DATA COMMUNICATION AND COMPUTER NETWORK

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BCA 303: Data Communication & Computer Networks

Question Paper pattern for Main University Examination Max Marks: 100

Part - I (very short answer) consists 10 questions of two marks each with two questions from each unit. Maximum limit for each question is up to 40 words.

Part - II (short answer) consists 5 questions of four marks each with one question from each unit.Maximum limit for each question is up to S0 words.

Part - III (Long answer) consists 5 questions of twelve marks each with one question from each unit with internal choice.

UNIT-I

Introduction: Network definition, Network topologies, Types of Network, Layered network architecture, Categories of Network, protocol, Standards and interface.

Network Models: OSI reference model, OSI model architecture and functions of layers.TCP/IP protocol suite.

UNIT- II

Data Communication Fundamentals and Techniques: Analog and digital signal. Data-rate limits, Digital to digital
line encoding schemes, Pulse code modulation, Digital to analog modulation- ASK, FSK, PSK, QAM, multiplexing
techniques- FDM, TDM, WDM, transmission modes

Transmission Media : Guided media (Twisted Pair Cable, Coaxial Cable & Fiber-Optic Cable) and Unguided media:
Radio wave, Infrared, Microwave Communication. Satellite, Geosynchronous Satellites Communication.

UNIT-III

Networks Switching Techniques: Circuit switching; Packet switching- Connectionless datagram switching,
Connection-oriented virtual circuit switching.

Data Link Layer Functions and Protocol: Error detection and error correction techniques, Data-link control-
framing and flow control, Error recovery protocols- Stop and wait ARQ, Go-back-n ARQ, Selective repeat ARQ,
Point to Point Protocol on Internet.

UNIT-IV

Access mechanisms Multiple Access Protocol and Networks: ALOHA,CSMA/CD protocols, Ethernet LANS,
connecting LAN and back-bone networks- Repeaters. Hubs, Switches, Bridges, Router and Gateways.

Networks Layer Functions and Protocols: Routing, Routing algorithms. Network layer protocol of Internet- IP
protocol. Internet control protocols.

UNIT-V

Transport Layer Functions and Protocols: Transport services, Berkeley socket interface overview, Transport
layer protocol of Internet- UDP and TCP. Overview of Application layer protocol, DNS protocol, WWW & HTTP protocols.

Unit I: Introduction to Networks

Introduction: Network definition, Network topologies, Types of Network, Layered network architecture,
Categories of Network, protocol, Standards and interface.

Network Models: OSI reference model, OSI model architecture and functions of layers.TCP/IP protocol suite.

📡 Introduction to Networking

Network ek aisa system hota hai jahan multiple devices — jaise computers, servers, routers, aur doosre network devices — aapas mein connected hote hain taaki wo **resources share kar sakein**, **information exchange kar sakein**, ya **communication** kar sakein.
Networks data transmission allow karte hain aur file sharing, email, web browsing jaise services ko enable karte hain.

🔑 Key Components of a Network:

- **Nodes**: Devices jaise computers, printers, routers jo network ka part hote hain.
- **Links**: Physical ya wireless connections jo in devices ko connect karte hain.
- **Protocols**: Rules ka set jo batata hai ki devices kaise communicate karein aur data transfer karein network ke andar.

Networking se efficient resource sharing aur communication possible hota hai, chaahe local ho ya global. Iska use kai sectors mein hota hai — jaise business, education, aur entertainment.

🧭 Network Topologies

Network topology ka matlab hota hai devices ka arrangement aur kaise wo interconnected hain. Har topology ka apna fayda hota hai aur alag-alag needs ke liye suitable hoti hai.

🔁 Common Types of Network Topologies:

- **Bus Topology**: Is layout mein sabhi devices ek common central communication medium (bus) se connected hote hain, aur data ek hi direction mein transmit hota hai. Ye simple hota hai par agar central bus damage ho jaaye toh pura network fail ho sakta hai.
- **Ring Topology**: Har device apne dono side ke do devices se connected hota hai, aur ek closed loop banata hai. Data ek direction mein ring ke around travel

karta hai. Ye data flow ko efficiently manage karta hai lekin agar ek bhi device ya connection fail ho gaya toh poora network disturb ho jaata hai.

- **Star Topology**: Star topology mein sabhi devices ek central hub ya switch se connected hote hain, jo data traffic ko direct karta hai. Ye setup manage karna easy hota hai aur easily expand bhi kiya ja sakta hai, lekin agar central hub fail ho gaya toh poora network ruk jaata hai.

- **Mesh Topology**: Is topology mein har device directly har doosre device se connected hota hai. Ye high redundancy aur resilience provide karta hai, lekin ismein bohot saare connections lagte hain, isliye ye expensive aur complex hoti hai.

- **Tree Topology**: Ye star aur bus topology ka hybrid hota hai. Isme ek central backbone hoti hai jismein multiple star-configured branches connected hoti hain. Ye scalable hoti hai lekin jaise-jaise network grow karta hai, manage karna mushkil ho sakta hai.

- **Hybrid Topology**: Do ya usse zyada topologies ka combination hoti hai, jisse har topology ka benefit milta hai. Example: Ek network jismein star-topology branches bus-topology backbone se connected hoon.

Har topology ke apne pros & cons hote hain, aur topology ka choice depend karta hai scalability, cost, fault tolerance, aur ease of management pe.

🌐 Types of Networks

Networks ko unki size, geographic reach, aur purpose ke basis pe classify kiya ja sakta hai. Kuch common types:

- **LAN (Local Area Network)**: Ye chhoti geographic area mein hota hai jaise ek building, office, ya campus. Isme high-speed connection hota hai computers aur printers ke liye. Example: Office network, home Wi-Fi.

- **WAN (Wide Area Network)**: Ye bada geographic area cover karta hai, aur multiple LANs ko connect karta hai. Sabse bada example: **Internet**. WAN banana aur maintain karna costly hota hai, lekin ye vast distance pe connectivity provide karta hai.

- **MAN (Metropolitan Area Network)**: Ye ek city ya large campus ko cover karta hai. LAN se bada aur WAN se chhota hota hai. Iska use multiple buildings ya offices ko ek metropolitan area mein connect karne ke liye hota hai.

- **PAN (Personal Area Network)**: Ye personal devices ke liye hota hai, usually 10 meters tak ke range mein. Example: Bluetooth connection between smartphone, laptop, wireless keyboard.

- **VPN (Virtual Private Network)**: Secure remote access provide karta hai kisi network pe via internet. Ye encryption aur tunneling protocols ka use karta hai taaki user aur network ke beech ka data private aur secure rahe.

🧱 Layered Network Architecture

Layered network architecture networking ke complex tasks ko simplify karta hai by dividing them into layers. Har layer ka ek specific function hota hai data communication mein. Is approach se troubleshooting, modularity aur standardization easy ho jaata hai.

Networking mein 2 key frameworks hote hain jo layers describe karte hain:

- **OSI Model**
- **TCP/IP Model**

📜 Protocols, Standards, and Interfaces

🔁 Protocol:

Protocol ek rules ka set hota hai jo decide karta hai data kaise network mein transmit hoga. Ye ensure karta hai ki devices effective aur reliable tareeke se communicate kar sakein. Kuch common protocols:

- **HTTP (Hypertext Transfer Protocol)**: Web pages transfer karne ke liye
- **FTP (File Transfer Protocol)**: Files transfer karne ke liye
- **TCP/IP (Transmission Control Protocol/Internet Protocol)**: Internet communication ka backbone
- **SMTP (Simple Mail Transfer Protocol)**: Emails bhejne ke liye
- **IP (Internet Protocol)**: Data packets ko address aur route karne ke liye

📏 Standards:

Standards consistency ensure karte hain taaki different devices aur software ek saath kaam kar sakein. Ye standards banate hain organizations jaise:

- **IEEE**
- **IETF**

Examples:

- **IEEE 802.3**: Ethernet ke liye
- **IEEE 802.11**: Wireless networking (Wi-Fi) ke liye

🔌 Interfaces:

Interfaces physical ya logical points hote hain jahan devices communicate karte hain.

Examples:

- **Ethernet Ports**: Physical interface jahan cable connect hoti hai
- **Wi-Fi**: Wireless interface jisme physical connection ki zarurat nahi hoti

🧩 Network Models

Network model ek conceptual framework hota hai jisse hum network ke functions ko layers ya components ke roop mein samajh sakte hain. Ye interoperability, scalability, aur reliability ensure karta hai.

📘 OSI Reference Model (7 Layers)

OSI Model (Open Systems Interconnection) ek conceptual framework hai jo network communication ko 7 layers mein divide karta hai. Isse network design, development, aur troubleshooting easy ho jaata hai.

1. Physical Layer:

Sabse lowest layer, jo raw data ko physical medium (jaise cables, radio waves, fiber optics) pe transmit karti hai. Ye electrical signals, physical connections aur data transmission ko define karti hai.
Examples: Ethernet cables, fiber optics, wireless signals.

2. Data Link Layer:

Ye layer ensure karti hai ki physical layer se data reliable tareeke se aaye. Ye bits ko frames mein convert karti hai aur error detection bhi karti hai.
Examples: Ethernet, Wi-Fi (802.11), MAC addressing.

3. Network Layer:

Data packets ko alag-alag devices ke beech route karta hai. Logical addressing aur routing ye handle karta hai.
Examples: IP (Internet Protocol), routers.

4. Transport Layer:

End-to-end communication handle karta hai. Data ko segments mein divide karta hai, aur error correction aur flow control bhi karta hai.
Examples: TCP, UDP.

5. Session Layer:

Applications ke beech sessions ya connections manage karta hai. Communication organized banata hai.
Examples: RPC, NetBIOS.

6. Presentation Layer:

Data translation, encryption, aur compression ke liye responsible hoti hai. Ye ensure karta hai ki data receiver ke liye understandable ho.
Examples: SSL/TLS, JPEG.

***7.* Application Layer:**

Topmost layer jahan se user directly interact karta hai. Services jaise web browsing, file transfer, email yahin se milti hain.
Examples: HTTP, FTP, SMTP.

🌐 TCP/IP Protocol Suite

TCP/IP Model networking aur internet communication ka base hai. Ye OSI model ka simplified version hai, jo mostly 4 layers mein describe kiya jaata hai:

1. Link Layer:

Ye OSI ke Physical aur Data Link layer ke barabar hoti hai. Ye physical transmission aur framing handle karti hai.
Examples: Ethernet, Wi-Fi.

2. Internet Layer:

Logical addressing, routing, aur data packet forwarding ka kaam karti hai. IP address ka use karti hai.
Examples: IP, ARP, ICMP.

3. Transport Layer:

Reliable data transmission ka kaam karti hai. Ye error handling, flow control, aur segmentation handle karti hai.
Examples: TCP, UDP.

4. Application Layer:

Application level services provide karti hai jaise file transfer, web browsing, email, etc.
Examples: HTTP, FTP, DNS.

TCP/IP suite large-scale networks (like Internet) ke communication ko support karta hai with flexibility, scalability, and interoperability.

🏁 Conclusion

Networking ke basic concepts, protocols aur models ko samajhna zaruri hai taaki hume pata chale ki devices local aur wide-area networks mein kaise communicate karte hain.

OSI aur TCP/IP models structured framework provide karte hain jisme har layer ka ek specific function hota hai.
Protocols, standards aur interfaces interoperability ensure karte hain – yaani alag-alag devices ek saath milke efficiently aur securely kaam karein.

Unit II: Data Communication

Data Communication Fundamentals and Techniques: Analog and digital signal. Data-rate limits, Digital to digital
line encoding schemes, Pulse code modulation, Digital to analog modulation- ASK, FSK, PSK, QAM, multiplexing
techniques- FDM, TDM, WDM, transmission modes

Transmission Media : Guided media (Twisted Pair Cable, Coaxial Cable & Fiber-Optic Cable) and Unguided media:
Radio wave, Infrared, Microwave Communication. Satellite, Geosynchronous Satellites Communication.

Data Communication Fundamentals and Techniques 📡

Data communication ka matlab hai devices ke beech data ko ek communication medium ke through bhejna. Modern networking mein ye bohot zaroori hai taaki data efficiently aur accurately transfer ho sake. Is unit mein hum data communication ke fundamental techniques aur principles ko explore karenge—signal types, encoding schemes, modulation techniques, multiplexing, aur transmission media. 🌐

Analog aur Digital Signals 📶

- **Analog Signals:** Analog signals continuous signals hote hain jo data ko wave-like form mein represent karte hain. Ye signals amplitude, frequency, ya phase mein vary karte hain, jo transmitted information par depend karta hai. Analog signals purani telecommunication systems aur technologies mein use hote hain.
    - **Characteristics:** Analog signals continuous hote hain, jo range of values ko represent karte hain. Lekin ye long distances par noise aur degradation ke liye zyada susceptible hote hain.
    - **Examples:** Telephone calls over traditional landlines, AM/FM radio signals. 📞📻
- **Digital Signals:** Digital signals data ko discrete binary form (0s aur 1s) mein represent karte hain, jo unhe noise ke prati zyada resistant aur long distances par zyada reliable banata hai. Ye signals binary data ko represent karne ke liye pulses ka sequence hote hain.
    - **Characteristics:** Digital signals noise aur interference se kam prabhavit hote hain, aur ye modern communication systems mein zyada efficient data transmission provide karte hain.
    - **Examples:** Internet communication, modern telephony, digital television. 💻📺

Data-Rate Limits 🚀

Data rate ka matlab hai data ko ek communication channel ke through transmit karne ki speed, jo bits per second (bps) mein measure hoti hai. Kai factors data rate ko influence karte hain, jaise bandwidth aur signal quality.

- **Bandwidth:** Ye communication channel ki frequency range hoti hai. Higher bandwidth zyada data ko simultaneously transmit karne ki suvidha deta hai.
- **Signal Quality:** Signal-to-noise ratio (SNR) maximum data rate ko determine karne ke liye crucial hota hai. High SNR se kam errors aur zyada reliable data transmission hota hai.
- **Transmission Medium:** Different types ke cables aur media different data rates ko support karte hain. Jaise fiber-optic cables copper cables ke mukable mein zyada data rates support karte hain. 🔗

Shannon-Hartley Theorem 📊

Ye theorem ek formula provide karta hai jo communication channel ki maximum theoretical data rate (C) ko calculate karta hai, jo uski bandwidth (B) aur signal-to-noise ratio (S/N) par based hota hai:

$$C = B \log_2(1 + \frac{S}{N})$$

Jahan:

- **C** = Channel capacity (maximum data rate)
- **B** = Bandwidth
- **S** = Signal power
- **N** = Noise power

Digital to Digital Line Encoding Schemes 💾

Line encoding ka matlab hai digital data ko ek specific format mein convert karna jo transmission ke liye suitable ho. Iska goal hai transmission ko zyada reliable banana, errors ko prevent karna, synchronization ko improve karna, aur signal integrity ko maintain karna.

- **NRZ (Non-Return-to-Zero):** Is method mein ek bit ko ek binary state ke liye high voltage aur dusre state ke liye low voltage se represent kiya jata hai. Isme bits ke beech zero par return nahi hota.

    - *Advantages:* Simple aur efficient
    - *Disadvantages:* Long transmissions mein synchronization mushkil hoti hai
- **RZ (Return-to-Zero):** Is scheme mein har bit ko half bit period ke liye positive voltage aur baaki half ke liye zero par represent kiya jata hai.
    - *Advantages:* NRZ ke mukable mein better synchronization
    - *Disadvantages:* Zyada bandwidth ka use hota hai
- **Manchester Encoding:** Is method mein har bit ko bit period ke beech mein transition se represent kiya jata hai. Logical 1 ko low-to-high transition se aur logical 0 ko high-to-low transition se dikhaya jata hai.
    - *Advantages:* Har bit mein transition hone se synchronization ensure hoti hai
    - *Disadvantages:* Zyada bandwidth ki zarurat hoti hai
- **Differential Manchester Encoding:** Ye Manchester encoding ke similar hai, lekin yeh data value ko represent karne ke liye transition ke direction ka use karta hai.

Pulse Code Modulation (PCM) 🎵

Pulse Code Modulation (PCM) ek method hai jo analog signals ko digital form mein convert karta hai. Ye digital audio aur telecommunication systems mein widely used hota hai. PCM ka kaam hai analog signal ko regular intervals par sample karna aur har sample ke amplitude ko finite set ke nearest value par quantize karna.

- **Process:**
    - *Sampling:* Analog signal ko constant rate par sample karna
    - *Quantization:* Har sample ko specific range ke andar nearest digital value par approximate karna
    - *Encoding:* Quantized values ko binary numbers mein encode karna
- **Applications:** PCM ka use digital telephony (jaise VoIP), audio recording, aur digital audio formats jaise CD aur DVD mein hota hai. 🎧

Digital to Analog Modulation Techniques 📡

Jab digital data ko analog channels par transmit karna hota hai, tab modulation ka use hota hai taaki digital signal ko analog signal mein convert kiya ja sake. Common digital-to-analog modulation techniques hain:

- **ASK (Amplitude Shift Keying):** Carrier signal ke amplitude ko binary data ke according change karte hain. High amplitude ek bit ko represent karta hai, aur low amplitude dusre bit ko.
    - *Advantages:* Simple implementation
    - *Disadvantages:* Noise aur interference ke prati zyada susceptible
- **FSK (Frequency Shift Keying):** Carrier signal ke frequency ko modulate kiya jata hai. Different frequencies different binary values ko represent karti hain (0 ya 1).
    - *Advantages:* ASK ke mukable mein noise ke khilaf zyada robust
    - *Disadvantages:* Zyada bandwidth ki zarurat
- **PSK (Phase Shift Keying):** Carrier signal ke phase ko modulate kiya jata hai taaki data ko represent kiya ja sake. Phase shift binary data ko represent karta hai.
    - *Advantages:* Efficient aur noise ke khilaf resistant
    - *Disadvantages:* Accurate phase synchronization ki zarurat
- **QAM (Quadrature Amplitude Modulation):** QAM amplitude aur phase dono ko modulate karta hai. Ek symbol par multiple bits ko encode kiya ja sakta hai, jo high data rates ko enable karta hai.
    - *Advantages:* High data rates aur efficient bandwidth usage
    - *Disadvantages:* Complex aur noise ke prati zyada susceptible

Multiplexing Techniques 🔗

Multiplexing ek technique hai jisme multiple data streams ko ek signal mein combine kiya jata hai, taaki available bandwidth ka optimal use ho sake. Iske kai types hain:

- **FDM (Frequency Division Multiplexing):** Available bandwidth ko multiple non-overlapping frequency bands mein divide karte hain, aur har data stream ko alag frequency par transmit kiya jata hai.
    - *Applications:* Analog radio aur television broadcasting, satellite communication
- **TDM (Time Division Multiplexing):** Transmission time ko time slots mein divide kiya jata hai. Har data stream ko ek specific time slot diya jata hai apna data transmit karne ke liye.
    - *Applications:* Digital telephony, satellite communication

- **WDM (Wavelength Division Multiplexing):** Ye FDM ke similar hai, lekin optical fiber communication mein use hota hai. Different wavelengths (colors) of light alag data streams ko same fiber-optic cable ke through carry karte hain.
    - *Applications:* Fiber-optic communication systems

Transmission Modes 📡

Transmission mode ka matlab hai do devices ke beech data flow ka direction. Ye teen categories mein classify hota hai:

- **Simplex Mode:** Data sirf ek direction mein flow karta hai, sender se receiver tak, bina kisi return communication ke.
    - *Example:* Television broadcasts
- **Half-Duplex Mode:** Data dono directions mein flow kar sakta hai, lekin ek saath nahi. Har device ko apne turn ka wait karna padta hai data bhejne ke liye.
    - *Example:* Walkie-talkies
- **Full-Duplex Mode:** Data dono directions mein ek saath flow karta hai. Dono devices simultaneously data bhej aur receive kar sakte hain.
    - *Example:* Telephone conversations 📞

Transmission Media 🌍

Transmission media ka matlab hai wo physical ya wireless medium jiska use data ko ek device se doosre device tak transmit karne ke liye hota hai. Ye do categories mein divide hota hai:

- **Guided Media (Wired):** Data physical cables ya fibers ke through transmit hota hai.
    - *Twisted Pair Cable:* Copper wires ke pairs twisted hote hain. Telecommunication aur Ethernet networks mein use hot

a hai.

- *Coaxial Cable:* Central conductor, insulating layer, metallic shield, aur outer jacket se bana hota hai. Cable TV aur broadband internet mein use hota hai.
- *Fiber-Optic Cable:* Light signals ka use karke data transmit karta hai, high bandwidth aur noise resistance provide karta hai. High-speed internet connections mein use hota hai.
- **Unguided Media (Wireless):** Data bina kisi physical cable ke air ke through transmit hota hai.

- *Radio Waves:* Wireless communication ke liye use hoti hain, jaise AM/FM radio aur Wi-Fi.
- *Microwave Communication:* High-frequency radio waves ka use hota hai, long distances ke liye, jaise satellite communication.
- *Infrared:* Short-range communication ke liye, jaise remote controls aur kuch wireless devices.

- **Satellite Communication:** Earth ke orbit mein satellites ke through signals transmit karna. Ye long-distance communication, TV broadcasting, weather monitoring, aur GPS services ke liye use hota hai.
  - *Geosynchronous Satellites:* Earth ke surface ke relative fixed position par orbit karte hain, jis se specific regions ke saath continuous communication hota hai.

Conclusion 🎯

Is unit mein humne data communication ke essential techniques aur methods cover kiye, jaise analog aur digital signals, encoding schemes, modulation techniques, multiplexing, aur transmission media. Guided aur unguided dono transmission media data ke successful transfer mein key role play karte hain. In concepts ko samajhna modern communication systems ke design aur operation ke liye bohot zaroori hai. 🚀

Unit III: Network Switching & Data Link Layer

Networks Switching Techniques: Circuit switching; Packet switching- Connectionless datagram switching,
Connection-oriented virtual circuit switching.

Data Link Layer Functions and Protocol: Error detection and error correction techniques, Data-link control-
framing and flow control, Error recovery protocols- Stop and wait ARQ, Go-back-n ARQ, Selective repeat ARQ,
Point to Point Protocol on Internet.

Network Switching Techniques 🔄

Network switching ka matlab hai data ko network mein route karne ke tareeqe. Switching important hoti hai kyunki ye decide karti hai ki ek packet kaunsa path lekar different networks ke through travel karega aur devices ke beech efficient communication ko ensure karega. Iske do primary types hain:

1. **Circuit Switching**
2. **Packet Switching**

1. Circuit Switching 📞

Circuit switching ek aisa method hai jisme do devices ke beech ek dedicated communication path ya circuit establish kiya jata hai unke conversation ya data transmission ke dauran. Jab tak communication chal raha hota hai, tab tak ye circuit reserved rehta hai, aur jab baat khatam ho jati hai to circuit release ho jata hai.

- **Kaise Kaam Karta Hai:**
  Sender aur receiver ke beech data bhejne se pehle ek connection establish hota hai. Ye path exclusive hota hai, aur koi aur data is par nahi bheja ja sakta. Ye method traditional telephone networks mein use hoti hai.

- **Advantages:**
  ✅ Constant data rate aur reliable communication
  ✅ Circuit establish hone ke baad koi delay nahi hota

- **Disadvantages:**
  ❌ Resources ka inefficient use: Jab koi data nahi bheja ja raha hota, phir bhi path reserved rehta hai
  ❌ Setup delay: Connection establish karne mein time lagta hai

Example: Traditional telephone networks jahan har call ke liye ek dedicated circuit establish kiya jata hai. 📞

2. Packet Switching 💻

Packet switching mein data ko chhote-chhote packets mein tod diya jata hai aur har packet ko network ke through independently bheja jata hai. Har packet alag-alag path le sakta hai aur receiver par wapas sahi order mein assemble ho jata hai.

- **Kaise Kaam Karta Hai:**
  Data ko chhote packets mein divide kiya jata hai, aur har packet ke saath routing information ka header hota hai. Ye packets network ke routers ya switches ke through travel karte hain, jo best path ko select karte hain. Jab saare packets destination par pahuch jaate hain, to unhe sahi order mein reassemble kiya jata hai.

- **Advantages:**
  ✅ Network resources ka efficient use
  ✅ Dedicated path ki zarurat nahi, multiple communications ek saath handle ki ja sakti hain

- **Disadvantages:**
  ❌ Data rates variable ho sakte hain: Packets alag-alag routes le sakte hain, jo delay la sakte hain
  ❌ Packet loss ya congestion ho sakta hai agar network overload ho

Types of Packet Switching 🌐

1. **Connectionless Datagram Switching:**
   Is method mein har packet ko independent tarike se treat kiya jata hai. Pre-established connection ki zarurat nahi hoti, aur packets alag-alag paths le sakte hain.
   - **Advantages:** Flexible aur scalable
   - **Disadvantages:** Packets out of order pahuch sakte hain aur zyada overhead ho sakta hai

2. **Connection-Oriented Virtual Circuit Switching:**
   Is method mein data bhejne se pehle ek virtual connection establish kiya jata hai. Packets ek hi predefined path ko follow karte hain taaki wo sahi order mein pahuch sakein.
   - **Advantages:** Reliable packet delivery aur in-order reception
   - **Disadvantages:** Virtual connection maintain karne ke liye thoda overhead hota hai

Examples:

- Internet IP-based communication ke liye connectionless datagram switching use karta hai.
- ATM (Asynchronous Transfer Mode) connection-oriented virtual circuit switching use karta hai.

Data Link Layer Functions and Protocols 🔗

Data Link Layer (DLL) OSI model ka doosra layer hai jo adjacent network nodes ke beech data transfer ke liye responsible hota hai. Iske key functions hain:

- Error detection aur correction
- Flow control
- Data framing

Error Detection and Correction Techniques ⚠️

- **Error Detection:**
    1. **Parity Bit:** Ek bit add ki jati hai taaki 1s ka number even ya odd ho. Ye errors ko detect karta hai lekin correct nahi kar sakta.
    2. **Checksums:** Data ka mathematical value calculate karke verify kiya jata hai ki data sahi hai ya nahi.
    3. **CRC (Cyclic Redundancy Check):** Polynomial division ka use karke errors ko detect karne ka advanced method hai.
- **Error Correction:**
  Jab error detect hota hai, to usse recover karne ke liye kuch techniques use hoti hain:
    1. **Forward Error Correction (FEC):** Redundant bits add ki jati hain taaki receiver bina retransmission ke errors ko correct kar sake.

Data-Link Control: Framing and Flow Control 📦

- **Framing:**
  Data ko chhoti-chhoti frames mein divide kiya jata hai. Har frame mein hota hai:
    - Header (control information)

- Data
- Trailer (error-checking information)

- **Types of Framing:**
  - **Character-Oriented Framing:** Special characters se frame ko mark kiya jata hai.
  - **Bit-Oriented Framing:** Bits ka sequence use kiya jata hai, aur bit-stuffing techniques se delimiters ko control kiya jata hai.

- **Flow Control:**
  Data transmission ka rate manage karne ke liye taaki receiver overload na ho.
  Types of Flow Control:
  - **Stop-and-Wait:** Sender ek frame bhejta hai aur acknowledgment ka intezaar karta hai.
  - **Sliding Window Protocol:** Multiple frames bhejne ke baad acknowledgment milta hai, jo zyada efficient hota hai.

Error Recovery Protocols 🛠️

- **Stop-and-Wait ARQ:**
  Sender ek frame bhejta hai aur acknowledgment ka intezaar karta hai. Agar acknowledgment nahi milta, to frame ko dobara bheja jata hai.
  - **Advantages:** Simple aur reliable
  - **Disadvantages:** High-latency networks mein inefficient

- **Go-Back-N ARQ:**
  Sender multiple frames bhejta hai aur agar koi error hota hai to us frame aur uske baad ke frames ko dobara bhejna padta hai.
  - **Advantages:** Resource utilization better hoti hai
  - **Disadvantages:** High-error-rate networks mein inefficient

- **Selective Repeat ARQ:**
  Sirf lost ya corrupted frames ko dobara bheja jata hai.
  - **Advantages:** Zyada efficient
  - **Disadvantages:** Complex implementation

Point-to-Point Protocol (PPP) on the Internet 🌍

PPP ek data link layer protocol hai jo do nodes ke beech direct connection establish karta hai, jaise dial-up connections ya VPNs mein.

Features:

- **Framing:** Data ko frames mein encapsulate karta hai
- **Error Detection:** Checksum ke through error detect karta hai
- **Authentication:** PAP ya CHAP jaise methods se identity verify karta hai

Usage: Old dial-up modems aur VPNs mein widely used hota hai.

Conclusion 🎯

Is unit mein humne network switching techniques aur data link layer functions ko detail mein cover kiya. Humne circuit aur packet switching, error detection, error correction, flow control, aur protocols jaise ARQ aur PPP ko samjha. Ye sab concepts data ko efficiently aur reliably transmit karne ke liye zaroori hain. 🚀

Unit IV: Access Mechanisms & Network Layer

Access mechanisms Multiple Access Protocol and Networks: ALOHA,CSMA/ CD protocols, Ethernet LANS,
connecting LAN and back-bone networks- Repeaters. Hubs, Switches, Bridges, Router and Gateways.

Networks Layer Functions and Protocols: Routing, Routing algorithms. Network layer protocol of Internet- IP
protocol. Internet control protocols.

Access Mechanisms, Multiple Access Protocols, and Networks 🔗

Network communication mein access mechanisms wo tareeqe hain jisse multiple devices ek hi communication medium ko share karte hain. Multiple access protocols important hote hain taaki network ke devices bina interference ke data ko transmit aur receive kar sakein. Is section mein hum alag-alag access mechanisms aur protocols ko explore karenge, saath hi LANs aur backbone networks ko connect karne ke components ke baare mein bhi jaanenge.

1. ALOHA Protocol 🌐

ALOHA (Additive Links On-line Hawaii Area) ek simple aur popular multiple access protocol hai jo communication ke liye use hota hai. Yeh pehle satellite communication ke liye develop hua tha lekin ab LANs mein bhi use hota hai.

- **Pure ALOHA:**
  Isme station jab bhi data bhejna chahta hai, bhej deta hai. Agar data transmission kisi aur station ke transmission se clash nahi karta, to data successfully receive ho jata hai. Agar collision hoti hai to station random time ke baad data ko dobara bhejta hai.
  - **Advantages:** Simple to implement.
  - **Disadvantages:** Busy networks mein collisions zyada hoti hain, is wajah se baar-baar retransmissions hoti hain.
- **Slotted ALOHA:**
  Isme time ko slots mein divide kiya jata hai, aur har station ek specific slot ke shuru hone ka intezaar karta hai data bhejne ke liye. Isse collision ki chances kam ho jaati hain kyunki sabhi stations ek hi time par data bhejne ki koshish karte hain.
  - **Advantages:** Pure ALOHA se zyada efficient.
  - **Disadvantages:** High network load par bhi collisions ho sakti hain.

2. CSMA/CD Protocol 🚀

Carrier Sense Multiple Access with Collision Detection (CSMA/CD) protocol Ethernet networks mein use hota hai jo shared communication medium ka access control karta hai. Iska aim hai data transmit karne se pehle channel ko check karna taaki collisions kam ho.

- **Kaise Kaam Karta Hai:**

    2. **Carrier Sensing:** Data bhejne se pehle channel ko sunta hai ki koi aur device transmit to nahi kar raha.

    3. **Transmission:** Agar channel free hai to data bhejta hai; agar busy hai to wait karta hai.

    4. **Collision Detection:** Transmission ke dauran bhi channel ko monitor karta hai. Agar collision hoti hai to data bhejna band kar deta hai, random backoff time ke baad dobara koshish karta hai.

- **Advantages:** Collisions ko minimize karta hai aur network congestion kam hoti hai.

- **Disadvantages:** Low-traffic conditions mein efficient hai, lekin heavy load par inefficient ho jata hai.

3. Ethernet LANs 📡

Ethernet ek widely used LAN technology hai jo CSMA/CD protocol par based hai. Ye local area mein devices ko ek shared medium ke through connect karta hai, jaise twisted pair cables ya fiber optics.

- **Ethernet Frames:**
  Isme header, data payload, aur checksum hota hai (error detection ke liye). Devices ko MAC addresses ke through identify kiya jata hai.

- **Ethernet Speeds:**
  Ethernet speeds 10 Mbps se badh kar 100 Mbps (Fast Ethernet), 1 Gbps (Gigabit Ethernet), aur 10 Gbps (10-Gigabit Ethernet) tak pahuch gayi hain.

- **Switching:**
  Modern Ethernet networks mein hubs ki jagah switches use hote hain, jo dedicated communication channels provide karte hain aur collisions ko kam karte hain.

4. Connecting LANs and Backbone Networks 🌉

Bade networks mein kai LANs ko connect karke ek backbone network banaya jata hai jo data traffic ko manage karta hai. Iske liye alag-alag devices use hote hain:

- **Repeaters:** Signals ko amplify ya regenerate karte hain taaki transmission distance badh sake.
- **Hubs:** Basic device hai jo data ko sabhi connected devices ko broadcast karta hai. Ye switches ke comparison mein kam efficient hota hai.
- **Switches:** Intelligent device hai jo data ko sirf correct MAC address wale device ko bhejta hai.
- **Bridges:** Do ya zyada network segments ko connect karte hain, aur traffic ko filter karte hain.
- **Routers:** Multiple networks ko connect karte hain, jaise LAN ko Internet se connect karna. Ye IP addresses ke basis par best path decide karte hain.
- **Gateways:** Different networks ko connect karte hain jinke protocols alag hote hain. Ye ek translator ki tarah kaam karte hain.

5. Network Layer Functions and Protocols 🗺️

Network Layer (Layer 3) ka kaam hota hai data ko source se destination tak route karna. Is layer mein addressing, routing, aur packet forwarding hoti hai.

- **Routing and Routing Algorithms:**
  Routing ka matlab hai data ke liye best path select karna. Routers alag-alag algorithms ka use karte hain.
  Routing Algorithms:

  5. **Distance Vector Routing:** Router distance table maintain karta hai aur Bellman-Ford algorithm ka use karta hai.
  6. **Link-State Routing:** Routers apne connected neighbors ki information bhejte hain aur Dijkstra's algorithm ka use karte hain.
  7. **Hybrid Routing:** Distance Vector aur Link-State dono ke features ko combine karta hai (jaise EIGRP).

- **Static vs Dynamic Routing:**

  1. **Static Routing:** Manually configure karte hain routing tables.
  2. **Dynamic Routing:** Routers apne routes ko network changes ke hisaab se automatically update karte hain.

6. Network Layer Protocols of the Internet 🌍

- **IP (Internet Protocol):** Internet ka fundamental protocol hai jo data packets ke addressing aur routing ko manage karta hai.
    - **IPv4:** 32-bit address format use karta hai (jaise 192.168.1.1).
    - **IPv6:** 128-bit address format use karta hai aur zyada secure aur efficient hai.
- **IP Addressing:**
    - **Network Part:** Network ko identify karta hai.
    - **Host Part:** Specific device ko identify karta hai.

7. Internet Control Protocols ⚡

- **ICMP (Internet Control Message Protocol):** Errors aur network status ke messages bhejne ke liye use hota hai. Ping command iske through kaam karta hai.
- **ARP (Address Resolution Protocol):** IP address ko MAC address se map karta hai.
- **DNS (Domain Name System):** Human-readable domain names ko IP addresses mein convert karta hai.

Conclusion 🎯

Is unit mein humne access mechanisms aur multiple access protocols jaise ALOHA, CSMA/CD, aur Ethernet LANs ko cover kiya. Humne alag-alag network devices jaise repeaters, hubs, switches, routers, aur gateways ko bhi discuss kiya. Saath hi network layer functions aur protocols jaise routing, IP, aur ICMP, ARP, DNS jaise control protocols ko samjha.

Ye concepts efficient network design aur management ke liye bahut important hain. 🚀

Unit V: Transport Layer & Application Protocols

Transport Layer Functions and Protocols: Transport services, Berkeley socket interface overview, Transport
layer protocol of Internet- UDP and TCP. Overview of Application layer protocol, DNS protocol, WWW & HTTP protocols.

Transport Layer Functions and Protocols 🚀

Transport Layer OSI model ka choutha layer hai, jo applications ke liye end-to-end communication services provide karta hai. Iska kaam hota hai data ko ek device se doosre device tak reliably bhejna, communication sessions ko establish karna, maintain karna, aur terminate karna. Is layer ka kaam flow control, error handling, aur data segmentation ko manage karna bhi hai.

Transport Services 🛠️

Transport Layer kuch important services provide karta hai jo reliable data communication ke liye zaroori hain:

- **Segmentation and Reassembly:**
  Bada data jo application layer se aata hai, usse chhote segments mein tod diya jata hai. Phir ye segments network ke through bheje jaate hain aur receiving side par dobara assemble kiye jaate hain.

- **Reliability:**
  Data ki reliability ensure karta hai. Error detection, acknowledgment, aur retransmission ke through data loss ya corruption ko prevent karta hai.

- **Flow Control:**
  Sender ko receiver ko zyada data bhejne se rokta hai. Isse data transmission efficient rehta hai aur receiver overload nahi hota.

- **Multiplexing:**
  Ek hi device par multiple applications ke beech communication possible banata hai. Har communication session ko unique port number diya jata hai.

- **Error Detection and Correction:**
  TCP jaise protocols error detection aur correction ke liye checksums use karte hain. Agar koi error detect hoti hai, to data ko dobara bhejne ka system hota hai.

Berkeley Socket Interface Overview 🔌

Berkeley Sockets API ek programming interface hai jo applications ko network ke through communicate karne ka tareeka deta hai. Yeh transport layer mein network applications ko implement karne ke liye widely used hota hai.

- **Socket:**
  Communication ka endpoint hota hai. Yeh IP address aur port number ka combination hota hai, jo do devices ke beech data transfer ko enable karta hai.

- **Types of Sockets:**

  1. **Stream Sockets (TCP):** Reliable, connection-oriented communication ke liye use hoti hai.

  2. **Datagram Sockets (UDP):** Connectionless aur unreliable communication ke liye use hoti hai.

- **Socket Operations:**
  Applications sockets create kar sakti hain, bind kar sakti hain, listen kar sakti hain, accept, connect, send, receive, aur close kar sakti hain network communication ke liye.

Transport Layer Protocols of the Internet 🌐

Internet ke transport layer mein do major protocols hote hain: **UDP (User Datagram Protocol)** aur **TCP (Transmission Control Protocol)**.

1. UDP (User Datagram Protocol) ⚡

UDP ek connectionless protocol hai jo fast aur low-latency communication ke liye design hua hai.

- **Key Features:**

  - **Connectionless:** Data bhejne se pehle connection establish nahi karta.

  - **No Acknowledgments:** Data ke loss hone par koi acknowledgment ya retransmission nahi hoti.

  - **No Flow Control:** Data transmission rate ko control nahi karta.

  - **Lightweight:** UDP headers chhote hote hain, jo chhoti aur frequent transmissions ke liye efficient hai.

- **Use Cases:**
  Video streaming, real-time gaming, DNS queries, aur VoIP applications ke liye ideal hai.

2. TCP (Transmission Control Protocol) 🔒

TCP ek connection-oriented protocol hai jo reliable aur error-checked communication provide karta hai.

- **Key Features:**
  - **Connection-Oriented:** Data bhejne se pehle connection establish karta hai.
  - **Reliability:** Acknowledgments, retransmissions, aur sequence numbers ke zariye data delivery ko reliable banata hai.
  - **Flow Control:** Sliding Window Protocol ke zariye data flow ko manage karta hai.
  - **Congestion Control:** Network congestion ke hisaab se data transmission rate ko adjust karta hai.
- **Use Cases:**
  Web browsing (HTTP), email (SMTP), file transfer (FTP), aur remote login (SSH) ke liye use hota hai.

Overview of Application Layer Protocols 🌍

Application Layer OSI model ka sabse upar wala layer hai, jo directly end-user applications ke saath interact karta hai. Kuch popular protocols hain: DNS, HTTP, aur WWW.

1. DNS Protocol (Domain Name System) 🌐

DNS ek application layer protocol hai jo human-readable domain names (jaise www.virendragoura.com) ko IP addresses (jaise 192.168.1.1) mein convert karta hai.

- **DNS Functionality:**
  - **Name Resolution:** Domain names ko IP addresses mein convert karta hai.
  - **Distributed Database:** DNS servers globally distributed hote hain jo domain name space ke alag-alag parts ko manage karte hain.
  - **Caching:** Queries ko cache karte hain taaki same domain ke liye baar-baar resolution na karna pade.

- **DNS Structure:**
    - **Recursive Queries:** DNS server client ke liye dusre servers ko query karta hai.
    - **Iterative Queries:** Client multiple servers ko direct query karta hai.

2. WWW & HTTP Protocols 🌐

World Wide Web (WWW) ek application layer service hai jo users ko internet par web pages, images, aur videos access karne ki facility deta hai. Iske liye HTTP (Hypertext Transfer Protocol) use hota hai.

- **HTTP (Hypertext Transfer Protocol):**
    - **Request-Response Model:** Client server ko request bhejta hai, aur server data ke saath response deta hai.
    - **Methods:**
        - **GET:** Server se data request karna (jaise web page dekhna).
        - **POST:** Server ko data bhejna (jaise form submit karna).
        - **PUT:** Data ko server par upload karna.
        - **DELETE:** Server se data delete karna.
    - **Stateless:** Har request independent hoti hai; server previous requests ki information nahi rakhta.
- **HTTPS (Hypertext Transfer Protocol Secure):**
  HTTPS HTTP ka secure version hai, jisme SSL/TLS protocols ke zariye data encrypt kiya jata hai. Isse sensitive information jaise login credentials aur financial transactions safe rehti hain.

Conclusion 🎯

Is unit mein humne Transport Layer ke essential functions aur protocols ko cover kiya. Humne UDP aur TCP ke differences samjhe, jo speed aur reliability ke hisaab se alag-alag applications ke liye suitable hote hain. Saath hi DNS aur HTTP jaise application layer protocols ko bhi explore kiya, jo modern web browsing aur Internet communication ke liye zaroori hain. Understanding transport layer aur application protocols networked applications banane aur manage karne ke liye bohot important hai! 🚀