NEPAL COLLEGE OF INFORMATION TECHNOLOGY

Balkumari, Lalitpur

Affiliated to Pokhara University

ASSIGNMENT FOR DATA COMMUNICATION

TUTORIAL 3

Submitted by:

Name: Arpan Adhikari

Roll No.: 231309

BE-CE (3rd SEM)

Submitted to:

Himal Acharya

Date :
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Name : Arpan Adhikari
Roll No. 231309
Data communication

Tutorial 3

(Q1) what is ALOHA and what are its drawbacks ? How CSMA/CD overcomes it ? Explain.

→

ALOHA is a simple communication protocol designed for a shared medium in computer networks. Devices transmit data whenever they have data to send.

Drawbacks of ALOHA :

1. High Collision Rate
Devices transmit without checking if the channel is busy, causing frequent collisions and loss of data.

2. Low Efficiency
* Pure ALOHA : 18.4% maximum channel utilization
* slotted ALOHA : 36.8% maximum utilization
This limits performance in high-traffic scenarios.

3. Unpredictable Delays
Collisions lead to random retransmissions, making delays variable and unsuitable for real time communication

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4. Poor scalability
Performance degrades significantly as more devices share the channel.

5. No channel sensing
Transmissions occur blindly, increasing the likelihood of collisions.

How CSMA/CD overcomes ALOHA's drawbacks:

1. Channel Sensing
Devices check if the channel is idle before transmitting, reducing the chances of collisions.

2. Collision Detection
If a collision occurs, it is detected during transmission and devices stop immediately to avoid wasting resources.

3. Backoff Mechanism
After detecting a collision, devices wait for random time before retransmitting, minimizing repeated collisions.

4. Higher Efficiency
CSMA/CD uses the channel more effectively by avoiding unnecessary transmissions, achieving better throughput.

5. Scalability
It handles increased network traffic better by reducing collisions and resolving them quickly.

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2. Differentiate between OSI and TCP/IP layer.

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Aspect	OSI Model	TCP/IP Model
1. Full form	Open system Interconnection Model	Transmission Control Protocol / Internet Protocol Model
2. Purpose	Conceptual framework to standardize communication	Practical model for real-world internet communication
3. Number of layers	7 layers	4 layers
4. Layers	Application, Presentation, Session, Transport, Network, Data link, Physical	Application, Transport, Internet, Network Access
5. Development	Developed by ISO	Developed by US Department of Defense in ARPANET project
6. Implementation	Purely theoretical; rarely implemented directly	widely used for real-world networking.
7. Layer Functions	Each layer has specific, detailed functions.	combines certain OSI layers for simplicity
8. Examples of protocols	Protocols like X.25 and ISDN are mapped.	Uses TCP, IP, FTP, HTTP, SMTP etc.

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3) OSI layer architecture is a reference model. support this statement and explain the basic function of each layer.

→

The OSI model is a reference framework standardizing network communication into seven layers, each with distinct functions, ensuring interoperability and modularity.

Functions of OSI Layers:

1. Physical Layer
Handles the physical connection between devices. It defines the electrical, mechanical, and procedural specifications for activating, maintaining and deactivating physical links.
- Defines hardware specifications

2. Data link Layer
- Ensures reliable data transfer through error detection, correction and framing.
- Manages access to the physical medium via protocols like Ethernet.

3. Network Layer
- Manages logical addressing, routing and packet forwarding across networks.
- Examples: IP addressing and routing protocols.

4. Transport Layer
- Provides reliable end-to-end communication, flow control and error recovery.
- Protocols: TCP (reliable) and UDP (unreliable)

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5. Session Layer
- Establishes, manages and terminates communication sessions between applications.
- synchronizes data exchange.

6. Presentation Layer
- Handles data translation, encryption, and compression to ensure interoperability.
- Formats data for the application layer.

7. Application Layer
- Interfaces directly with user applications and provides services like file transfer, email and web browsing.
- Examples : HTTP, FTP and DNS

Q4) Write the advantages of layered network model.

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A layered network model, such as the OSI model, offers several advantages in designing and managing communication systems. These include :

1. Modularity and clarity
- Each layer focuses on specific tasks, making the system easier to understand and design.
- changes in one layer donot affect others, ensuring independence and flexibility.

2. Simplified Troubleshooting and Maintenance
- Problems can be isolated to a specific layer, simplifying debugging and issue resolution.

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3. Interoperability and standardization
Promotes the use of standardized protocols, enabling devices from different vendors to communicate seamlessly.

4. Scalability
Allows networks to grow and evolve by updating or replacing individual layers without overhauling the entire system.

5. Flexibility in Development
Developers can focus on one layer at a time, speeding up protocol design and implementation.

6. Encourages Innovation
New protocols or technologies can be added to a layer without disrupting the overall architecture.

7. Cost Efficiency
Modular design reduces redundancy and improves resource utilization, lowering costs.

Q5) Explain the concept of addressing in each layer of TCP/IP model.

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Addressing in the TCP/IP model helps ensure data is sent and received by the correct device and application. Each layer has its own type of addressing:

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1. Network Access Layer
- Uses MAC addresses to identify devices within a local network.
- Example : 00:1A:2B:3C:4D:5E. These are hardware addresses unique to each device.

2. Internet Layer
- Uses IP addresses to identify devices across different networks.
- Example : IPv4 (192.168.1.1) or IPv6 (2001:db8::1). IP addresses enable routing and delivery of data.

3. Transport Layer
- Uses port numbers to direct data to direct data to specific applications or services on a device.
- Example : Port 80 for HTTP (web traffic) and port 443 for HTTPS.

4. Application Layer
- Uses hostnames or URLs for user-friendly identification of destinations (e.g. www.example.com).
- These are resolved into IP addresses using DNS.

Each type of address helps data move smoothly from the source application to the correct destination application.

Q6) Define X.25, frame relay and ATM briefly.

A. X.25
Definition : An early packet switched network protocol designed for reliable data transfer over public networks.

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Key features :
- Provides error detection, correction, and flow control.
- Operates at the physical, data link, and network layers.
- Uses virtual circuits for communication.

Use Case : Legacy systems, especially for financial transactions like ATMs.

B. Frame Relay
Definition : A packet-switched network protocol designed for efficient and high-speed data transfer over unreliable networks.

Key Features :
- Focuses on speed by minimizing error checking and correction.
- Uses virtual circuits for data transmission.
- suitable for bursty data traffic.

Use Case :
Wide Area Networks (WANs) for connecting remote offices.

C. ATM (Asynchronous Transfer Mode)
Definition : A high-speed networking protocol that uses fixed-size cells for data transmission, supporting real-time and non-real time services.

Key Features :
- Fixed cell size (53 bytes) ensures predictable performance.
- supports voice, video and data simultaneously.
- operates at both LAN and WAN levels.

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Use case:
Multimedia applications requiring consistent quality of service (QoS).

Q7) what is PDU?

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A PDU (Protocol Data Unit) is a unit of data enchanged between two devices at a specific layer of a network model, such as the OSI or TCP/IP model. It represents how data is organized and encapsulated for transmission at each layer.

PDUs at different layers:

1. Application Layer : Message - The data created by an application, like an email or webpage content.

2. Transport Layer : segment (TCP) or Datagram (UDP) - Data with extra information like port numbers for the destination application.

3. Network Layer : Packet - Data that includes the destination IP address for routing across networks.

4. Data Link Layer : Frame - Data packaged with information like the device's physical address (MAC address).

5. Physical Layer : Bits - The raw data (1s and 0s) sent through cables or wireless signals.

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Q8) Differentiate between LLC and MAC sublayer of OSI reference model.

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Aspect	LLC (Logical Link Control)	MAC (Media Access Control)
Function	Manages communication with the network layer.	controls access to the physical transmission medium.
Focus	Logical addressing, flow control, and error checking.	Physical addressing and coordination of data transmission.
Addressing	Identifies protocols (e.g. IP) for upper layer communication.	Uses MAC addresses for device identification.
Error Handling	Performs error detection and correction.	Detects error but relies on LLC for correction.
Independence	Independent of the under-lying physical medium.	Dependent on the network technology in use.
Example protocols	IEEE 802.2	Ethernet, Wi-Fi
Primary concern	Logical communication between layers.	Efficient and collision free access to medium.

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a9) Explan different types of signal impairments in communication systems.

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Signal impairments in communication systems degrade signal quality and can cause errors. The main types are:

1. Attenuation
Loss of signal over distance.
solution : Use amplifiers or repeaters.

2. Distortion
Alteration of signal shape due to different speed of components.
solution : use equalizers

3. Noise
Unwanted signals interfering with communication (e.g. thermal noise, crosstalk)
solution : Use shielding and error correction.

4. Delay distortion
Signal components arrive at different times, causing timing errors.
solution : Use synchronization techniques.

5. Jitter
variations in signal timing, affecting real time applications.
solution : use buffers

6. Interference
External signals disrupting the communication.
Solution : Use shielding and proper frequency planning.

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Q10) What do you mean by propagation? why do you need it? Explain ~~with different~~ types of propagation ~~mechanism~~.

→

Propagation refers to the movement of electromagnetic waves or signals through a medium like air, space or cables) from a transmitter to receiver.

Propagation is needed :

- To enable the transmission of data between devices over short or long distances.
- It ensures the effective deliveny of signals in various communication applications, such as radio, television, mobile networks and satellite communication.

Types of ~~Propagation Mechanisms~~ Propagation Mechanism :

1. Ground Wave Propagation
Signals travel close to earth's surface.
Freq. range : upto 2 MHz
Use case : Long-distance communication, especially in areas where obstacles block higher-frequency waves.

2. Sky Wave Propagation
signals are reflected back to Earth by the ionosphere.
Freq. Range : 2MHz to 30 MHz
Use case : Shortwave radio and international broadcasting.

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3. Line-of-sight (LOS) Propagation :
signals travel in straight lines between the transmitter and receiver.
Freq. Range : Above 30 MHz (e.g. VHF, UHF)
Use case : TV, FM radio, and microwave communication.

4 Space wave Propagation
signals travel directly through space or reflect off obstacles like buildings or the Earth's surface.
Freq. Range : Above 30 MHz
Use case : satellite communication, GPS, and mobile networks

Q(ii) Why wireless propagation is important ? Explain ~~types of propagation~~ with different propagation mechanism.

Importance of wireless propagation :

wireless propagation is crucial because it allows communication without physical connections, enabling mobility and accessibility. It supports technologies like mobile phones, Wi-Fi, satellites & radio broadcasting. It ensures signal can travel over varying distances and through different environments while maintaining quality.

Propagation Mechanism

Refers to the material or space through which signals travel during propagation.

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Examples:

* Air or Atmosphere
For most wireless communications (eg. radio, Wi-Fi)

* Vacuum
For satellite and space communication.

* Water
For underwater communication (e.g. sonar)

* Solid Materials (cables)
For wired communication (e.g. Fiber optics, coaxial cables)

Q12) Explain working principle of optical fiber.

→ The working principle of optical fiber is based on the phenomenon of total internal reflection. Its made up of structure as core, cladding and coating.

1. Light Entry
A light signal (usually a laser or LED) is introduced into the core at a specific angle.

2. Total Internal Reflection
- when light hits the core-cladding boundary at an angle greater than the critical angle, it reflects back into the core instead of escaping.

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- This keeps the light confined within the core, even when the fiber bends slightly.

3. Transmission
The light travels through the fiber by repeated reflections, carrying data encoded as light pulses.

4 Receiver
At the other end, the light signal is converted back into electrical signals for processing.

Q13) Compare guided transmission media in terms of bandwidth, channel capacity, SNR, security, cost, attenuation, delay & repeater spacing.

Parameter	Twisted Pair	Coaxial cable	Optical fiber
Bandwidth	low	Moderate	High
channel capacity	limited	Moderate	Very high
SNR	low	Moderate	High
Security	low	Moderate	High
cost	low	Moderate	High
Attenuation	high	Moderate	low
Delay	Moderate	Moderate	low
Repeater spacing	short	Moderate	long

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Q14) Explain the electromagnetic spectrum & its application in wireless transmission media with their modes of propagation.

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The electromagnetic spectrum spares all electromagnetic wave frequencies & supports various wireless technologies.

- Radio waves : 3KHz - 300GHz = Used in AM/FM, radio, TV, mobiles etc
- Microwaves : 300 MHz - 300GHz = Used in satellite communication, radar, bluetooth etc.
- Infrared (IR) : 300GHz - 430THz = Used in remote controls, thermal imaging
- Visible light : 430 THz - 490 THz = Used in optical communication (fiber optics)
- Ultraviolet (UV) : 790THz - 30PHz = Used in medical sterilization, fluorescence

Its application & propagation modes are :

* Radio waves
- Used in AM/FM radio, TV, mobile networks
- Propagation : Ground wave, sky wave & ios propagation

* Microwaves
- Used in satellite links, wi-fi
- Propagation : Line-of-sight, reflection, diffraction

* Infrared
- Used in remote controls, wireless links
- Propagation : Line-of-sight

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* Visible light
- Used in fiber optics, free space optical communication.
- Propagation : Guided (fiber) & free space

Q15) If a signal at the beginning of cable with 0.3 dB/Km has power of 2mW, what is the power of a signal at 5 km? Comment on a result.

Sol^n

Given,
Initial Power (P_i) = 2mW
Attenuation (A) = 0.3 dB/Km
Distance (d) = 5 km
Output power (P_{out}) = ?

Then, Total attenuation = axd = 0.3x5 = 1.5dB
Attenuation factor = $10^{-axd/10}$ = $10^{-1.5/10}$ = $10^{-0.15}$

Now,

$P_{out} = P_{in} \cdot 10^{-0.15}$
$= 2 \times 10^{-0.15}$
$= 2 \times 0.7079 = 1.4158$ mW
$\therefore P_{out} \approx 1.42$ mW

The power of the signal at 5km is approximately 1.42 mW.

The result demonstrate that the signal experiences a gradual reduction in power as it travels through the cable due to attenuation. With a low attenuation factor of 0.3 dB/km, the power only decreases by about 29% after 5km, showing that this case is efficient for transmitting signals over relatively short distances.

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Q16) Explain the working principle of satellite communication.

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Satellite communication involves the use of artificial satellites to transmit & receive signals for communication between distant locations on Earth.

It works based on following fundamental principles:

* Uplink (Transmission)
A ground station transmits signals to the satellite in space using a specific frequency.

* Satellite Processing:
The satellite receives the signals, amplifies them, changes their frequency & prepares them for retransmission.

* Downlink (Reception):
The satellite sends the processed signals back to Earth on a different frequency.

* Ground Reception
Ground stations or user terminals receive the downlink signals & decode the information

Satellite Orbits

* Genstationary (GEO) = 35786 km above the ~~equatio~~ equator, stationery relative to Earth, used for TV & weather
* Medium Earth Orbit (MEO) = 2000 - 20000 km, used for SPS
* Low Earth Orbit (LEO) = < 2000 km, used for satellite internet.