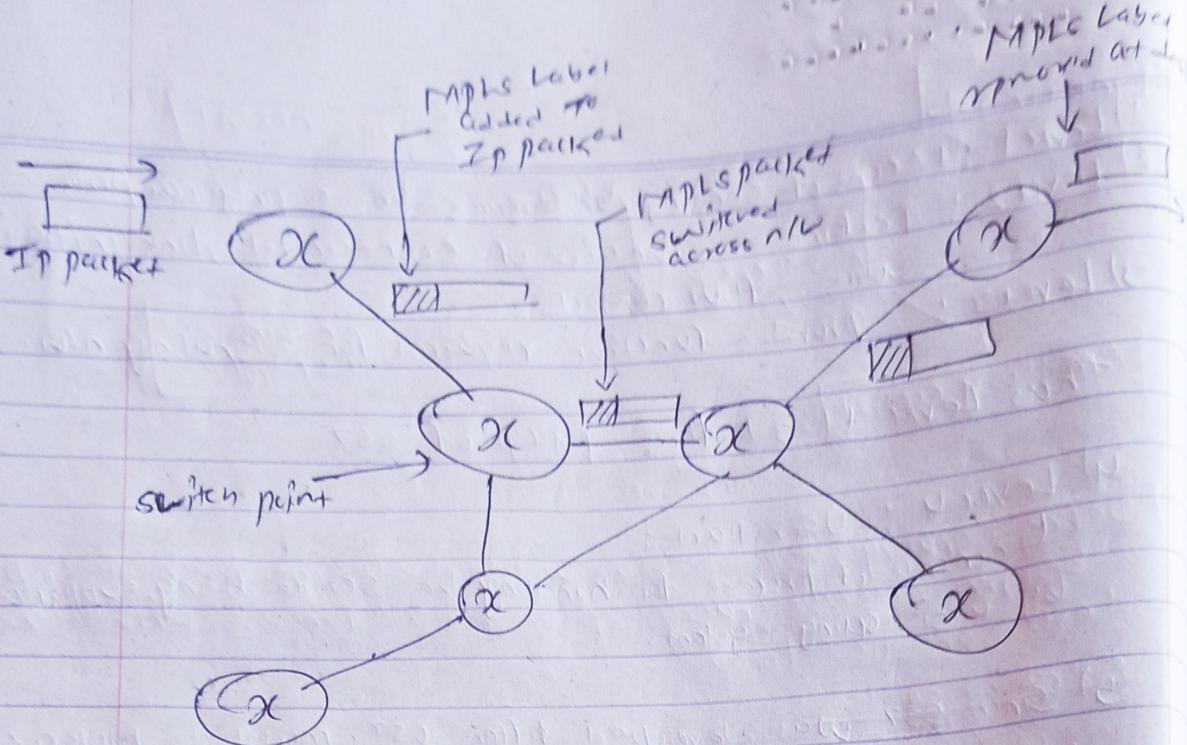
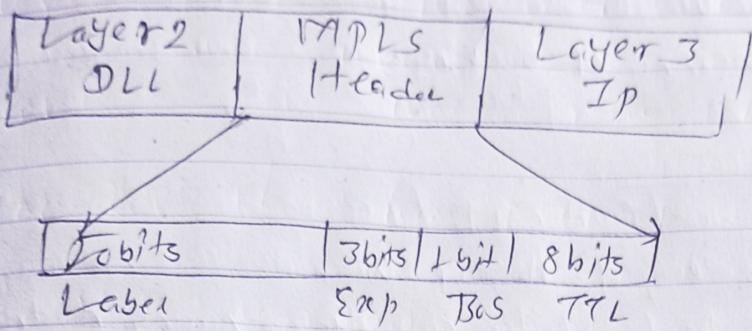


Fig: MPLS HW

Working

- 1) Incoming packets are assigned a 'label' by a 'label edge router (LER)'.
- 2) Packets are forwarded along a 'label switch path' (LSP) where each 'label switch router (LSR)' makes forwarding decisions based solely on contents of labels.
- 3) At each hop, LSP strips off existing label and applies a new label which tells the next hop how to forward the packet.
- 4) LSRs are established by n/w operators for a variety of purposes, such as:
 - To guarantee certain level of performance.
 - To route around n/w congestion.
 - To create IP tunnels for n/w-based VPM.

MPLS Header



Label → 20 bits

EXP → 3 bits long

Used for QoS

Bottom of stack

(TOS) → 1 bit

TTL → 8 bits long and value decremented by 1 at each hop to prevent packet from getting stuck in network.

Advantages & Disadvantages of MPLS NW:

Advantages

i) Cost effective as efficient resource sharing, private routing for customer data

ii) Scalability:

↳ Easily scalable for large networks

iii) Efficiency:

↳ Offers much higher quality connections without packet loss and jitter.

Using it along with VoIP is great

Disadvantages

i) Security:

Security of MPLS solutions are totally in the hands of the user

ii) Maintenance:

Relies on ISP for maintenance

iii) Control:

↳ Configuration is taken care by service provider, only control user has is dynamic routing

iv) Accessibility:

↳ MPLS is not optimized for cloud applications. It's more exclusive for point-to-point activity.

v) Reliability:

MPLS uses Labels for forwarding packets so it's highly reliable to deliver to correct destination

vi) Bandwidth to its optimum level

4

b)

Derive the mathematical model for loss call system.

→ (Erlang B) Ans for relayed system (Erlang C)

Elaborate meaning of blocking system and relayed system.

→ Mathematical Models :

i) Lost call system / Erlang B / Lcc Model :

→ provides probability of blockage of switch due to congestion.

• Determinas the GOS of lost call system having 'n' trunks.

Assumptions • Means that any / every calls that arrive can be connected to any outgoing trunk which is free.

① pure chance traffic

② statistical equilibrium If there are ' ∞ ' calls in progress then we have

③ full availability

$$P(x) = \frac{A^x}{x!} p(0)$$

(However, there can't be ∞ number of calls and there can't be more than ' n ' servers. $(0 \leq x \leq n)$)

$$\therefore \sum_{x=0}^n P(x) = 1$$

$$\text{or, } \sum_{x=0}^n \frac{A^x}{x!} p(0) = 1$$

$$\therefore p(0) = \frac{1}{\sum_{x=0}^n \frac{A^x}{x!}}$$

Putting value of $p(0)$

$$P(x) = \frac{A^x}{x!} \times \frac{1}{\sum_{x=0}^n \frac{A^x}{x!}}$$

and the blocking probability is

$$B = P(N) = \frac{A^N}{N!} \left| \sum_{k=0}^{N-1} \frac{A^k}{k!} \right|$$

2) Lost Call Delay (LCD) system / Queueing system / 2nd Erlang Distribution / Erlang C

→ Erlang determines the probability of encountering delay when traffic A' is offered to a queueing system with N' trunks

Assumptions

- ① Pure chance traffic
- ② Statistical equilibrium
- ③ Full availability
- ④ Calls which encounter congestion enter a queue and are stored there until a server becomes free.

If $x \leq N$

There is no queue and behavior of system is as that of Lost call system in absence of congestion

$$P(x) = \frac{A^x p(0)}{x!} \quad | \text{ for } 0 \leq x \leq N$$

If $x \geq N$ (N served, $x-N$ in queue)

1) The probability of a call arrived in a very short period of time ' Δt ' is given by p

$$p(\Delta t) = \frac{A \Delta t}{h!}, \text{ where}$$

h = Mean service time

→ Probability of transition from $(x-1)$ to \underline{x} calls during $'t'$ is given by;

$$P(x-1 \rightarrow x) = p(x-1) \cdot \frac{A s(t)}{h}$$

→ prob. of transition from x to $(x-1)$ calls is given by

$$P(x \rightarrow (x-1)) = p(x) \times \frac{N s(t)}{h}$$

For statistical equilibrium

$$P(x-1 \rightarrow x) = P(x \rightarrow x-1)$$

Call arrival = Call termination

$$P(x) \cdot \frac{N s(t)}{h} = P(x-1) \cdot \frac{A s(t)}{h}$$

$$P(x) = P(x-1) \cdot \frac{A}{N}$$

For

$$P(N+1) = P(N) \cdot \frac{A}{N}$$

$$\text{But } P(N) = \frac{A^N}{N!} P(0)$$

$$P(N+1) = \frac{A^N}{N!} P(x) \frac{A}{N} = P(0) \frac{A^{N+1}}{N \cdot N!}$$

Similarly,

$$P(N+2) = P(N+1) \cdot \frac{A}{N}$$

$$= \frac{P(0) \cdot A^{N+1}}{N \cdot N!} \times \frac{A}{N}$$



नेपाल सरकार

शिक्षा मन्त्रालय

परीक्षा नियन्त्रण कार्यालय, सानोठिमी
एसएलसी थप उत्तरपुस्तिका

विषय

मिति

मूल उत्तरपुस्तिका नं

निरीक्षकको संही:

यप उत्तरपुस्तिकाको दुवैतफँ यसे पेजदेखि लेख्नुहोला। यसमा सि.ने. तथा अन्य कुनै सङ्केत लेखेको पाइएमा परीक्षा रद्द हुन्नु।

$$\text{or } P(M+2) = \frac{P(0) A^{M+2}}{N^2 N!}$$

In general for $x > M$

$$P(x) = \frac{P(0) A^x}{N^{x-N} N!}$$

$$\text{Here } x = M+2 \\ \Rightarrow x = M = 2$$

$$= \frac{P(0) A^x}{N^x N^{-N} N!} = \frac{N^N}{N!} \left(\frac{A}{N}\right)^N \cdot P(0)$$

$$\therefore P(x) = \frac{N^N}{N!} \left(\frac{A}{N}\right)^N P(0)$$

This is carlang C distribution

5(a) Define ISDN and BISDN. Explain the protocol architecture of ISDN along with B-channel and D-channel

→ ISDN is a set of communication standards for simultaneous digital transmission of voice, video data and other n/w services over the traditional circuits of PSTN, as its a circuit-switched telephone n/w system, but it also provides access to packet-switched n/w that allows digital transmission of data and voice.

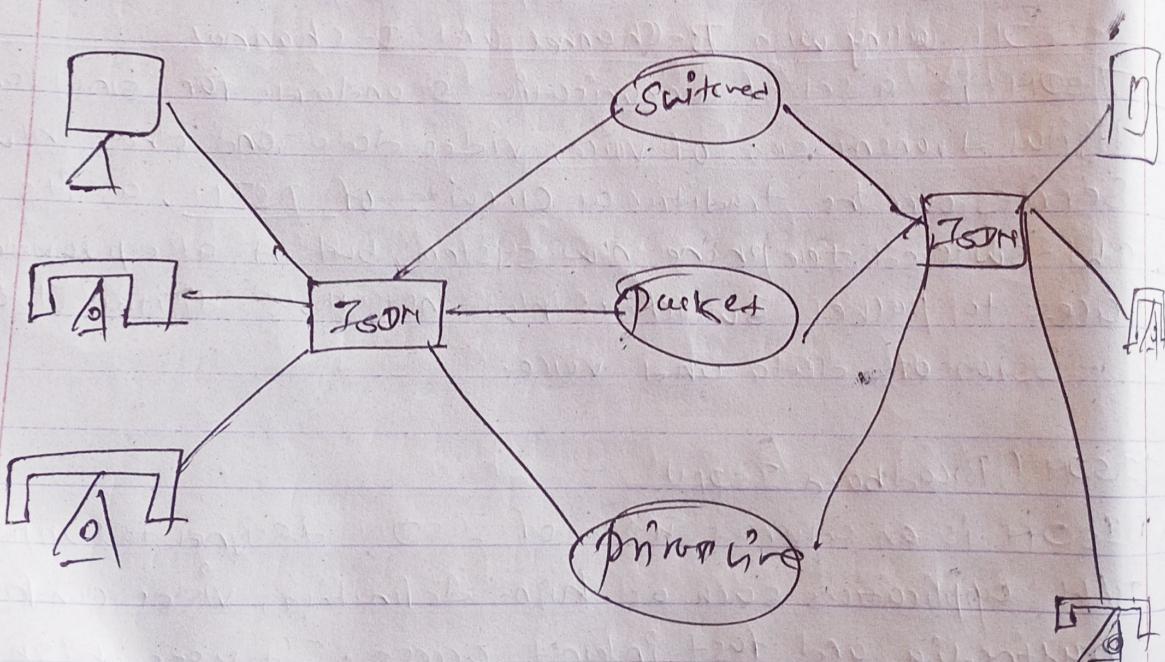
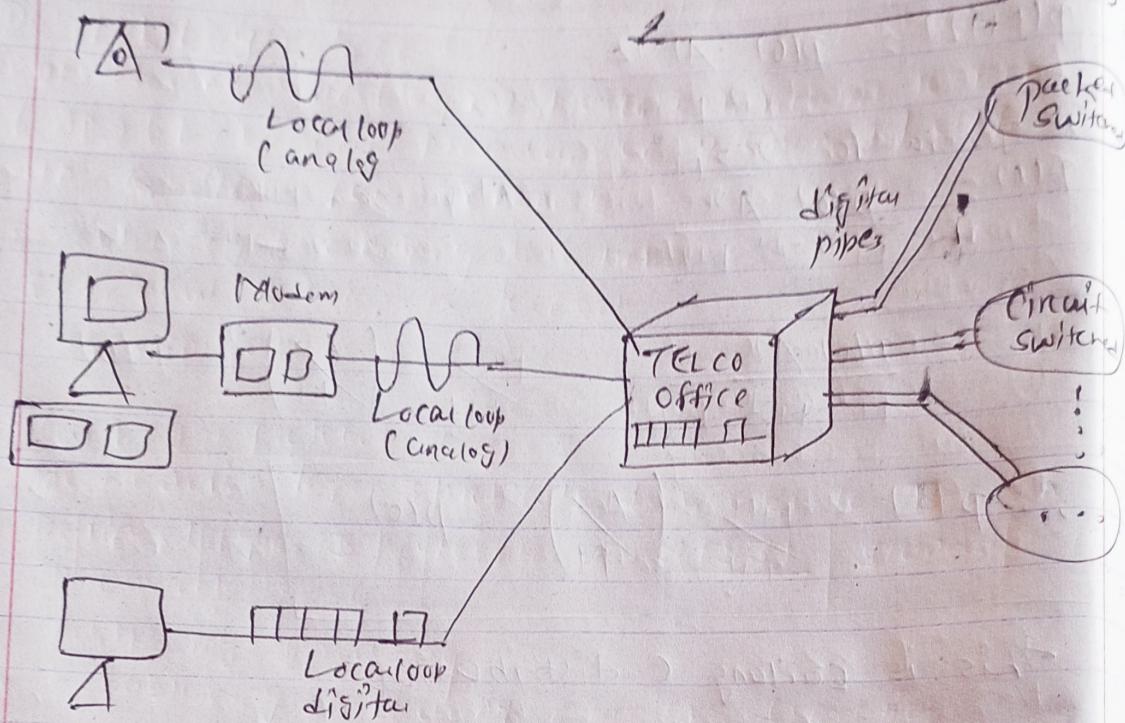
BISDN (Broadband ISDN)

→ BISDN is an advanced version of ISDN designed to support high T1/H1 applications such as high-definition, video conferencing, multimedia, and fast internet access. It uses high speed transmission technologies and supports much faster data rates compared to ISDN.

IDN: (Integrated Digital n/w)

According to these n/w, access to these n/w is by digital pipes which are time multiplexed channels sharing very high speed paths.

IDN





 नेपाल सरकार
शिक्षा मन्त्रालय
परीक्षा नियन्त्रण कार्यालय, सानोठिमी
एसएलसी थप उत्तरपुस्तिका

नेपाल सरकार

शिक्षा मन्त्रालय

न्त्रण कार्यालय, सानोठिमी

एसएलसी थप उत्तरपुस्तिका

विषय

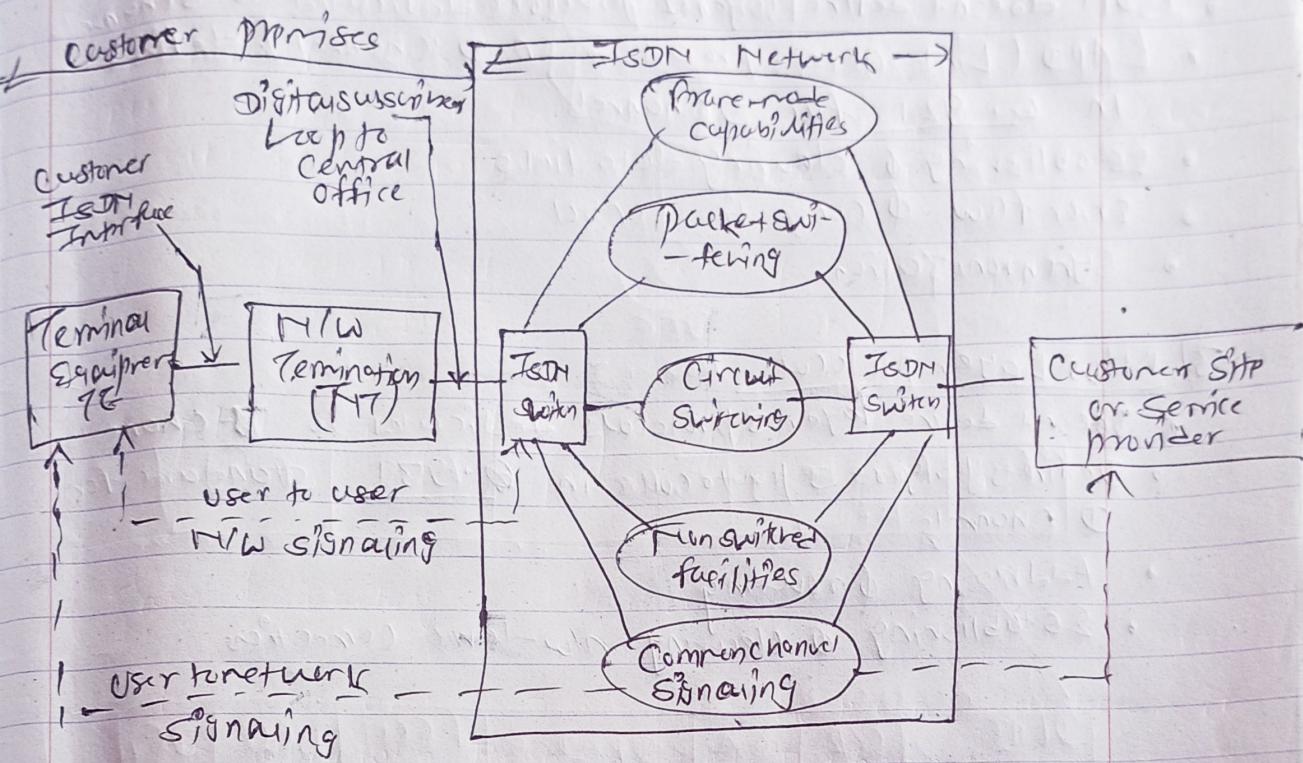
मिनि

मूल उत्तरपूरितका न

निरीक्षकको सही:

यथ उत्तरपुस्तिकाको दुवेतफ यस पेजदेखि लेख्नुहोला । यसमा सि.ने तथा अन्य कुनै सद्केत लेखेको पाइएमा परीक्षा रद्द हुनेछ ।

ISDN Architecture :



JSON protocol Architecture

	Q channel	T channel
Layer 3	DSS1 (G.931)	IP/IPx
Layer 2	LAPS (G.921)	PPP / HDLC / Pn
Layer 1	I.430 / I.431	

Physical Layer protocol :

- B-channels and D-channels are multiplexed on same physical interface.

ISDN B-channels and D-channels at physical layer use
the same protocols:

ITU - T II.430 (BRI) ⚡

ITU - T I.431 (PRI)

2) Data Link Layer:

- ISDN doesn't define layer 2 protocols dedicated to B-channels
- LAPD (Link access procedure on D-channel) defined in Q.921 for D-channels
- Establishing & clearing data links
- Error flow & congestion control
- Synchronization

3) Network Layer protocol

- Doesn't define layer 3 protocols dedicated to B-channels
- Defines layer 3 protocols in Q.931 standard for D-channels
- Addressing & routing
- Establishing & clearing network connections



नेपाल सरकार

शिक्षा मन्त्रालय

परीक्षा नियन्त्रण कार्यालय, सानोठिमी
एसएलसी थप उत्तरपुस्तिका

थप उत्तरपुस्तिको दुवैतर्फ यसे पेजदेखि लेख्नुहोला । यसमा सिन्. तथा अन्य कुनै माइक्रो प्रोसेसर पाइएमा परीक्षा रद्द हुनेछ ।

विषय

मिति

मूल उत्तरपुस्तिका नं

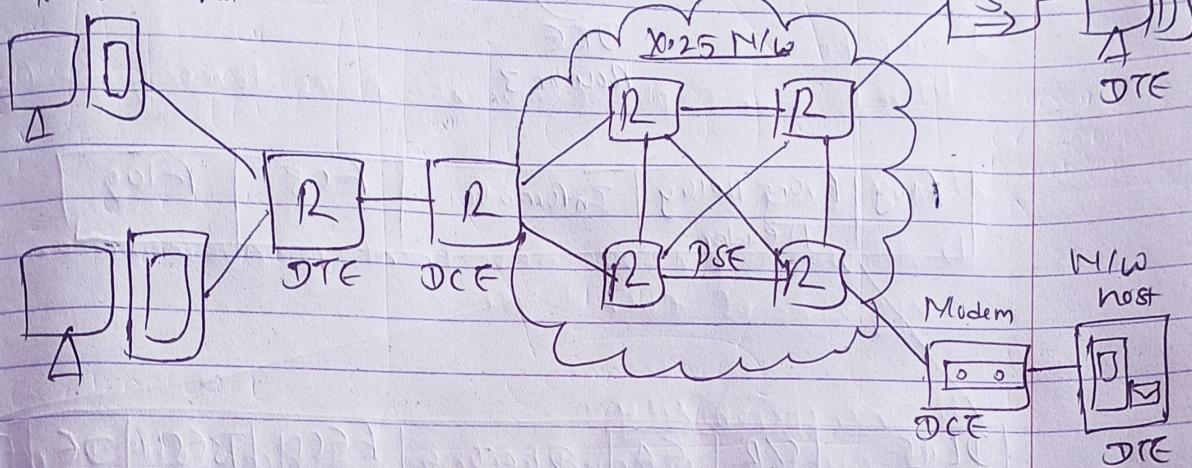
निरीक्षकको सही:

**Q1) What is X.25? Describe architecture of X.25 protocol layers.
Explain frame relay.**

→ X.25 is an ITU standard, well known and most widely used protocol, standard for packet-switched WAN communication
X.25 is a connection oriented protocol used in LAN

Packet switched exchange

X.25 Terminal



Q2) Frame Relay:

- A Frame Relay is a packet-switching nw protocol that is designed to work at the data link layer of nw.
- It works by dividing data into packets known as frames and transmitting these frames across the nw.
- Used to connect LAN and transmit data across WAN
 - LAN to WAN
 - WAN to LAN
- More efficient than X.25 and a higher process speed is achieved
- Evolved from X.25 packet switching and the objective is to reduce nw delays, protocol overheads and equipment cost

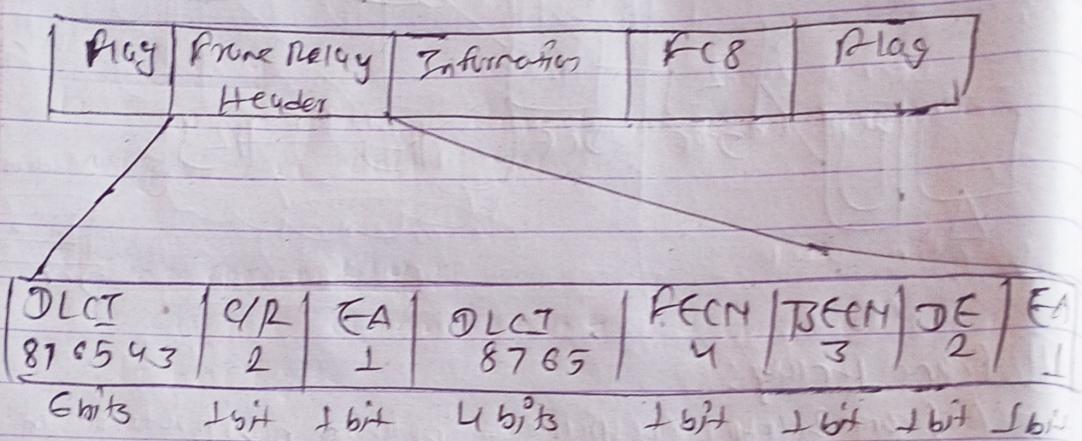
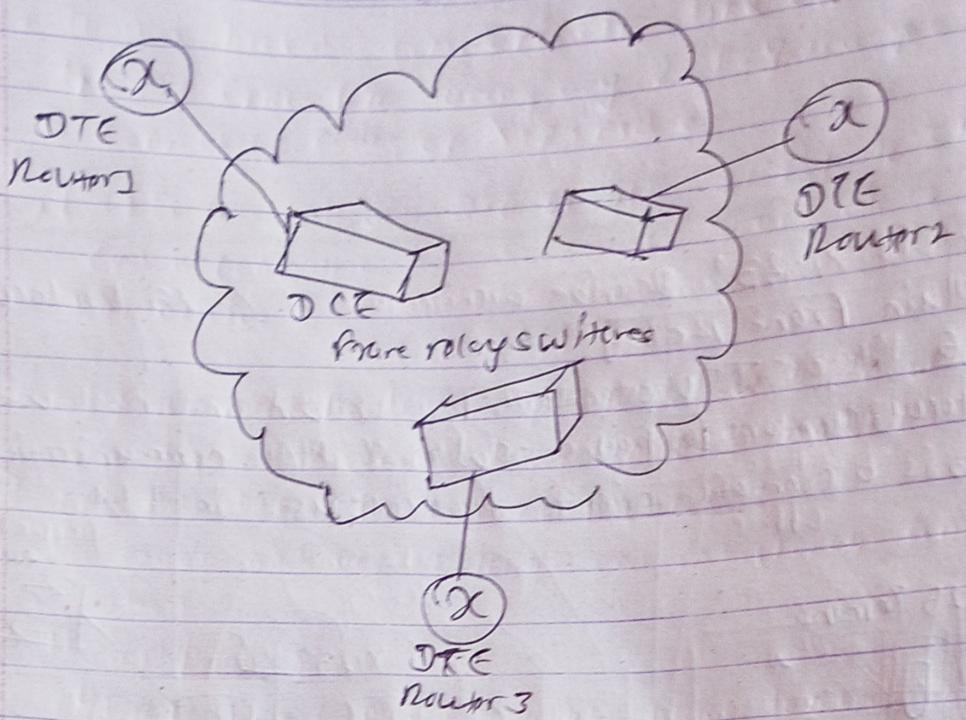


Fig: Standard Frame Relay frame

DLCI → Data Link Connection Identifier

C/R → Command / Response

EA → Extended Address

FCS → Frame check sequence

FECH → Forward Explicit Congestion Notification

DE → Discard Eligibility

BECH → Backward Explicit Congestion notification



नेपाल सरकार

शिक्षा मन्त्रालय

परीक्षा नियन्त्रण कार्यालय, सानोठिमी
एसएलसी थप उत्तरपुस्तिका

यप उत्तरपुस्तिकाको दुवैतर्फ यसे पेजदेखि लेख्नुहोला। यसमा सिनै तथा अन्य कुनै सद्वकेत लेखेको पाइएमा परीक्षा रद्द हुन्छ।

विषय

मिति

मूल उत्तरपुस्तिका ने

निरीक्षकको गही

X.25 Protocol Architecture :

Application Layer

Presentation Layer

Session Layer

Transport Layer

Network Layer

Data-Link Layer

Physical Layer

Upper Layer
Protocol

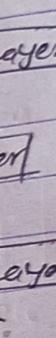
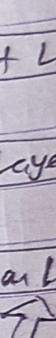
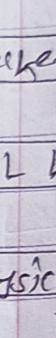
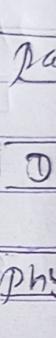
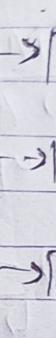
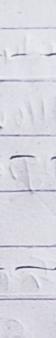
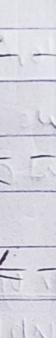
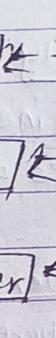
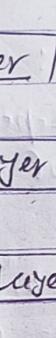
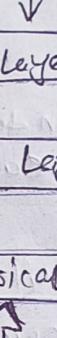
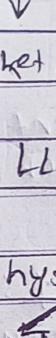
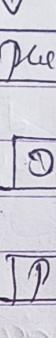
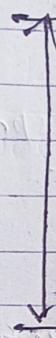
Packet Layer

DL Layer

Physical Layer

DCE

Communicates with the
remote DTE & upper layer
protocols



1) Physical Layer :

→ defines specifications of electrical interfaces connecting DTE and DCE devices

- X.21, X.21 bis and V.24 physical interfaces are being used

2) DLL :

- Also known as Frame Layer
- DLL of X.25 is link access procedure balanced (LAPB) using high level data link control (HLD)

- It also provides communication links and transmission that is error-free among any 2 physically connected nodes or X.25 nodes.
- LAPB also allows DTE or DCE simply to start or end a communication session or start data transmission.

Q1) Explain need for layered protocol? How the NW functions are divided in various layers in OSI model?

→ To era Need for layered protocol:
To enable modular, scalable and interoperable communication

1) Simplification:

↳ Breaks down complex communication process to manageable layers

2) Modularity:

↳ Allows independent development, maintenance and upgrades of each layer.

3) Interoperability:

↳ Supports communication with devices with different technologies

4) Trouble shooting:

↳ Makes it easier to diagnose and fix issue by isolating problems to specific layers

5) Scalability & Flexibility:

↳ Changes in one layer can be made without impacting the entire system, allowing NW to scale easily.



नेपाल सरकार

शिक्षा मन्त्रालय

परीक्षा नियन्त्रण कार्यालय, सानोठिमी
एसएलसी धप उत्तरपुस्तिका

विषय

मिति

मूल उत्तरपुस्तिका नं

निरीक्षकको सही

धप उत्तरपुस्तिका द्वावैतर्फ यसे पेजदेखि लेख्नुहोला। यसमा सि.ने. तथा अन्य कुनै सङ्केत लेखेको पाहाएमा परीक्षा रद्द हुनेछ।

N/W functions in OSI Model layers :

Layer	Functions	Tasks
Layer 1 Physical Layer	<ul style="list-style-type: none"> ① Deals with physical connection between devices 	<ul style="list-style-type: none"> ① Bit transmission, signal encoding, h/w components
Layer 2 DLL	<ul style="list-style-type: none"> ② Ensures error-free data transfer on same n/w 	<ul style="list-style-type: none"> ② Frame detection, error correction, MAC address
Layer 3 N/W	<ul style="list-style-type: none"> ③ Manages data routing and logical addressing (IP) between networks 	<ul style="list-style-type: none"> ③ Routing, IP addressing, packet forwarding
Layer 4 Session	<ul style="list-style-type: none"> ④ Manages end-to-end communication and reliability 	<ul style="list-style-type: none"> ④ Flow control, error recovery, segmentation, (TCP/UDP)
Layer 5 Session	Manages sessions b/w applications	<ul style="list-style-type: none"> Session establishment, maintenance, termination, dialog control (async/seqn)
Layer 6 Presentation	Translates and formats data for application layer	<ul style="list-style-type: none"> Data translation, encryption, compression, Character encoding
Layer 7 Application	Provides n/w services to end-user apps	<ul style="list-style-type: none"> Application protocols eg HTTP, FTP, SMTP