

Introduction to Internet Technologies

Introduction to Internet Technologies

An overview of the fundamental concepts, protocols, and services that make the modern Internet work.

1. What Is the Internet?

Aspect	Description
Definition	A global network of interconnected computers and devices that communicate using standardized protocols.
Scope	Over 5 billion devices, spanning personal gadgets, servers, IoT sensors, and industrial systems.
Core Idea	“Any-to-any” communication: any device can reach any other device (subject to routing, firewalls, etc.).

2. Key Building Blocks

Layer (OSI / TCP ?IP)	Main Function	Typical Protocols / Technologies
Physical	Transmission of raw bits over a medium	Ethernet (copper/fiber), Wi-Fi (802.11), Cellular (LTE/5G), Satellite
Data Link	Framing, error detection, MAC addressing	Ethernet (IEEE?802.3), Wi-Fi (IEEE?802.11), PPP
Network	Routing packets across multiple links	IP (IPv4, IPv6), ICMP, ARP
Transport	End-to-end reliability & flow control	TCP, UDP, SCTP
Application	User-level services & data formats	HTTP/HTTPS, FTP, SMTP, DNS, TLS/SSL, WebSocket, MQTT

The TCP/IP model collapses the OSI layers into four practical layers (Link, Internet, Transport, Application).

Introduction to Internet Technologies

3. Core Internet Protocols

3.1 Internet Protocol (IP)

- **IPv4:** 32-bit address space (~4.3 billion addresses). Uses dotted-decimal notation (e.g., 192.0.2.1).
- **IPv6:** 128-bit address space (~ 3.4×10^38 addresses). Uses colon-hex notation (e.g., 2001:db8::1).
- **Functions:** Addressing, packet fragmentation/reassembly, routing.

3.2 Transmission Control Protocol (TCP)

- Connection-oriented, reliable byte-stream service.
- Features: three-way handshake, sequence numbers, acknowledgments, retransmission, flow control (window), congestion control (e.g., Reno, CUBIC).

3.3 User Datagram Protocol (UDP)

- Connectionless, best-effort delivery.
- Low overhead, used for latency-sensitive traffic (DNS, VoIP, video streaming, gaming).

3.4 Hypertext Transfer Protocol (HTTP/HTTPS)

- **HTTP:** Application-layer request/response protocol for web resources.
- **HTTPS:** HTTP over TLS/SSL, providing encryption, integrity, and authentication.

3.5 Domain Name System (DNS)

- Distributed hierarchical database that maps human-readable domain names to IP addresses.
- Key record types: A, AAAA, CNAME, MX, TXT, SRV.

3.6 Simple Mail Transfer Protocol (SMTP) & POP/IMAP

- **SMTP:** Pushes email from client to server and between mail servers.
- **POP3 / IMAP:** Pull email from server to client; IMAP supports server-side folder management.

Introduction to Internet Technologies

3.7 Secure Transport (TLS/SSL)

- Provides encryption, authentication, and data integrity for any TCP-based application.
- Handshake establishes symmetric keys; certificates bind public keys to domain names.