**R&D Document: Working of TCP & UDP Protocols, HTTP, HTTPS & ICMP Protocol**

**1. TCP (Transmission Control Protocol)**

* Functionality:
* TCP is a connection-oriented protocol that ensures reliable data transfer.
* It sets up a connection using a three-way handshake (SYN, SYN-ACK, ACK).
* It guarantees reliable delivery through positive acknowledgment and retransmission (PAR).
* It includes flow control, error checking, and congestion control mechanisms.

Use Cases:

* Web browsing (HTTP/HTTPS)
* Email (SMTP)
* File transfers (FTP)

Features:

* Sequencing of data
* Guaranteed delivery
* Error recovery
* Full duplex communication

**2. UDP (User Datagram Protocol)**

* Functionality:
* UDP is a connectionless protocol that allows fast data transmission without reliability.
* It does not use handshakes or acknowledgments.
* It has minimal overhead with just an 8-byte header.

Use Cases:

* DNS
* VoIP
* Online gaming
* Streaming services

Features:

* No guaranteed delivery
* No sequencing
* Low latency
* Supports broadcasting and multicasting

**3. Comparison of TCP vs UDP**

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| --- | --- | --- |
| **Feature** | **TCP** | **UDP** |
| Connection | Connection-oriented | Connectionless |
| Reliability | Reliable with retransmissions | Unreliable, no retransmissions |
| Speed | Slower | Faster |
| Packet Order | Maintained | Not guaranteed |
| Overhead | Higher | Lower |
| Error Checking | Yes (with recovery) | Yes (discard on error) |
| Use Cases | HTTP, FTP, SMTP | DNS, VoIP, Gaming |

**4. HTTP (HyperText Transfer Protocol)**

* Functionality:
* HTTP is a stateless, application-layer protocol built on TCP.
* It facilitates data communication on the web through requests and responses.
* It runs over port 80.

Key Operations:

* GET, POST, PUT, DELETE requests
* The client (browser) sends a request, and the server responds with HTML, JSON, or similar formats.

**5. HTTPS (HTTP Secure)**

* Functionality:
* HTTPS is HTTP with SSL/TLS encryption for security.
* It ensures data confidentiality, integrity, and authentication.
* It operates over port 443.

Security Features:

* Encrypted communication using TLS
* Server authentication through digital certificates

6. ICMP (Internet Control Message Protocol)

* Functionality:
* ICMP is used for error reporting and diagnostics in IP networks.
* It does not handle data exchange between user applications.

Common Messages:

* Echo Request/Reply (used by ping)
* Destination Unreachable
* Time Exceeded

Use Cases:

* Network troubleshooting
* Route diagnostics (e.g., traceroute)

**Conclusion**

* TCP provides reliable communication through connection setup and error handling.
* UDP is faster and simpler, suitable for situations where low latency is essential.
* HTTP/HTTPS utilize TCP for web communication, with HTTPS providing encryption.
* ICMP is important for error reporting and network diagnostics, but it does not handle data transfer.

**References:**

* Wikipedia: Transmission Control Protocol, User Datagram Protocol
* Cisco Networking Academy
* Real-time application guides (e.g., VoIP, Gaming)