OSI Mode with Protocol Examples

The OSI (Open Systems Interconnection) model is a theoretical framework that standardizes the functions of a telecommunication or computing system into seven abstraction layers. It was developed by the International Organization for Standardization (ISO) to facilitate interoperability between different systems and devices in network communication. Each layer serves a specific purpose and communicates with the layers directly above and below it. This document provides a detailed explanation of each layer, including their roles, responsibilities, and common protocols associated with them.

Layer 7 – Application Layer

This is the topmost layer of the OSI model. It directly interacts with the end-user and provides services such as email, file transfer, and web browsing. It handles high-level APIs, including resource sharing, remote file access, and directory services.

Purpose:
- Providing network services to the application
- User interface
- Data formatting and display

Examples:
- HTTP, HTTPS
- FTP
- SMTP
- DNS
- Telnet
- MQTT

In the UDP chat application, this layer represents the terminal interface where the user types and receives messages.

Layer 6 – Presentation Layer

This layer is responsible for translating data between the application layer and the lower layers. It ensures that data is in a readable format by handling encryption, compression, and translation between different data formats.

Purpose:
- Data encoding/decoding
- Data compression and decompression
- Data encryption and decryption

Examples:
- SSL/TLS

- JPEG
- ASCII
- MPEG

In many embedded systems, this layer is often minimal or combined with the application layer unless secure communication is required.

Layer 5 – Session Layer

The session layer is responsible for managing sessions between applications. It establishes, maintains, and terminates communication sessions. It also handles authentication and session checkpointing.

Purpose:
- Session establishment, maintenance, and termination
- Synchronization and dialog control
- Managing multiple sessions simultaneously

Examples:
- NetBIOS
- RPC (Remote Procedure Call)
- PPTP

In the UDP chat app, session control can be manually implemented if needed, though UDP does not inherently manage sessions.

Layer 4 – Transport Layer

This layer is responsible for delivering messages between networked hosts. It provides either connection-oriented (TCP) or connectionless (UDP) communication services. It handles segmentation, flow control, and error control.

Purpose:
- Reliable or fast data transmission
- Error recovery and flow control (TCP)
- Data segmentation and reassembly

Examples:
- TCP (Transmission Control Protocol)
- UDP (User Datagram Protocol)

The UDP chat application uses UDP at this layer to send and receive datagrams without connection setup.

Layer 3 – Network Layer

The network layer manages device addressing, tracks the location of devices on the network, and determines the best way to move data. It is responsible for packet forwarding including routing through different routers.

Purpose
- Logical addressing (IP addressing)
- Routing and forwarding
- Fragmentation and reassembly

Examples:
- IP (Internet Protocol)
- ICMP
- IGMP
- IPSec

In our use case, the IP address used in the UDP client (e.g., 127.0.0.1) is interpreted and handled by this layer.

Layer 2 – Data Link Layer

This layer provides node-to-node data transfer—a link between two directly connected nodes. It also detects and may correct errors that may occur in the physical layer.

Purpose:
- Physical addressing (MAC addresses)
- Error detection and correction
- Frame synchronization

Examples:
- Ethernet
- ARP (Address Resolution Protocol)
- PPP
- HDLC

On the Rugged Board or any Linux-based system, the Ethernet or Wi-Fi driver takes care of this layer.

Layer 1 – Physical Layer

This is the lowest layer of the OSI model and deals with the physical connection between devices. It includes the hardware elements involved in the actual transmission and reception of raw data bits over a physical medium.

Purpose:
- Bit-level transmission

- Physical topology
- Modulation and transmission mode

Examples:
- Ethernet cables
- Wi-Fi signals
- Bluetooth
- USB

OSI Model with WhatsApp Message Example

This document explains how the OSI (Open Systems Interconnection) model applies in a real-world messaging scenario using WhatsApp. The flow illustrates the journey of a simple message like 'hi' sent from one user to another via the WhatsApp server using client-server architecture.

Scenario

User A sends a WhatsApp message saying 'hi' to User B. This message is sent from User A's phone (Client), reaches the WhatsApp server, and then is delivered to User B's phone (Client). Both client and server systems process the message through all OSI layers.

1. Client Side (Your Phone) – Sending 'hi'

OSI Layer	What Happens
Layer 7 – Application	You type 'hi' in WhatsApp. WhatsApp prepares the message and adds recipient and metadata.
Layer 6 – Presentation	Message is converted to UTF-8 and encrypted using end-to-end encryption (e.g., AES).
Layer 5 – Session	TLS/SSL session is maintained with the WhatsApp server for secure communication.
Layer 4 – Transport	TCP breaks the message into segments and ensures reliable delivery.
Layer 3 – Network	IP addresses are used to route the message from your phone to the server.
Layer 2 – Data Link	MAC address is added by your Wi-Fi or mobile adapter. Data is framed.
Layer 1 – Physical	Bits are transmitted as radio waves (Wi-Fi/mobile) to the nearest router or cell tower.

2. Server Side (WhatsApp Server)

OSI Layer	What Happens

OSI Layer	What Happens
Layers 1–2	Receives bits over physical network (e.g., fiber) and decodes frames via Ethernet.
Layer 3 – Network	Reads sender's IP and routes data internally to correct server instance.
Layer 4 – Transport	Reassembles TCP segments into a full encrypted message.
Layers 5–6	Session is kept alive; message remains encrypted due to end-to-end encryption.
Layer 7 – Application	Server identifies recipient and queues the message to be delivered.

3. Receiver Side (Friend's Phone)

OSI Layer	What Happens
Layers 1–2	Data received via mobile/Wi-Fi and converted to bits/frames.
Layer 3 – Network	IP layer identifies packet is for the friend's device.
Layer 4 – Transport	TCP reassembles the full message correctly.
Layer 5 – Session	Session is resumed or established for communication.
Layer 6 – Presentation	Message is decrypted using the friend's private key.
Layer 7 – Application	WhatsApp shows 'Sudarsan: hi' in the chat window.

Summary

This example illustrates how each OSI layer plays a critical role in message transmission from one user to another over the network. Even simple messages like 'hi' involve layered processing, including encryption, TCP/IP delivery, and UI display.

Client-Server Understanding

- The server (WhatsApp backend) is always online, waiting to receive and deliver messages.
- The client (your phone and your friend's phone) initiates communication.
- Both sides use the OSI stack for communication.
- End-to-end encryption ensures only the sender and receiver can read the messages.