

Week 7 Revision Notes

Week 7 - Application Layer Protocols

1. Introduction to the Application Layer

- **Application Layer Role:**
 - The **Application Layer** is the top layer in the OSI model, providing services directly to user applications.
 - It handles protocols that allow different applications to communicate over the network, including web browsing, email, and file transfers.



2. Domain Name System (DNS)

- **Purpose of DNS:**
 - Converts human-readable domain names (like `example.com`) into IP addresses (like `192.168.1.1`).
 - DNS acts like the internet's "phone book," mapping names to numbers.
- **DNS Structure:**
 - **Root Domain:** Top of the DNS hierarchy, containing all top-level domains (TLDs).
 - **TLDs:** Top-Level Domains, divided into:
 - **Country-Code TLDs (ccTLDs):** Specific to countries (e.g., `.au` for Australia).
 - **Generic TLDs (gTLDs):** Represent types of organizations (e.g., `.com`, `.gov`).
 - **Fully Qualified Domain Name (FQDN):** A complete domain name that specifies an exact location in the DNS hierarchy (e.g., `www.example.com`).
- **DNS Server Roles:**
 - **Authoritative Servers:** Provide information about specific domain names they control.
 - **Non-Authoritative Servers:** Respond with information not originally in their database but found by querying other servers.
 - **Recursive vs. Iterative Queries:**
 - **Recursive:** Local DNS server is responsible for providing a complete answer.
 - **Iterative:** Server provides what information it has, and the client may need to query further.
- **Basic DNS Resolution Process:**
 1. User types a website (e.g., `example.com`) into the browser.
 2. DNS client requests IP from a local DNS server.

- Local DNS server queries root servers, TLD servers, and finally, authoritative servers to resolve the IP address.



3. Hypertext Transfer Protocol (HTTP)

- **Role of HTTP:**
 - The foundation of data communication on the **World Wide Web (WWW)**.
 - **HTTP** is a protocol for transferring hypertext, including images, text, and multimedia.
 - Works on **port 80** and follows a **request-response model** between clients (browsers) and servers.
- **HTTP Basics:**
 - **Request:** The client sends an HTTP request to a server (e.g., `GET /index.html`).
 - **Response:** The server processes the request and sends back a response, including status (e.g., `200 OK`) and content.
 - **URL Structure:** Each web resource is identified by a **Uniform Resource Locator (URL)**, which includes:
 - **Service Type:** (e.g., `http`).
 - **Host Name:** Domain name (e.g., `example.com`).
 - **Path:** Location of the file on the server (e.g., `/page.html`).
- **HTTP Encapsulation:**
 - Data moves through multiple layers: HTTP formats the data, **TCP** handles reliable transmission, **IP** routes the packet, and finally, it's sent over a network medium.



4. Simple Mail Transfer Protocol (SMTP) and Email Protocols

- **Email Protocols:**
 - Three main protocols handle email:
 - **SMTP (Simple Mail Transfer Protocol):** Used to send emails over the Internet (uses port **25**).
 - **POP3 (Post Office Protocol 3):** Downloads emails from the server to the client and deletes them from the server (uses port **110**).
 - **IMAP4 (Internet Message Access Protocol 4):** Manages emails directly on the server without downloading (uses port **143**).
- **Email Flow:**
 1. **SMTP:** Sends emails from the client to the email server.
 2. **POP3/IMAP4:** Retrieves emails from the server to the client.
- **Comparison of POP3 and IMAP4:**
 - **POP3:** Good for offline access; emails are stored locally.

- **IMAP4**: Ideal for online access; emails remain on the server, accessible from multiple devices.



5. File Transfer Protocol (FTP)

- **Purpose of FTP:**
 - **FTP** allows the transfer of files between a client and a server.
 - It is **not secure** by default, as data (including passwords) is transmitted in plaintext.
- **FTP Operation:**
 - Uses two ports:
 - **Port 21**: For control commands.
 - **Port 20**: For data transfer.
 - **Access Methods:**
 - **Web Browser**: By entering an FTP URL (e.g., `ftp://example.com`).
 - **FTP Client Software**: Specialized tools for managing files over FTP.
 - **Command Line**: Direct command inputs (e.g., `ftp example.com`).
- **Is FTP Still Relevant?**
 - While FTP was revolutionary, it is now largely replaced by secure alternatives like **SFTP** (Secure FTP).



6. Telnet and Secure Shell (SSH)

- **Telnet:**
 - Enables users to connect to remote devices and execute commands.
 - Operates on **port 23** and is **insecure** as it sends data, including passwords, in plaintext.
- **SSH (Secure Shell):**
 - **SSH** is a secure alternative to Telnet, encrypting data for safe transmission.
 - Operates on **port 22** and allows secure remote access, commonly used for server management.
- **Common SSH Tools:**
 - **PuTTY**: A popular client program supporting SSH, Telnet, and other remote protocols.



7. Dynamic Host Configuration Protocol (DHCP)

- **Role of DHCP:**
 - Automatically assigns **IP addresses** to devices on a network, making network configuration easy and efficient.

- Uses **UDP port 67** for server-side communication and **UDP port 68** for client-side communication.
- **DHCP Lease Process:**
 1. **DHCPDISCOVER:** The client broadcasts a request for an IP.
 2. **DHCPOFFER:** The DHCP server responds with an IP offer.
 3. **DHCPREQUEST:** The client accepts the IP offer.
 4. **DHCPACK:** The server acknowledges and finalizes the lease.
- **Lease Renewal:**
 - The client renews its IP lease when 50% of the lease time has passed. If it fails, it tries again at 87.5% of the lease time.
- **Benefits of DHCP:**
 - Centralized management of IP addresses.
 - Reduced risk of IP conflicts.
 - Simplifies device configuration and network management.



Summary of Key Protocols

| Protocol | Port | Purpose |
|----------|-------|--|
| DNS | 53 | Resolves domain names to IP addresses |
| HTTP | 80 | Transfers web pages and multimedia files |
| SMTP | 25 | Sends email messages |
| POP3 | 110 | Retrieves emails from the server (download/delete) |
| IMAP4 | 143 | Retrieves emails from the server (sync online) |
| FTP | 20/21 | Transfers files between client and server |
| Telnet | 23 | Remote command execution (insecure) |
| SSH | 22 | Secure remote command execution |
| DHCP | 67/68 | Dynamically assigns IP addresses |

