📁 1) FTP (File Transfer Protocol)

- FTP is used to **transfer files between computers over the Internet.**

- Uses **client-server architecture**:

  - **FTP Client** sends/receives files.

  - **FTP Server** stores files.

- **Uses TCP and port 21.**

- **Two connections** are used:

  - **Control connection:** For login, commands, directory navigation.

  - **Data connection:** For actual file transfer.

- **Example:** FileZilla software.

- FTP allows **reliable and efficient file sharing between remote systems.**

💻 2) Telnet

- **TELNET (Telecommunication Network)** is used for **remote login** to another computer.

- Works using **TCP on port 23**.

- Steps:

  1. Client runs a telnet program.

  2. Connects to telnet server using IP.

  3. Enters **username and password.**

  4. Can **execute commands remotely** on that computer.

- **Not secure** (data is plain text) → replaced by **SSH (Secure Shell)** which uses encryption (port 22).

📧 3) Email System – SMTP, POP3, IMAP

Email Overview

- Email is an **asynchronous communication system**.

- Allows sending text, attachments, photos, HTML content etc.

- **Components:**

  - **User Agent (UA):** App used to write/read emails (e.g. Outlook).

  - **Mail Servers:** Store and forward emails.

  - **Protocols:** SMTP, POP3, IMAP.

SMTP (Simple Mail Transfer Protocol)

- Used to **send emails from client to server and between mail servers.**

- Uses **TCP on port 25**.

- Only sends emails (not used for reading emails).

- If receiver's server is down, email waits in sender's server.

- Works with **7-bit ASCII text** only.

SMTP Example:

1. Alice writes email to computer@darshan.ac.in

2. Her UA sends it to her mail server (queued)

3. SMTP opens TCP connection to Bob's mail server

4. Sends Alice's email

5. Bob's server puts it in Bob's mailbox

6. Bob reads it using his UA

POP3 (Post Office Protocol v3)

- Used by client to **download emails from mail server.**

- Uses **TCP**, has 3 phases:

  o **Authorization:** Login using username/password.

  o **Transaction:** Read, delete, download emails.

  o **Update:** After logout, server deletes downloaded emails.

- Emails are **removed from server after download.**

IMAP (Internet Mail Access Protocol)

- Keeps **all emails on the server.**

- Allows organizing into folders, searching emails on server.

- Downloads only **needed parts** of messages (good for slow internet).

- Emails are **not deleted from server** unless user deletes.

🔬 4) SNMP (Simple Network Management Protocol)

- Used to **monitor, manage, and control network devices** (routers, switches, servers, printers etc.)

- **Components:**

  - **SNMP Manager:** Central system that requests data.

  - **SNMP Agent:** Runs on devices and collects data.

  - **MIB (Management Information Base):** Database of device properties.

- Uses **OIDs (Object IDs)** to access data.

- **Example uses:**

  - Monitor CPU/memory usage

  - Track traffic on router

  - Get alerts when link goes down

🌐 5) DHCP (Dynamic Host Configuration Protocol)

- Used to **automatically assign IP addresses** to devices.

- Saves time for admins and avoids manual errors.

- Uses **client-server model**:

  - **DHCP Server:** Gives IPs (usually a router)

  - **DHCP Client:** Any device (PC, mobile, laptop)

- IP is given only for a **limited time (lease time).**

DORA Process:

1. **Discover:** Client asks for IP.

2. **Offer:** Server offers IP.

3. **Request:** Client accepts IP.

4. **Acknowledge:** Server confirms and assigns IP.

Benefits:

- No manual setup

- Avoids duplicate IPs

- Easy for mobile/IoT devices

🌍 6) DNS (Domain Name System)

- DNS translates **domain names (www.google.com)** into **IP addresses (142.250.190.36)**.

- It is an **application layer protocol.**

- Works like a **phonebook for the internet.**

- **Hierarchy:**

    o **Root DNS servers** (13 in total)

    o **TLD servers** (.com, .org, .edu, .in etc.)

    o **Authoritative servers** (maintained by organizations)

    o **Local DNS servers** (used by your ISP)

Example (www.amazon.com):

1. Local DNS asks Root → gets TLD (.com)

2. Asks TLD → gets Authoritative server for amazon

3. Asks Authoritative → gets IP address

Why DNS is Distributed:

- Avoid single point of failure

- Handle heavy traffic

- Reduce delays

- Easier maintenance and updates

🧩 **7) Socket Programming (TCP & UDP)**

Socket: Interface between application and transport layer for sending/receiving data.

Types of Sockets:

- **TCP (SOCK_STREAM):**

    o Reliable

    o Ordered delivery

    o Connection-oriented

    o Bi-directional

- **UDP (SOCK_DGRAM):**

    o Unreliable

    o No order guarantee

    o Connectionless

    o One-direction

How it works:

- Server creates socket and waits for client.

- Client creates socket and connects to server.

- They exchange data using the socket.