Research & Development Document

Title: Understanding Network Models and Protocols

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1. Working of All Layers in OSI Model

The OSI (Open Systems Interconnection) model is a conceptual 7-layer model that standardizes the functions of a communication system or network.

Layer 7 - Application: Interacts with the end-user directly. Handles services like web browsing, email, file transfer. Protocols: HTTP, SMTP, FTP

Layer 6 - Presentation: Translates data between application and network format (e.g., encryption, compression, encoding).

Layer 5 - Session: Establishes, maintains, and terminates communication sessions between applications.

Layer 4 - Transport: Ensures reliable data transmission. Handles error detection, recovery, and flow control. Protocols: TCP, UDP

Layer 3 - Network: Handles logical addressing and routing. Decides how data is forwarded. Protocols: IP, ICMP

Layer 2 - Data Link: Handles physical addressing (MAC), error detection (frame-level), and access to media.

Layer 1 - Physical: Transmits raw binary data over physical medium (cables, signals, etc.). Examples: Ethernet cables, Wi-Fi signals

2. Working and Functionality of TCP/IP Model

The TCP/IP model is the practical model used for internet communication. It is a 4-layer model mapping closely to OSI but simpler and widely used.

Application Layer: Provides network services to applications. Includes all OSI layers 5, 6, 7. Protocols: HTTP, FTP, DNS

Transport Layer: Responsible for host-to-host communication, flow control, error correction. Protocols: TCP (reliable), UDP (faster)

Internet Layer: Handles logical addressing and routing using IP addresses. Protocols: IP, ICMP, ARP

Network Access Layer: Deals with physical transmission, framing, and media access. Protocols: Ethernet, Wi-Fi

3. Working of TCP and UDP Protocols

TCP (Transmission Control Protocol)

Type: Connection-oriented, reliable.
Use: Web, email, file transfers.
Working Steps:
1. Connection Setup – 3-way handshake (SYN, SYN-ACK, ACK)
2. Data Transmission – Divides data into segments, numbered and tracked.
3. Acknowledgement – Receiver confirms receipt of each segment.
4. Error Handling – Retransmits lost packets.
5. Connection Termination – 4-step process (FIN → ACK → FIN → ACK)

UDP (User Datagram Protocol)

Type: Connectionless, fast, unreliable.
Use: Streaming, gaming, DNS queries.
Working:
- Sends data in independent datagrams without guarantee.
- No acknowledgments, sequencing, or retransmissions.
- Lightweight and efficient.

4. Working of HTTP, HTTPS, and ICMP Protocols

HTTP (HyperText Transfer Protocol)

Layer: Application
Port: 80
Use: Web browsing
Working:
- Client (browser) sends request → Server responds with webpage.
- Stateless – each request is independent.

HTTPS (HTTP Secure)

Layer: Application + Transport (via SSL/TLS)
Port: 443
Use: Secure websites, online banking, login systems.
Working:
- Adds encryption using SSL/TLS over HTTP.
- Ensures privacy, authentication, and data integrity.

ICMP (Internet Control Message Protocol)

Layer: Network
Use: Diagnostic tools like ping and traceroute.
Working:
- Sends control messages (e.g., host unreachable, time exceeded).
- Helps in error reporting and network troubleshooting.
- Does not carry application data.

5. Summary

Protocol	Layer	Reliable	Used For
TCP	Transport Layer	Yes	Web Browsing, Email, File Transfers
UDP	Transport Layer	No	Video Streaming, Online Games, DNS
HTTP	Application Layer	No	Accessing Web Pages
HTTPS	Application + Transport	Yes (via SSL/TLS)	Secure Web Access, Online Payments
ICMP	Network Layer	N/A (Control Protocol)	Ping, Traceroute, Network Diagnostics

In this R&D document, we have explored the core concepts of the OSI and TCP/IP models and the working of fundamental protocols like TCP, UDP, HTTP, HTTPS, and ICMP. A deep understanding of these models and protocols is essential for developing reliable and secure network systems, especially in modern cloud and data-driven environments.