

Set 2

- 1) What is FTTH (Fiber to Home Network) and triple play service provided by Nepal Telecom? The trend shows that Telco operators are replacing their existing copper cable landline network with fiber network. Give reasons to support your answer for same.
- FTTH (Fiber to Home Network) is a broadband network technology that delivers high speed internet, voice and television services through optical fiber cables directly to individual homes and businesses. FTTH provides significantly higher B/H, faster data transmission and improved reliability.

Triple play service by Nepal Telecom :

→ NT ~~provides~~ offers a "Triple play service" through its FTTH network, which includes:

- ① High Speed Internet :
 - ↳ Broadband internet with enhanced speed and low latency
- ② VOIP (Voice over IP) Telephone :
 - ↳ Digital voice services with improved call quality and additional features
- ③ IP TV (Internet protocol TV) :
 - ↳ TV services with HD channels and video-on-demand (VOD) features.

Reasons for replacing copper cable network with fiber networks :

→ NT is shifting from copper-based landline network to fiber optic technology due to several technologies advantages:

- ① Higher B/H and Speed :
 - ↳ Fiber optic cables support significantly higher data transmission speeds than traditional copper wires, making them ideal for modern digital communication needs.
- ② Improved Reliability & Durability :
 - ↳ Unlike copper cables, fiber optics are less affected by weather conditions, electromagnetic interference, and signal degradation over long distances.

(iii) Lower Maintenance costs :

↳ Fiber networks require less maintenance compared to copper infrastructure, reducing operational expenses for telecom operators.

(iv) Support for Advanced Services :

↳ Fiber networks enable advanced digital services such as IP, video conferencing, cloud computing and smart home applications.

(v) Enhanced Security :

↳ Fiber optic communication is more secure than copper, as it is difficult to tap or intercept, reducing risk of data breaches.

Due to the above explanations, telecom are replacing legacy copper-based landline networks with FTTx to improve service quality, enhance connectivity and meet the growing demand for high-speed internet and digital services.

Q) "Crossbar system is more economic solution in switching compared to shaper switches"; Justify.

Design a 2 stage NLO using 4x4 switches to connect 16 incoming trunks to 16 outgoing trunks, using a consistent numbering arrangement for associating switches with links.

→ Crossbar system uses a grid of horizontal and vertical paths, controlled by electronic or electro-mechanical switches to establish a connection between I/O and O/I lines.

More economic because of following reasons:

- (i) Lower hw complexity compared to fully connected networks.
- (ii) Reduced cost of implementation
- (iii) Lower Maintenance cost
- (iv) Efficient utilization of resources
- (v) Lower power consumption
- (vi) faster call setup compared to manual switching.

2 stage switching nw using 4x4 switches to connect 16 incoming trunks to 16 outgoing trunks.

i) List out essential ^{features} of line coding? Generate HDB3 and B8ZS waveform for following "bit pattern"

10 110000000 100000 11

-> Line Coding is a process of converting digital data (binary 1s and 0s) into a signal format suitable for transmission over a communication channel.

Features:

① Synchronization

↳ Ensuring the receiver can correctly interpret the transmitted signal without external clock signals

② Error detection & correction:

↳ Enabling detection and potential correction of errors introduced during transmission

③ B/W Efficiency:

↳ Optimizing the signal to use minimum b/w while maintaining data integrity

④ Minimizing ISI (Inter-symbol Interference)

↳ Preventing overlappings of signals that can cause errors in data interpretation

HDB3 → High density bipolar 3.

B8ZS → Bipolar with 8-Zero substitution

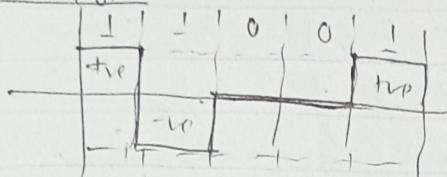
(Sampling)

HDB → High density Bipolar 3 0's substitution

B8ZS → Bipolar 8 0's substitution

AMI → Alternate Mask Inversion

AMI logic



For B8ZS (Logic) \Rightarrow 8 consecutive '0'

Case 1: \downarrow depends on polarity of last non zero pulse

tvp Last known voltage/pulse

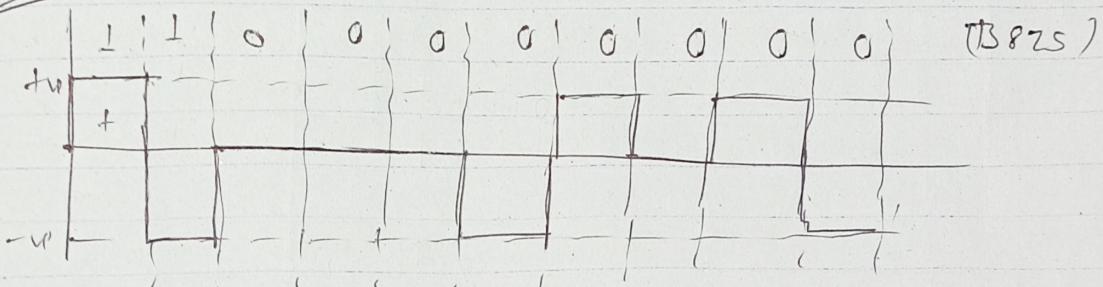
000 tvp -vp 0 -vp tvp \Rightarrow [000+ - 0 - +]

Case 2:

-vp Last known voltage

000 -vp tvp 0 +vp -vp \Rightarrow [000- + 0 + -]

Eg

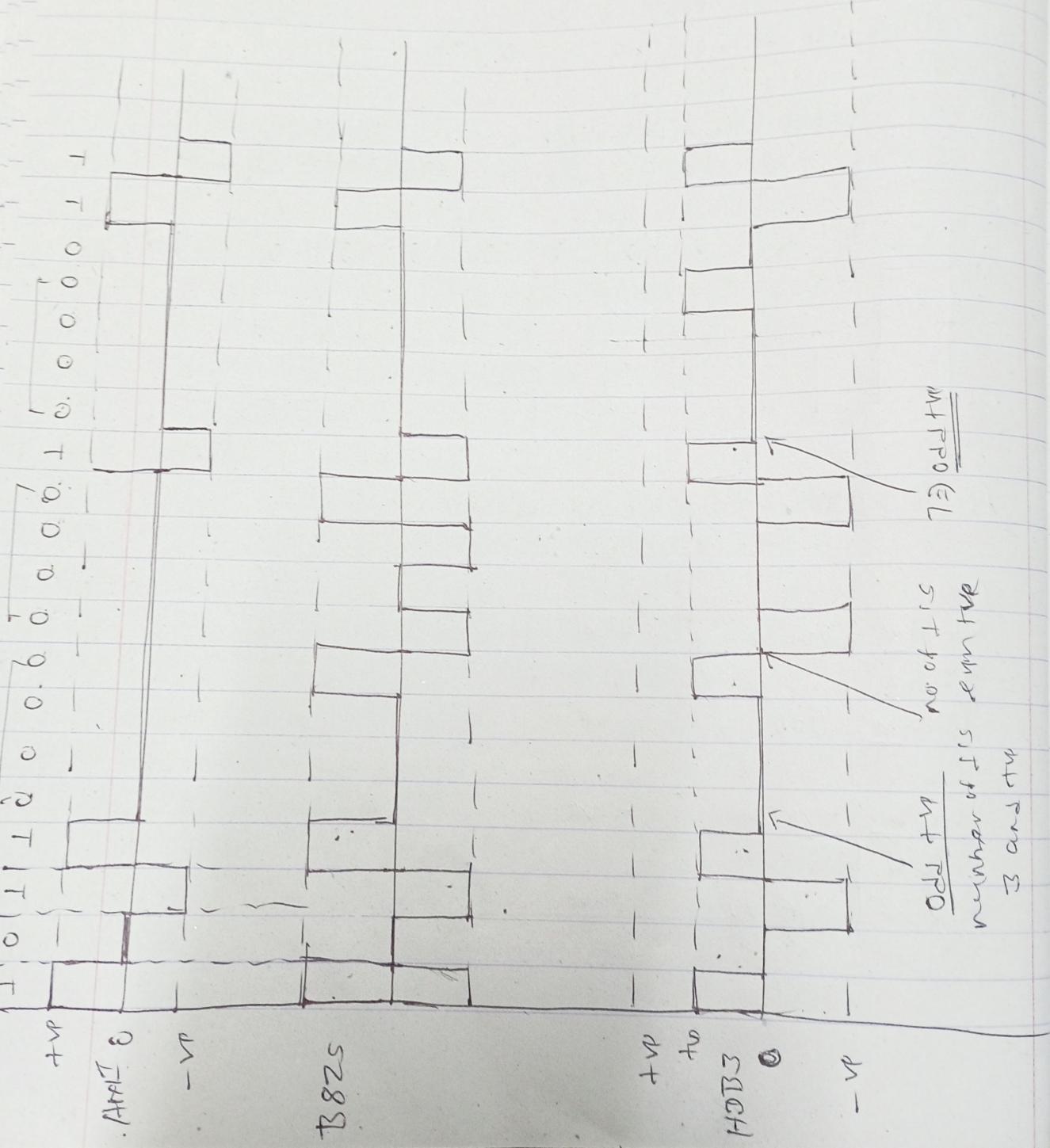


For HDB3 (4 consecutive zeroes)

	B	V
Case 1	1	
<u>Odd +vp</u>	000	+vp
Case 2		
<u>Odd -vp</u>	000	-vp
Case 3		
<u>Even +vp</u>	-vp 00	-vp
Case 4		
<u>Even -vp</u>	+vp 00	-vp

HDB3

• Replace 4 consecutive zeros
 with a bipolar violation \vee and return
 - using pulse B to maintain DC balance



2(b) Explain SDH and list out benefits over PDH? Mention the important characteristics of Aloha, Slotted Aloha and CSMA/CD protocols.

→ SDH (Synchronous Digital Hierarchy):

→ SDH is a multiplexing technology used in telecommunication n/w to transport multiple digital signals using a synchronous frame work.

It is used in high-speed data transmission and is widely used for optical fiber network.

Benefits of SDH over PDH (Plesiochronous Digital Hierarchy):

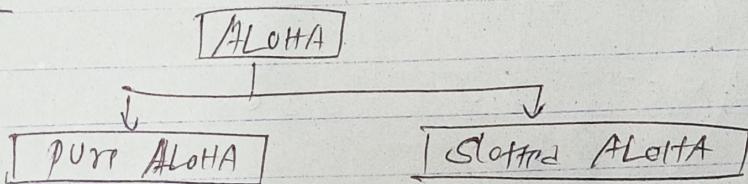
- (i) Precise clocking, synchronizing and alignment of data.
- (ii) Consistently uses more simplified and multiplexing and demultiplexing techniques.
- (iii) Optical fiber bandwidth can increase without limit.
- (iv) It quickly interconnects with various networks.
- (v) It has a comprehensive network management system.
- (vi) It enables rapid recovery from failure.
- (vii) It can transport existing PDH, broadband and broadcast signals.

Important characteristics:

i) Aloha

ii) Aloha is a random access protocol, that handles collision which happens when two devices try to send data at a public network channel, causing interference.

Types



Pure Aloha :

- (i) It introduces backoff time before transmitting frame to avoid collisions.
- (ii) Since there is only one channel to share, so there is a chance that frames from multiple stations will collide.
- (iii) Throughput :
 $S = G \times e^{-G}$ when,
 $S = \text{Throughput} (\text{avg no. of successful packet transmission per packet time})$
 $G = \text{avg no. of packet generated by system in one packet time}$

Avg throughput at $G = 0.5$

$$S_{\text{avg}} = 0.5 \times e^{-2 \times 0.5}$$

$$= 0.5 \times e^{-1} \approx 0.184$$

Channel efficiency is 18.4% (now) it's lost due to collisions

Slotted Aloha :

- (i) Better version as channel is divided into small, fixed length time slots to avoid collisions; also users are allowed to transmit data at beginning of each time slot.
- (ii) Stations can only transmit at beginning of time slot.
- (iii) Reduced collision compared to Pure Aloha.
- (iv) Synchronization of transmission of packets is established.

$$S = G \times e^{-G}$$

At $G = 1$, max throughput occurs i.e

$$S_{\text{max}} = 1 \times e^{-1} = \frac{1}{e} = 0.368$$

Channel efficiency = 36.8%, lost due to collisions



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विषय.....

मिति.....

मूल उत्तरपुस्तिका नं

निरीक्षकको सही:

उत्तरपुस्तिकाको दुवैतर्फ यसै पेजदेखि लेख्नुहोला । यसमा सि.न. तथा अन्य कुनै सङ्केत लेखको पाइएमा परीक्षा रद्द हुनेछ ।

CSMA/CD (Carrier sense Multiple Access/Collision Detection)

- ① CSMA/CD doesn't use an acknowledgement system rather uses checks for successful and unsuccessful transmissions through collision signals.
- ② Detects and resolves collision during transmission
- ③ Primarily used in wired Ethernet network
- ④ Stations listen to medium before transmitting (carrier sense)
- ⑤ If medium is busy, station waits before attempting transmission
- ⑥ If collision occurs, the station stops transmitting and retries after a random backoff time

4) What is DTMF and pulse dialing, explain with figures? Explain the relationship between CCITT no 7 functional levels and layers of OSI 7 layer model.

→ DTMF and pulse dialing are 2 different methods used for telephone signaling when dialing a number

DTMF (Dual Tone Multi Frequency) Dialing :

- ① Dialing method used in push-button telephones
- ② Uses a combination of 2 different frequency tones to represent each key pressed
- ③ Uses a 4x4 matrix keypad layout \Rightarrow 16 combinations $(0-9) = 10, (\# - *) = 4, (\#, \#) = 2$
- ④ Each digit generates a specific number of pulses (Eg: dialing '8' produces '8' pulses)

Allows faster and more reliable dialing than compared to pulse dialing.

Fig:

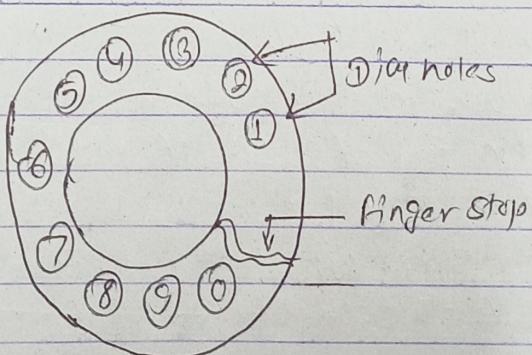
LH	1209	1336	1447	1638
697	1	2	3	A
770	4	5	6	B
852	7	8	9	C
941	*	0	#	D

- Each key generates a dual tone corresponding to row and column frequencies.

Pulse Dialing :

(i) Dialing method used in rotary dial phones

- (ii) Works by generating pulses or digits to represent each digit dialed
- (iii) Sends a series of electrical pulses corresponding to the dialed number
- (iv) Each number corresponds to series of pulses
(Eg: '1' dialing generates 5 pulses)
- (v) Rotary dial mechanism opens and closes circuit to create pulses
- (vi) Exchange counts the pulses and routes the calls accordingly.





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यप उत्तरपुस्तिकाको दुवैतर्फ यसै पेजदेखि लेख्नुहोला । यसमा सिन. तथा अन्य कुनै सङ्केत लेखेको पाइएमा परीक्षा रद्द हुनेछ ।

विषय

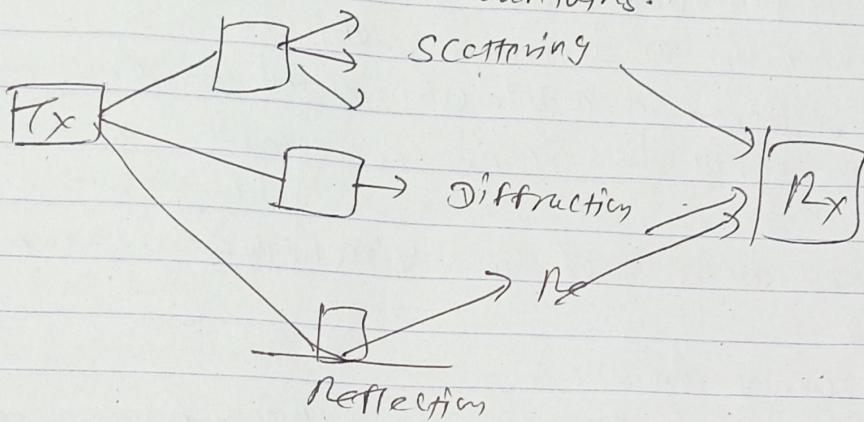
मिति

मूल उत्तरपुस्तिका ने

निरीक्षकको सही:

3) What is multipath propagation? What type of fading is more serious in Telecommunications? Explain the various reception methods of diversity techniques.

⇒ A phenomenon that occurs when a transmitted signal reaches the receiver's antenna by 2 or more paths, due to reflection, diffraction or scattering caused by obstacles like buildings, trees or mountains.



These multiple versions of signal can interfere with each other causing fading, delay spread and phase distortion.

Types of Fading Serious in Telecommunication are:

Fading ⇒ Refers to the variation in amplitude or phase of a signal due to multipath propagation and other environmental factors.

Serious: frequency-selective fading, fast fading, etc.

(a) Frequency Selective Fading :

- ① Different frequency components of signal experience different levels of fading
- ④ Caused by ISI (Inter-Symbol Interference)
- ⑤ Occurs when $B/W > B_c$ (Bandwidth is greater than coherence bandwidth)
- $(B > B_c)$
- ⑥ More problematic for broadband signals like Wi-Fi and LTE

(b) Fast Fading :

- ⑦ Rapid fluctuations due to movement of receiver, transmitter or surrounding objects
- ⑧ Significant in mobile communications and can cause signal loss if not corrected

(b) Reception methods of diversity Techniques to combat fading

(i) Frequency Diversity :

- ① Same signal is transmitted on different frequencies (separated by at least one coherence block)
- ② If one frequency experiences fading, another remains strong
- ③ Used in OFDMA in WiFi and LTE

(ii) Time Diversity :

- ① Same signal is transmitted at different time intervals to counteract fast fading.
- ② Used in H-Transmission based systems like HARQ (Hybrid Automatic Repeat Requests).



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विषय विभाग

मूल उत्तरपुस्तिका न

निरीक्षकको सही:

① Space Diversity (Antenna Diversity) :

- ① Multiple antennas receive signals at different locations and best signal is selected.
- ② Antennas are placed far apart so that they receive signals with different fading characteristics.
- ③ Used in MIMO (Multiple Input Multiple Output) system in 4G and 5G networks.

② Polarization Diversity :

- ① Signals are transmitted using 2 orthogonally polarized antennas (horizontal and vertical).
- ② Each polarization undergoes different fading, improving reliability.
- ③ Used in satellite and wireless communication.

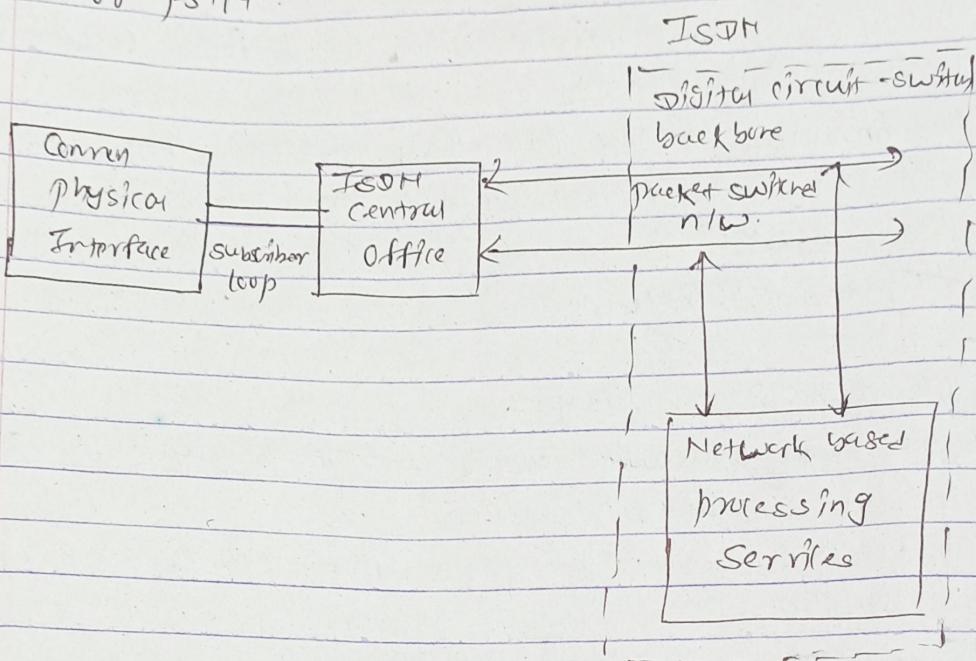
③ Angle Diversity :

- ① Different directional antennas.
- ② Uses directional antennas to receive signals from different angles.
- ③ Used in beamforming and smart antenna system.

4

⑥ Define ISDN. Explain the protocol architecture of ISDN along with its features and applications.

→ ISDN is a set of communication standards for simultaneous digital transmission of voice, video, data and other new services over the traditional circuits of PSTN.



ISDN protocol Architecture :

	(Data)	(Bearer)
① Channel		TB Channel
Layer 3	DSS1 (Q.931)	IP / IPX
Layer 2	LAPD (Q.921)	PPP / HDLC / FR
Layer 1	I.430 / I.431	

ⓐ Physical Layer protocol ?

ⓑ B Channel and ① Channel are multiplexed on same physical interface

⑩ ISDN B Channel and ① channel at physical layer use same protocols.

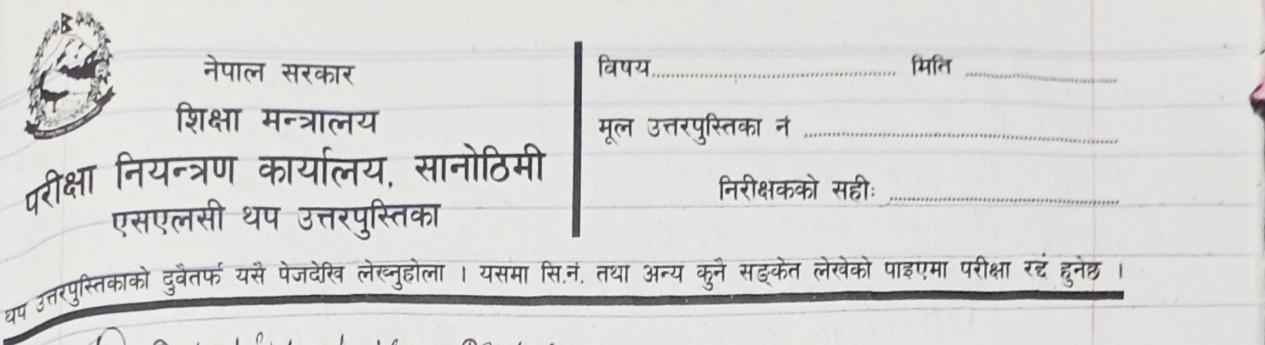
ITU-T.I.430(BRI) &

ITU-T.I.431(PRI)

⑩ uses

B → for data transmission

D → for signaling



- (b) Data Link Layer Protocol
- ① ISO doesn't define Layer 2 protocols dedicated to B-channel
 - ② Link access procedure on D-channels (LAPD) defined in Q.921 for D-channels
 - ③ Establishing and clearing data links
 - ④ Error flow and congestion control
 - ⑤ Synchronization

- (c) N/W Layer protocol :
- ① ISO doesn't define Layer 3 protocols dedicated to B channels
 - ② Defines Layer 3 protocols in Q.931 standard for D channels
 - ③ Addressing and routing
 - ④ Establishing and clearing n/w-level connections

Feature & Applications

Features :

- ① Direct digital connection between user using point to point connection
- ② Faster call setup : Reduces call connection time compared to analog n/w
- ③ Supports multiple services : voice, audio, video, and data on a single n/w.
- ④ Higher data rates : Supports speeds from 64kbps to 2Mbps.
- ⑤ N/W Management function :
 - ↳ Includes error correction, routing, and congestion control
- ⑥ Works with PSTN, mobile n/w and broadcast services

Applications :

- (I) Provides high speed internet access
- (II) Video conferencing
- (III) Remote access to LANs.
- (IV) Multimedia communication
 - (i) Transfer images, graphics and video efficiently
- (V) Additional Telephone Lines :
 - (i) Supports multiple voice connection over a single physical line

Q) What do you mean by elastic store? Discuss about routing control and flow control in network management.

→ Elastic store is a type of dual-port buffer used in network communication devices, particularly in TI, GI and GJ transmission systems.

It enables clock domain conversion by temporarily storing data and allowing it to be read at different clock rates.

Eg

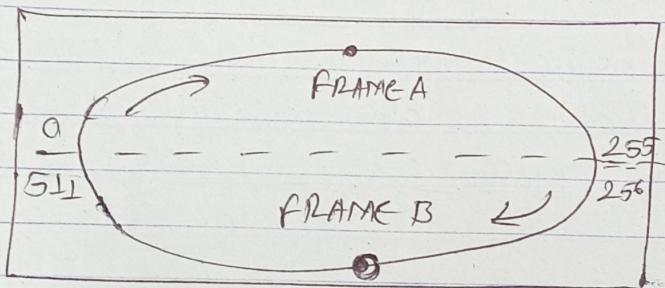


Fig: Elastic store and write pointers are exactly one frame apart



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विषय

प्रिय

मूल उत्तरपुस्तिका मे

निरीक्षकसे मही

उत्तरपुस्तिका को दुखेन्फ यसे पेजदेखि लेन्ड्रुहोला। यसमा यिन् तथा अन्य कृति भडकेन लेखको पाहारमा परीक्षा रहे हुनेछ।

Routing Control in NW Management

→ Routing control is the process of determining best path for data packets in a nw. It ensures efficient data transmission by considering factors like cost, distance and n/w congestion.

Routing Metrics: Hops, B/W, Logs, cost, Reliability

Fuctions of Routing control

(i) Efficient Data Transmissions :

↳ selects best paths to reduce delays.

(ii) Optimal Resource Utilization :

↳ minimizes bandwidth usage and processing power

(iii) Dynamic Adaptation :

↳ uses dynamic routing protocols (e.g: OSPF, ISGP) to adjust routes automatically in case of failures

(iv) Security Management :

↳ Implements Access control lists (ACLs) to prevent unauthorized access

Types

1) Static Routing : Manual configuration routes

2) Dynamic Routing : Uses routing algorithm (RIP, OSPF, ISGP) for adapting path selection

3) Default Routing : Sends all traffic to a single destination gateway.

Flow Control :

- ↳ Flow control is a mechanism used to prevent data congestion between sender and receiver by regulating data transmission rate.
- It ensures smooth communication by preventing buffer overflow and packet loss.
- ↳ Technique which ensures that transmitting entity doesn't overwhelm the receiving entity with data.

Types :

- I) Window-Based Control : e.g.: TCP Sliding Window protocol
- II) Credit-Based Flow Control
- III) Data-Based Flow Control

Eg: Traffic shaping techniques in switches like MPLS

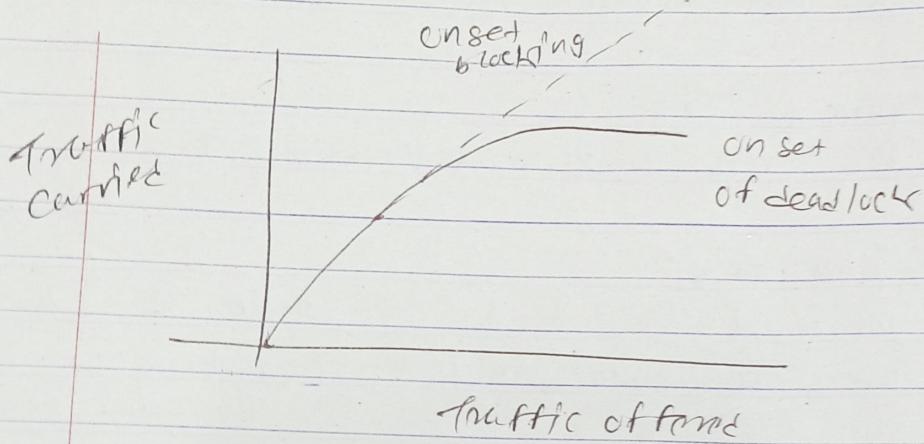


Fig: Carries traffic vs traffic offered with no flow control

5(b) Explain Real Time Transport protocol? Explain the working of resource reservation protocol (RSVP) with example

→ Real-time Transport protocol (RTP)

RTP is an on/off protocol used for delivering real-time audio, video and multimedia traffic over IP networks. It is widely used in applications like VoIP, video conferencing and live streaming.

RTP Header Format:

Ver	P	X	Continuity	payload Type	Sequence Number
				Time Stamp	
				Synchronization Source Identifier	
				Contribution Identifier	
				:	
				Contribution Identifier	

Advantages:

- (i) Low latency for real-time communication
- (ii) Supports multicast transmission
- (iii) Sequencing numbering ensures proper order of packets

Resource Reservation protocol (RSVP)

RSVP is a transport layer protocol used to reserve new resources and provide QoS (Quality of service) for time-sensitive applications like video streaming and VoIP.

It's not a routing protocol but a signalling protocol.

Two important types of RSVP messages are:

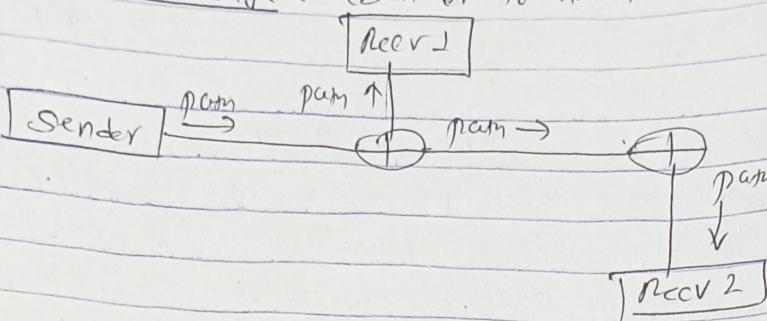
- (i) Path message
- (ii) Resv message

• Generally used by receiver side for fast delivery of transmission packets from sender to receiver

Working

RSVP is a receiver-initiated protocol, meaning the receiver or data flow requests the reservation of resources.

① Path message: (Sender to receiver)

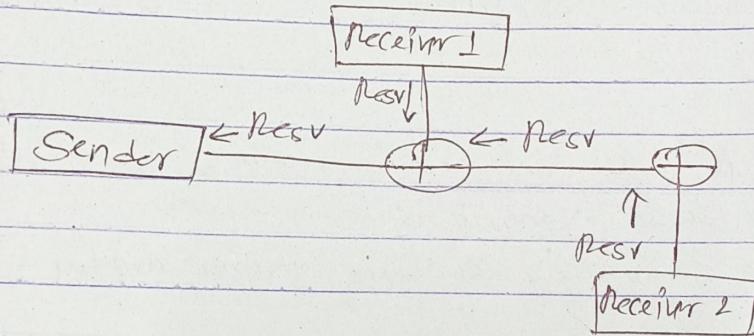


• Path message travels from sender and reaches to all receivers by multi-casting and path message stores necessary info for receivers

② Resv message:

• Each router along the path stores the path message info in a PSB (path setup block)

③ Resv message (Receiver to sender)



① Upon receiving path message, receiver sends a Resv (Reservation) msg upstream to the sender.

② Resv message consists of type and amount of resources required for data flow

③ Each router along the path processes the Resv message and reserves resources if available. If not then router sends error message back to receiver

④ Reservation info is stored in a Reservation State Block (RSB) on each router

3) Resource Allocation

- ① Once RSVP msg reaches the sender, the end-to-end resource reservation is complete.
- ② Now refreshes along the path allocates the reserved resources for specific data flow.

4) Soft State Maintenance

- RSVP uses a soft state mechanism, meaning reservations must be periodically refreshed by sending path and Resv messages.
- ① If no refresh messages are received, the reservation times out and resources are released.

Eg of RSVP

⊕ SI

- Suppose a company plans to broadcast a live video every Monday at 7PM.
- Users interested in broadcast send RSVP requests to reserve bandwidth.
- The ISP checks if enough bw is available.
- If successful, the reservation is confirmed, the video is transmitted smoothly.

Q) What is convergence of media? Explain integrated and differentiated service architectures with their advantages and disadvantages.

→ Convergence of media refers to the integration of different types of communication technologies (TV, radio, print and internet) into a single digital platform. It enables seamless access to multiple media formats through devices like Smartphones, tablets and computers.

ISA (Integrate Service Architecture) : (Intserv)

- ISA provides end-to-end QoS for different types of n/w traffic (voice, video, data). It ensures guaranteed b/w allocation and real-time communication.
- It uses RSVP to signal and reserve resources for each flow.
- Intserv aims to guarantee specific performance levels for apps like VoIP (voice over Internet protocol) or video streaming.

Advantages of ISA :

- ① Efficient resource utilization through centralized management.
- ② Guaranteed QoS for real-time applications like VoIP and video conferencing.
- ③ Enhanced security via controlled access and monitoring.

Disadvantages of ISA :

- ① High complexity due to the integration of multiple n/w services.
- ② Dependency on n/w components, leading to vulnerability in case of failure.
- ③ Higher costs for implementation and maintenance.

Differentiated Service Architecture (DiffServ)

- Diffserv prioritizes traffic by classifying and marking packets to ensure QoS in large-scale networks.
- unlike ISA, diffserv doesn't guarantee end-to-end service but offers relative priority levels.

QoS architecture that provides 'coarse-grained' traffic classification and prioritization.

- Instead of reserving resources for individual flows, Diffserv groups traffic into classes (high, medium, low priority) and applies QoS policies to each classes

Advantages of Diffserv :

- (i) Scalable as it does not require pre-flow state tracking
- (ii) Cost-effective because it allows resource prioritization instead of strict reservations
- (iii) Flexible policy configuration for different traffic types.

Disadvantages :

- (i) No absolute guarantee for service delivery.
- (ii) Complexity in configuration due to traffic classification
- (iii) Potential unfairness if lower-priority traffic is excessively delayed

Q) Comparing with the traditional TDM n/w, what do you think are the key features that NGN has incorporated that highly motivates telecom authorities to migrate towards NGN? Explain with its architecture, concept and suitable scenario of its implementation

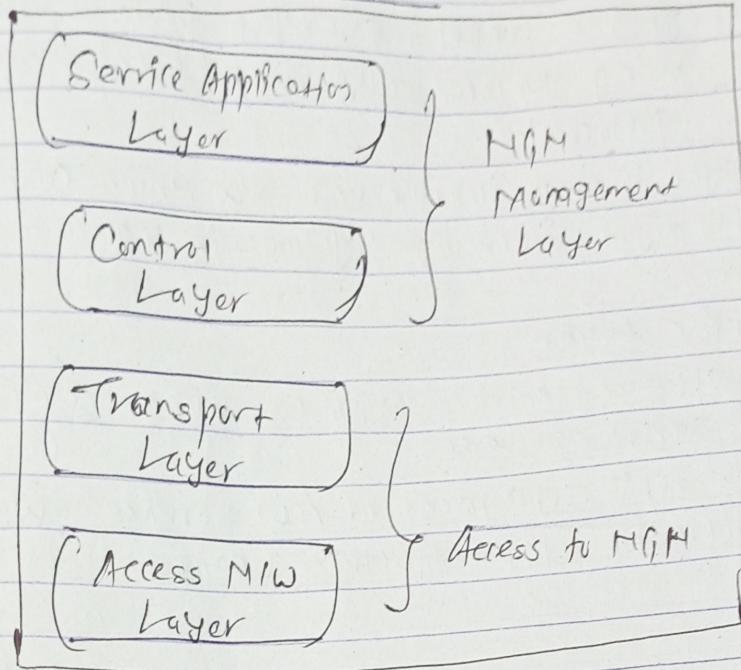
NGN :

- NGN is a packet based n/w that enables multiple services (voice, video, and data) over a single unified infrastructure
- Unlike traditional TDM n/w which uses circuit-switched technology, NGN utilizes IP-based packet switching, improving efficiency, scalability and service integration

Key features of NGM compared to TDM N/W

Feature	Traditional TDM N/W	NGM
Switching type	Circuit - switched (fixed BW allocation)	Packet - switched (efficiency, b/w utilization)
Flexibility	Dedicated <u>SETS</u> for each service	Converged service (voice, video, data)
Scalability	Difficult to scale due to HW limitation	Easily scalable using SW based architectures
QoS	Fixed b/w ensures stable QoS	Dynamic QoS, prioritizing time-sensitive services
Mobility Support	Limited mobility features	Full support for mobile users (VoIP, 5G, LTE)
Security	HW based security, difficult to update	SW-based security with advanced threat detection
	TDM Based	IP Based
Use of Standard SS7 Signaling		Use of different signaling and protocols for supporting multiple services
Different Services, Different platform (voice, data or video)		Multiple Services, one platform (IP) Approach

Architecture of NGN



NGN follows a modular, multi-layered architecture designed for efficient service delivery. It consists of following components

1) Access Layer:

- Consists of physical infrastructure that connects user to NGN, such as cables, switches, DSL fiber and routers
- Replaces traditional copper-based access in TDM n/w

2) Transport Layer:

- This layer consists of core n/w infrastructure including routers and switches
- Uses IP/MPLS for efficient packet switching and routing
- Enables reliable and high speed data transmissions across the n/w.

3) Control Layer

- Manages call control, signalling and Session Management using protocols like SIP (Session Initiation Protocol).
- This layer is more flexible and service driven compared to the rigid signalling system in TDMA.

4) Service Layer

- ↳ Hosts apps and services such as VoIP, IPTV, Cloud Services etc.
- ↳ Enables rapid deployment of new services without significant infrastructure changes.

Implementation Scenario of NGN

Use case: Migration from TDMA to NGN

Scenario: A telecom operator wants to transition from existing PSTN to IP-based NGN infrastructure.

Steps

1) Assessment and planning

- ↳ Analyze current TDMA network limitations and define migration goals

2) Deploy VoIP & soft switches:

- ↳ Replace Ckt-switched-exchanges with IP-based softswitches

3) Upgrade Access Network:

- ↳ Implement fiber-optic (FTTH), LTE and 5G for last-mile connectivity

4) Service Migration:

- ↳ Gradually shift voice and multimedia services to NGN

5) Security and QoS optimization
↳ use firewalls, encryption and traffic prioritization to maintain service quality

① Short Notes:

a) STM-1 vs STS-1 frame

STM-1 → Synchronous Transport Module - 1

STS-1 → Synchronous Transport Signal - 1

STM - 1

① part of SDH (Synchronous Digital Hierarchy)

② Data rate is 155.52 Mbps

③ Larger frame size
 $9 \text{ rows} \times 270 \text{ cols}$

④ Its payload capacity is higher due to frame size

⑤ uses virtual containers (VCs) to carry payloads

⑥ Applicable for long-distance and high-capacity transmission

STS-1 (S)

① part of synchronous optical network (SONET)

② Data rate is 51.84 Mbps

③ Frame size is smaller
9 rows \times 90 cols

④ Lower compared to STM-1

⑤ uses virtual tributaries (VTS) to carry payloads

⑥ Applicable for high-speed communication in LAN

① Numbering & charging plan

- Numbering plan is a system used in telecommunication to assign unique address (phone number) to devices or subscribers in a network.

- * For numbering purpose world is divided into 9 zones.
- * Each zone is given a single digit (1-9).

Zone code table

Codes	Zones
1	NA, US, Canada
2	Africa
3-4	European countries
5	Latin America
6	Australia
7	Russia
8	East Asia, Japan
9	South East Asia (Ex: Nepal, India)

Country code	National number
1-3 digits	9-12 digits max.
8	12 digits maximum

Area trunk code	Exchange code	Line number

b) National telephone number

Fig: Telephone numbers structure

Charging plan: A charging plan for a telecommunication service levies mainly 3 different charges on a subscriber.

- ① An initial charge for providing a new communication connection
 - ② A rental or leasing charge
 - ③ Charges for individual calls made
- 2 Categories for charging individual calls:
- a) Duration independent charging (Ex: local calls)
 - b) Duration dependent charging.