Computer Networking (4343202) - Winter 2024 Solution

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Question 1(a) [3 marks]

What is the Computer Network? Why it is important?

Solution

Answer: A computer network is a collection of interconnected computing devices that can exchange data and share resources.
Diagram:

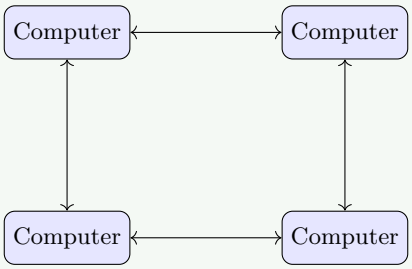

Figure 1. Simple Computer Network

- **Resource sharing**: Enables sharing of printers, files, applications
- **Communication**: Facilitates information exchange between users
- **Scalability**: Allows networks to grow as needs increase

Mnemonic

"CSI - Connect, Share, Interact"

Question 1(b) [4 marks]

Define terms: 1) Web Server, 2)Encrypted data, 3)Hacking, 4)Client-server

Solution

Definitions:

Table 1. Network Terms

Term	Definition
Web Server	Software/hardware that serves web content to clients using HTTP/HTTPS
Encrypted Data	Information converted to code to prevent unauthorized access
Hacking	Unauthorized access to computer systems through security vulnerabilities
Client-Server	Network model where centralized servers provide services to client computers

Client-Server Model:

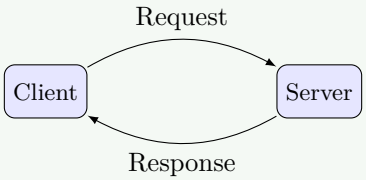

Figure 2. Client-Server Interaction

Mnemonic

"WECHS - Web servers Encrypt data, Clients and Hackers use Servers"

Question 1(c) [7 marks]

Classify and explain the transmission media in detail.

Solution

Transmission Media Types:

Table 2. Transmission Media Classification

Category	Types	Characteristics	Applications
Guided Media			
Twisted Pair	UTP, STP	100m range, 10Mbps-10Gbps	Office LANs
Coaxial Cable	Baseband, Broadband	500m range, 10-100Mbps	Cable TV, Internet
Fiber Optic	Single/Multi-mode	Long distance, high speed	Backbone, WAN
Unguided Media			
Radio Waves	WiFi, Cellular	Omnidirectional	Wireless networks
Microwaves	Terrestrial/Satellite	Line-of-sight	Point-to-point
Infrared	IrDA	Short-range	Remote controls

Diagram:

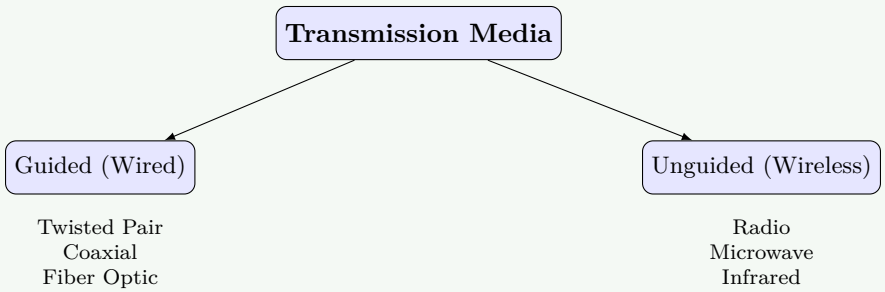

Figure 3. Transmission Media Hierarchy

- **Guided media**: Physical paths for signal confinement
- **Unguided media**: Wireless transmission through air/space
- **Selection factors**: Cost, bandwidth, distance, environment

Mnemonic

"TCFRIM - Twisted pair, Coaxial, Fiber, Radio, Infrared, Microwave"

Question 1(c) OR [7 marks]

Explain WAN and MAN type of network.

Solution

Comparison:

Table 3. MAN vs WAN

Feature	MAN (Metropolitan)	WAN (Wide)
Coverage	City-wide (5-50 km)	Country/Global (>50 km)
Speed	10 Mbps - 10 Gbps	1.5 Mbps - 1 Gbps
Ownership	Municipal/Telecom	Multiple organizations
Examples	City wifi, Campus Data	Internet, 4G/5G

Network Scope Diagram:

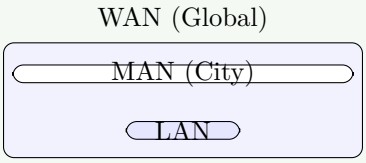

Figure 4. Network Scope Hierarchy

- **MAN**: Connects LANs within a city/metropolitan area
- **WAN**: Spans large geographical areas across cities/countries
- **Management**: WAN typically requires major service providers

Mnemonic

"SWIM - Size: WAN Is Massive compared to MAN"

Question 2(a) [3 marks]

Explain in detail: Transmission technology.

Solution

Transmission Technologies:

Table 4. Transmission Types

Technology	Description	Example
Point-to-Point	Direct connection between two nodes	Leased line
Broadcast	Single channel shared by all nodes	Wireless LAN
Multipoint	Multiple devices share single link	Cable TV

- **Analog**: Continuous signal, susceptible to noise
- **Digital**: Discrete signal, more reliable

- **Baseband**: Single signal uses entire bandwidth (Ethernet)
- **Broadband**: Multiple signals share bandwidth (Cable TV)

Mnemonic

"ABP-DMB - Analog/Baseband Point-to-point; Digital/Multipoint Broadcast"

Question 2(b) [4 marks]

Draw and explain Star topology in detail.

Solution

Star Topology Diagram:

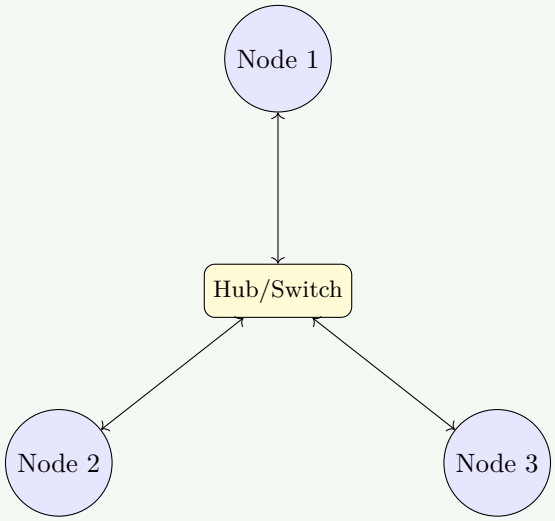

Figure 5. Star Topology

Analysis:

Table 5. Star Topology Pros/Cons

Advantages	Disadvantages
Easy installation	Single point of failure (Hub)
Simple troubleshooting	More cable required
Scalable	Higher cost due to central device

Mnemonic

"CASE - Centralized, All connected, Simple expansion, Easy troubleshooting"

Question 2(c) [7 marks]

Draw and explain TCP/IP model.

Solution

TCP/IP Model Layers:

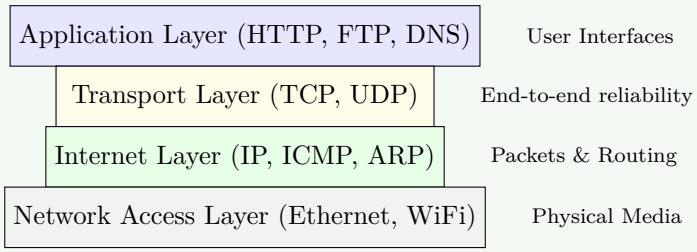

Figure 6. TCP/IP Stack

Layer Functions:

- **Application**: Interface between user applications and network
- **Transport**: Reliable data transfer between end systems
- **Internet**: Addressing and routing of packets
- **Network Access**: Physical hardware interface

Mnemonic

"ATNI - Application Talks, Network Internet Interfaces"

Question 2(a) OR [3 marks]

Draw and explain Bus topology in detail

Solution

Bus Topology Diagram:

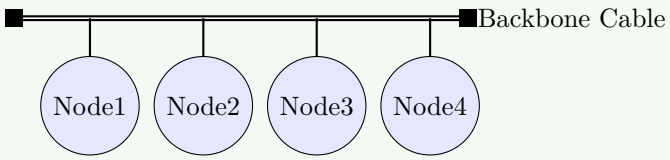

Figure 7. Bus Topology

Analysis:

- **Advantages**: Simple layout, less cabling, low cost
- **Disadvantages**: Backbone failure stops all, difficult troubleshooting
- **Terminator**: Required at ends to prevent signal reflection

Mnemonic

"SLUE - Simple Layout, Uses less cable, Easy installation"

Question 2(b) OR [4 marks]

Explain Network Classification based on its architecture.

Solution

Network Architectures:

Table 6. Architecture Comparison

Architecture	Characteristics	Example
Peer-to-Peer	Equal privileges, decentralized	torrents, home LAN
Client-Server	Centralized services	Enterprise networks
Three-Tier	Presentation, Logic, Data tiers	Web apps

Diagrams:

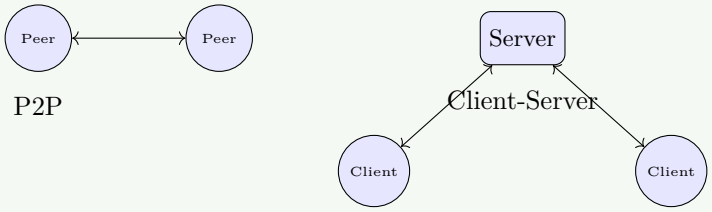

Figure 8. Architecture Models

Mnemonic

"PCAN - Peer-to-peer, Client-server, Architecture Networks"

Question 2(c) OR [7 marks]

Explain classification of IP address.

Solution

IP Classifications:

Table 7. IP Addressing Classes

Class	Range (1st Octet)	Mask	Hosts
A	1 - 126	255.0.0.0	16M+
B	128 - 191	255.255.0.0	65,534
C	192 - 223	255.255.255.0	254
D	224 - 239	N/A	Multicast
E	240 - 255	N/A	Reserved

Structure Diagram:

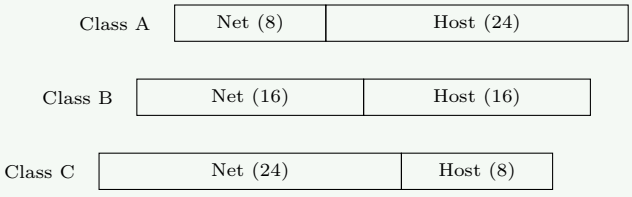

Figure 9. Classful Addressing Structure

- **Special Ranges**: Private IPs (10.x, 192.168.x), Loopback (127.0.0.1)
- **CIDR**: Newer classless routing replaces this legacy system

Mnemonic

"ABCDE - Address Blocks Categorized by Decreasing End-host counts"

Question 3(a) [3 marks]

What is full name of LAN? Explain it in detail.

Solution

Definition: LAN stands for Local Area Network, a network confined to a limited geographic area.
Diagram:

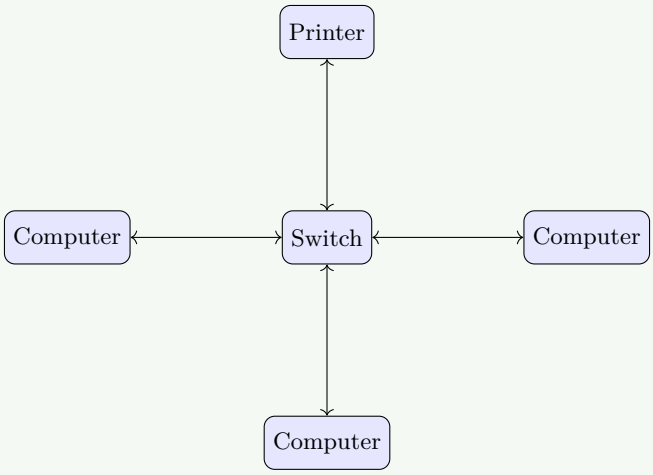

Figure 10. Local Area Network

Characteristics:

Table 8. LAN Features

Characteristic	Description
Scope	Building/Campus (1-2 km)
Speed	High (10 Mbps - 10 Gbps)
Ownership	Single organization/individual
Media	Twisted pair, Fiber, WiFi

Mnemonic

"LOCAL - Limited in range, Owned by one entity, Connected devices, Access control, Low latency"

Question 3(b) [4 marks]

Write a short-note of Repeater.

Solution

Repeater Function:

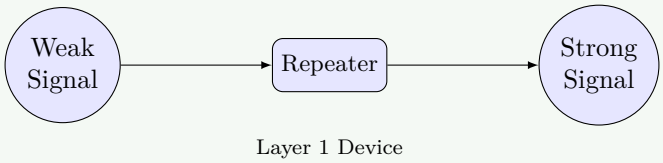

Figure 11. Repeater Operation

- **Layer**: Physical Layer (OSI Layer 1)
- **Function**: Regenerates and amplifies signals
- **Purpose**: Extend network distance beyond cable limits
- **Limitation**: Cannot filter traffic or separate collision domains

Mnemonic

"RARE - Repeaters Amplify and Regenerate Electrical signals"

Question 3(c) [7 marks]

Write short note on FTP.

Solution

File Transfer Protocol (FTP):

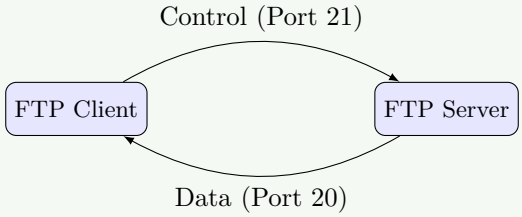

Figure 12. FTP Dual Connections

Key Features:

Table 9. FTP Details

Feature	Description
Ports	21 (Control) and 20 (Data)
Modes	Active and Passive
Auth	Username/Password or Anonymous
Data Types	ASCII (text) and Binary

- **Dual Channel**: Separates commands from data transfer
- **Commands**: GET, PUT, LIST, DELETE, RENAME
- **Security**: Basic FTP is insecure; use FTPS/SFTP

Mnemonic

"CDATA - Control channel, Data channel, Active/passive modes, Transfer types, Authentication"

Question 3(a) OR [3 marks]

What is full name of PAN? Explain in detail.

Solution

Personal Area Network (PAN):

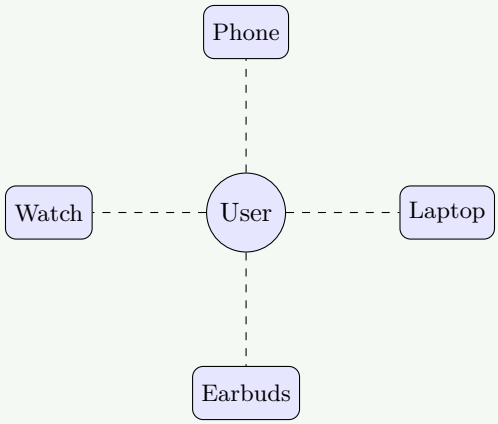

Figure 13. PAN Ecosystem

- **Scope**: Very small (1-10 meters), centered on a person
- **Tech**: Bluetooth, Zigbee, NFC (Wireless); USB (Wired)
- **Use**: Data sync, audio streaming, wearables

Mnemonic

"PIPER - Personal, Individual, Proximity, Easy setup, Reduced range"

Question 3(b) OR [4 marks]

What is the importance of a Bridge? Write short-note on it.

Solution

Bridge Operation:

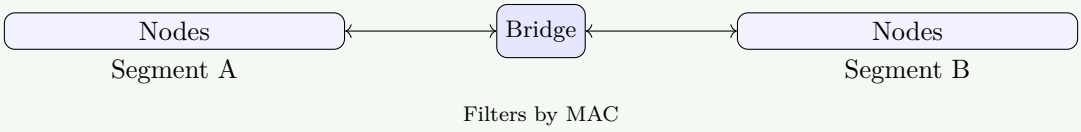

Figure 14. Network Bridge

- **Layer**: Data Link Layer (Layer 2)
- **Function**: Connects segments, filters traffic using MAC addresses
- **Benefit**: Reduces collision domains, reduces traffic
- **Types**: Transparent, Source-route

Mnemonic

"SELF - Segmentation, Extension, Learning addresses, Filtering traffic"

Question 3(c) OR [7 marks]

What is DSL? Explain its different types.

Solution

Digital Subscriber Line (DSL):

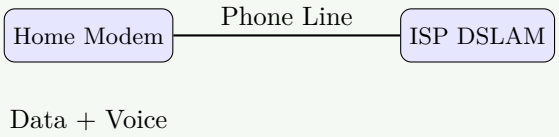

Figure 15. DSL Connection

DSL Types:

Table 10. DSL Variants

Type	Name	Characteristics
ADSL	Asymmetric	Faster download than upload (Home use)
SDSL	Symmetric	Equal speeds (Business use)
VDSL	Very High-bit-rate	Very fast, short distance
HDSL	High-bit-rate	T1/E1 replacement

- **Mechanism**: Uses higher frequencies on copper phone lines
- **Advantage**: Simultaneous voice and data, always-on

Mnemonic

"SAVHI - Symmetric, Asymmetric, Very high-bit-rate, High-bit-rate, ISDN DSL"

Question 4(a) [3 marks]

Explain an error control and flow control at data link layer.

Solution

Data Link Controls:

Table 11. Control Mechanisms

Mechanism	Purpose	Techniques
Error Control	Detect/fix errors	CRC, Checksum, Retransmission (ARQ)
Flow Control	Prevent overflow	Stop-and-wait, Sliding Window

Flow Control Diagram:

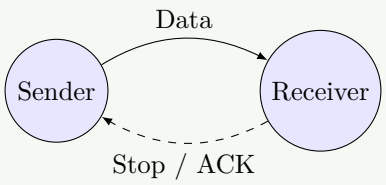

Figure 16. Flow Control Concept

Mnemonic

"SAFE - Stop-and-wait, Acknowledgment, Flow control, Error detection"

Question 4(b) [4 marks]

What is Firewall? Explain it in detail.

Solution

Firewall Operation:

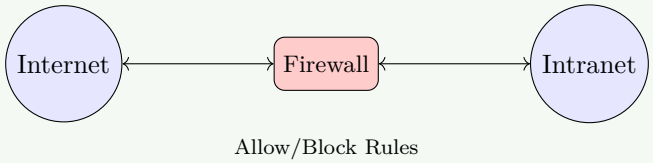

Figure 17. Network Firewall

Types:

- **Packet Filtering**: Checks headers (IP/Port)
- **Stateful**: Tracks connection context
- **Application**: Inspects payload data
- **Next-Gen**: Integrated security features

Mnemonic

"PAPSI - Packet filtering, Application layer, Policies, Stateful inspection"

Question 4(c) [7 marks]

Compare IPV4 and IPV6.

Solution

Comparison:

Table 12. IPv4 vs IPv6

Feature	IPv4	IPv6
Size	32-bit (4.3B addresses)	128-bit (Undecillion)
Format	Dotted Decimal	Hexadecimal with colons
Header	Variable (20-60B)	Fixed (40B)
Security	Optional (IPSec)	Built-in (IPSec)
Checksum	In header	Removed

Header Structures:

Figure 18. Simplified Header Structure

- **Auto-config**: IPv6 supports stateless auto-configuration (SLAAC)
- **No NAT**: IPv6 restores end-to-end connectivity

Mnemonic

"SHAPE - Size, Header, Addressing, Performance, Extensibility"

Question 4(a) OR [3 marks]

What is an IP address? How it is used in network?

Solution

IP Address Definition: A numerical identifier assigned to each device on a network for communication.
Diagram:

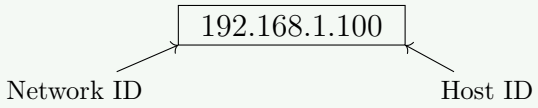

Figure 19. IPv4 Structure

- **Identification**: Uniquely names devices
- **Addressing**: Locates devices (like a postal address)
- **Routing**: Enables finding paths across networks

Mnemonic

"IRAN - Identification, Routing, Addressing, Network division"

Question 4(b) OR [4 marks]

Compare FDDI and CDDI.

Solution

FDDI vs CDDI:

Table 13. Technology Comparison

Feature	FDDI (Fiber)	CDDI (Copper)
Media	Fiber Optic	Twisted Pair (Copper)
Speed	100 Mbps	100 Mbps
Range	Up to 200 km	100 meters
Cost	High	Low
Topology	Dual Ring	Dual Ring

Dual Ring Topology:

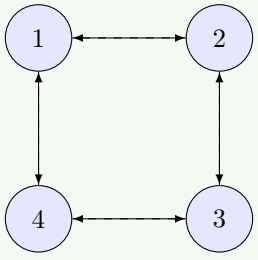

Figure 20. Dual Counter-Rotating Rings

Mnemonic

"FDDI Flies, CDDI Crawls (Distance wise)"

Question 4(c) OR [7 marks]

Draw and explain OSI reference model in detail.

Solution

OSI Layered Model:

7. Application (User)
6. Presentation (Format)
5. Session (Dialog)
4. Transport (Segments)
3. Network (Packets)
2. Data Link (Frames)
1. Physical (Bits)

Figure 21. OSI 7-Layer Model

Analysis:
- **Encapsulation**: Data moves down layers, gaining headers.
- **Layers 1-3**: Media layers (Network specific).
- **Layers 4-7**: Host layers (Application specific).

Mnemonic

"All People Seem To Need Data Processing"

Question 5(a) [3 marks]

What is ISO? How it works in information security?

Solution

Definition: ISO (International Organization for Standardization) creates global standards, including the ISO 27000 series for security.
Functionality:
- **Standards**: ISO 27001 (ISMS), 27002 (Controls).
- **Framework**: Provides structured risk management (ISMS).
- **Compliance**: Organizations get certified for trust.

Mnemonic

"PRIMP - Policies, Risk assessment, Implementation, Monitoring, Process improvement"

Question 5(b) [4 marks]

Explain terms in detail for cryptography: 1) Encryption 2) Decryption

Solution

Cryptography Concepts:

Figure 22. Crypto Process

- **Encryption**: Converting plaintext to unreadable ciphertext to ensure confidentiality. Uses algorithms (AES, RSA).
- **Decryption**: Reverting ciphertext to plaintext using the correct key.

Mnemonic

"PACK-DUKE - Plaintext Algo Cipher Key - Decoding Using Key Extraction"

Question 5(c) [7 marks]

Write a short-note on 1) E-mail and 2) DNS

Solution

1) E-mail System:

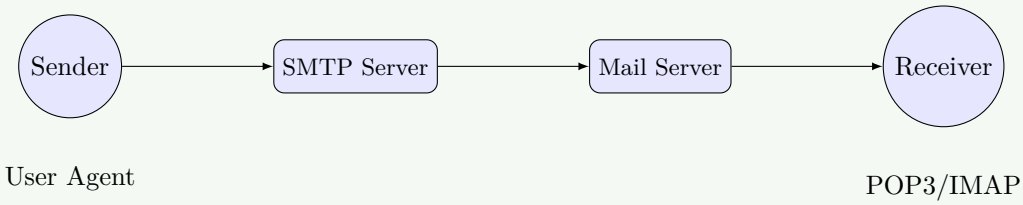

Figure 23. Email Flow

- **Protocols**: SMTP (Send), POP3/IMAP (Receive).
- **Components**: MUA (Client), MTA (Server).

2) DNS (Domain Name System):

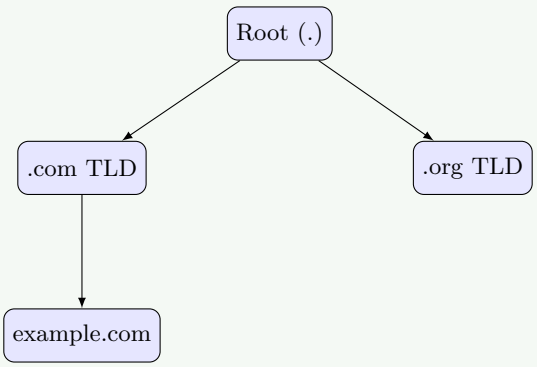

Figure 24. DNS Hierarchy

- **Function**: Translates Domain Names -> IP Addresses.

- **Hierarchy**: Root -> TLD -> Authoritative.
- **Records**: A (IPv4), AAAA (IPv6), MX (Mail).

Mnemonic

"MAPS - Mail needs Addresses, Protocols, and Servers. HARD - Hierarchy, Addressing, Resolution, Distributed"

Question 5(a) OR [3 marks]

What do you mean by security topology and security zone?

Solution

Concepts:

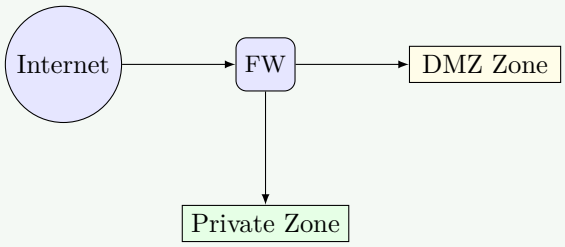

Figure 25. Security Zones

- **Security Topology**: The physical/logical layout of security controls (Firewalls, IDS).
- **Security Zone**: A network segment with a specific trust level (e.g., DMZ vs Internal).

Mnemonic

"TIPS - Topology Isolates and Protects Systems"

Question 5(b) OR [4 marks]

Write short-note on Voice and Video IP.

Solution

VoIP / Video over IP:

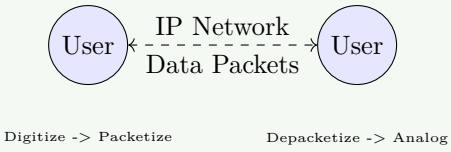

Figure 26. Packet Voice/Video

Table 14. Key Components

Component	Examples
Codecs	G.711 (Voice), H.264 (Video)
Protocols	SIP (Setup), RTP (Transport)
Requirements	Low latency (QoS), High bandwidth

Mnemonic

"CLEAR - Codecs compress, Latency matters, Encodes AV, Real-time transport"

Question 5(c) OR [7 marks]

What is IP security? Explain in detail.

Solution

IPsec (Internet Protocol Security): A protocol suite for securing IP communications via authentication and encryption.

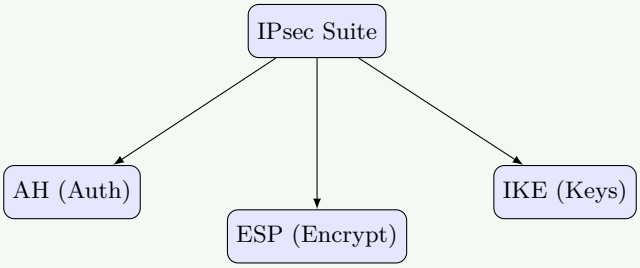

Figure 27. IPsec Components

Components:
- **AH (Authentication Header)**: Integrity & Auth. No encryption.
- **ESP (Encapsulating Security Payload)**: Encryption + Integrity + Auth.
- **IKE (Internet Key Exchange)**: Negotiates keys (SA).

Modes:
- **Transport Mode**: Encrypts payload only (Host-to-host).
- **Tunnel Mode**: Encrypts entire packet (VPNs).

Mnemonic

"AVID TC - Auth, Verification, Integrity, Data protection, Transport/Tunnel modes, Confidentiality"