



Kalinga University

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UNIT – V

Transport Layer Functions

1. Segmentation and Reassembly: Breaking down data into smaller segments for transmission and reassembling them at the receiving end.
2. Connection Establishment and Termination: Establishing and terminating connections between devices.
3. Reliable Data Transfer: Ensuring that data is delivered accurately and reliably.
4. Flow Control: Regulating the amount of data that can be sent at one time.
5. Multiplexing and Demultiplexing: Allowing multiple applications to share the same connection.
6. Error Detection and Correction: Detecting and correcting errors that occur during data transmission.

Transport Layer Protocols

1. TCP (Transmission Control Protocol): A connection-oriented protocol that provides reliable data transfer.
2. UDP (User Datagram Protocol): A connectionless protocol that provides best-effort delivery.

3. SCTP (Stream Control Transmission Protocol): A connection-oriented protocol that provides reliable data transfer and supports multiple streams.
4. DCCP (Datagram Congestion Control Protocol): A connectionless protocol that provides congestion control.

TCP (Transmission Control Protocol)

1. Connection Establishment: TCP establishes a connection using a three-way handshake (SYN, SYN-ACK, ACK).
2. Segmentation: TCP breaks down data into smaller segments for transmission.
3. Reliable Data Transfer: TCP ensures reliable data transfer using sequence numbers, acknowledgments, and retransmissions.
4. Flow Control: TCP regulates the amount of data that can be sent at one time using windowing.

UDP (User Datagram Protocol)

1. Connectionless: UDP does not establish a connection before sending data.
2. Best-Effort Delivery: UDP provides best-effort delivery, but does not guarantee reliable data transfer.
3. No Flow Control: UDP does not regulate the amount of data that can be sent at one time.
4. No Error Correction: UDP does not provide error correction, but instead relies on the application layer to handle errors.

TCP (Transmission Control Protocol)

1. Connection-oriented: Establishes a connection before data is sent.
2. Reliable: Ensures data is delivered accurately and in the correct order.

3. Error-checked: Detects and retransmits corrupted or lost data.
4. Flow-controlled: Regulates data flow to prevent network congestion.
5. Ordered delivery: Ensures data is delivered in the correct order.

TCP Characteristics

1. Three-way handshake: Establishes a connection using SYN, SYN-ACK, and ACK packets.
2. Segmentation: Breaks down data into smaller segments for transmission.
3. Acknowledgments: Receives acknowledgments for each segment to ensure reliable delivery.
4. Retransmissions: Retransmits lost or corrupted segments.

UDP (User Datagram Protocol)

1. Connectionless: Does not establish a connection before data is sent.
2. Best-effort delivery: Does not guarantee reliable delivery.
3. No error-checking: Does not detect or retransmit corrupted or lost data.
4. No flow control: Does not regulate data flow.
5. Unordered delivery: Does not ensure data is delivered in the correct order.

UDP Characteristics

1. No handshake: Does not establish a connection before data is sent.
2. Datagram-based: Sends data in individual datagrams.

3. No acknowledgments: Does not receive acknowledgments for data delivery.
4. No retransmissions: Does not retransmit lost or corrupted data.

Key Differences

1. Reliability: TCP ensures reliable delivery, while UDP does not.
2. Connection: TCP establishes a connection, while UDP does not.
3. Error-checking: TCP detects and retransmits corrupted or lost data, while UDP does not.

Choosing Between TCP and UDP

1. Use TCP for: Reliable data transfer, such as file transfers, email, and web browsing.
2. Use UDP for: Real-time applications, such as video streaming, online gaming, and voice over IP (VoIP).

Transport Services

1. Connection Establishment: Establishing a connection between the sender and receiver.
2. Data Transfer: Transferring data between the sender and receiver.
3. Connection Termination: Terminating the connection between the sender and receiver.
4. Reliability: Ensuring that data is delivered accurately and reliably.
5. Flow Control: Regulating the amount of data that can be sent at one time.

Error Control

1. Error Detection: Detecting errors that occur during data transmission.
2. Error Correction: Correcting errors that occur during data transmission.
3. Retransmission: Retransmitting data that is lost or corrupted during transmission.

Types of Error Control

1. Stop-and-Wait ARQ: A simple error control protocol that uses acknowledgments and retransmissions.
2. Go-Back-N ARQ: An error control protocol that uses acknowledgments and retransmissions, and allows for multiple packets to be sent before receiving an acknowledgment.
3. Selective Repeat ARQ: An error control protocol that uses acknowledgments and retransmissions, and allows for selective retransmission of packets.

Flow Control

1. Windowing: Regulating the amount of data that can be sent at one time by using a window size.
2. Acknowledgments: Using acknowledgments to regulate the flow of data.
3. Buffering: Using buffers to regulate the flow of data.

Types of Flow Control

1. Stop-and-Wait Flow Control: A simple flow control protocol that uses acknowledgments to regulate the flow of data.
2. Sliding Window Flow Control: A flow control protocol that uses a sliding window to regulate the flow of data.

3. Rate-Based Flow Control: A flow control protocol that regulates the flow of data based on the rate at which data is being sent.

Congestion Control

1. Congestion Avoidance: Preventing network congestion by regulating the flow of data.
2. Congestion Control: Controlling network congestion by regulating the flow of data.

Types of Congestion Control

1. TCP Congestion Control: A congestion control protocol used in TCP to regulate the flow of data.
2. UDP Congestion Control: A congestion control protocol used in UDP to regulate the flow of data.

Connection Establishment

Connection establishment is the process of setting up a connection between two devices in a network. The process involves several steps:

1. Connection Request: The sender sends a connection request to the receiver.
2. Connection Acknowledgment: The receiver sends a connection acknowledgment to the sender.
3. Parameter Negotiation: The sender and receiver negotiate parameters such as window size, maximum segment size, and acknowledgment timeout.
4. Connection Establishment: The connection is established, and data transfer can begin.

Three-Way Handshake

The three-way handshake is a connection establishment protocol used in TCP:

1. SYN (Synchronize): The sender sends a SYN packet to the receiver.
2. SYN-ACK (Synchronize-Acknowledgment): The receiver sends a SYN-ACK packet to the sender.
3. ACK (Acknowledgment): The sender sends an ACK packet to the receiver, and the connection is established.

Connection Release

Connection release is the process of terminating a connection between two devices in a network. The process involves several steps:

1. FIN (Finish): One device sends a FIN packet to the other device to initiate the connection release process.
2. ACK (Acknowledgment): The other device sends an ACK packet to acknowledge the FIN packet.
3. FIN-ACK (Finish-Acknowledgment): The first device sends a FIN-ACK packet to acknowledge the ACK packet.
4. Connection Release: The connection is released, and the devices can establish new connections.

Four-Way Handshake

The four-way handshake is a connection release protocol used in TCP:

1. FIN (Finish): One device sends a FIN packet to the other device.
2. ACK (Acknowledgment): The other device sends an ACK packet to acknowledge the FIN packet.

3. FIN (Finish): The other device sends a FIN packet to initiate the connection release process.
4. ACK (Acknowledgment): The first device sends an ACK packet to acknowledge the FIN packet, and the connection is released.

Three-Way Handshake Process

The Three-Way Handshake is a connection establishment protocol used in TCP/IP networks. It involves three steps:

1. SYN (Synchronize): The client sends a SYN packet to the server to initiate the connection. The SYN packet contains the client's initial sequence number.
2. SYN-ACK (Synchronize-Acknowledgment): The server responds with a SYN-ACK packet, which acknowledges the client's SYN packet and sends its own initial sequence number.
3. ACK (Acknowledgment): The client sends an ACK packet to acknowledge the server's SYN-ACK packet, completing the three-way handshake. The connection is now established.

Three-Way Handshake Steps

Here's a summary of the three-way handshake steps:

Step	Sender	Receiver	Packet Type	Description
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1	Client	Server	SYN	Client initiates connection
2	Server	Client	SYN-ACK	Server acknowledges client's SYN
3	Client	Server	ACK	Client acknowledges server's SYN-ACK

Importance of Three-Way Handshake

The three-way handshake is essential for establishing a reliable connection between two devices in a TCP/IP network. It ensures:

- Connection establishment
- Sequence number synchronization
- Acknowledgment of packets

Without the three-way handshake, connections would not be reliable, and data transmission would be prone to errors.

Session Layer (Layer 5)

Functions

1. Connection Establishment: Establishes, maintains, and terminates connections between applications.
2. Session Management: Manages dialogue between applications, controlling the exchange of data.
3. Token Management: Manages tokens, which are used to synchronize data transfer.

Protocols

1. NetBIOS: A session-layer protocol used for communication between devices on a local area network (LAN).
2. SSH: A secure remote access protocol that operates at the session layer.

Presentation Layer (Layer 6)

Functions

1. Data Encryption: Encrypts data to ensure confidentiality and security.
2. Data Compression: Compresses data to reduce transmission time and bandwidth usage.
3. Data Formatting: Formats data into a standardized format for transmission.
4. Data Conversion: Converts data between different formats, such as ASCII to EBCDIC.

Protocols

1. SSL/TLS: A presentation-layer protocol used for secure communication between web browsers and servers.
2. MIME: A presentation-layer protocol used for formatting and transmitting multimedia data, such as email attachments.
3. JPEG: A presentation-layer protocol used for compressing and transmitting image data.

In summary, the Session Layer establishes and manages connections between applications, while the Presentation Layer formats, compresses, and encrypts data for transmission.

Application Layer Protocols

The Application Layer is the topmost layer of the OSI model, providing services to end-user applications.

Functions

1. **Process-to-Process Communication:** Enables communication between processes running on different devices.
2. **Resource Sharing:** Allows resources to be shared between devices.
3. **Remote Access:** Enables remote access to devices and resources.

Protocols

1. **HTTP (Hypertext Transfer Protocol):** Used for web communication, transferring data between web browsers and servers.
2. **FTP (File Transfer Protocol):** Used for transferring files between devices.
3. **SMTP (Simple Mail Transfer Protocol):** Used for sending and receiving email.
4. **DNS (Domain Name System):** Used for resolving domain names to IP addresses.
5. **SNMP (Simple Network Management Protocol):** Used for managing and monitoring network devices.

Overview of DNS

DNS (Domain Name System) is a critical Application Layer protocol that enables devices to communicate with each other using easy-to-remember domain names instead of IP addresses.

Functions

1. **Domain Name Resolution:** Resolves domain names to IP addresses.

2. IP Address Resolution: Resolves IP addresses to domain names.
3. Name Server Management: Manages name servers, which store DNS records.

DNS Components

1. Domain Names: Human-readable names assigned to devices.
2. Name Servers: Store DNS records, which map domain names to IP addresses.
3. DNS Records: Store information about domain names, such as IP addresses and mail servers.
4. Resolvers: Software components that resolve domain names to IP addresses.

DNS Process

1. User Request: A user requests a website or sends an email.
2. DNS Query: The resolver sends a DNS query to a name server.
3. Name Server Response: The name server responds with the IP address associated with the domain name.
4. Connection Establishment: The device establishes a connection with the destination device using the resolved IP address.

What is the Internet?

The Internet is a global network of interconnected computers and servers that communicate with each other using standardized protocols.

History of the Internet

1. 1960s: The Internet originated from the United States Department of Defense's ARPANET project.
2. 1980s: The Internet Protocol (IP) was developed, allowing different networks to communicate with each other.
3. 1990s: The World Wide Web (WWW) was invented, making it easy for users to access and share information using web browsers and hyperlinks.

Key Components of the Internet

1. Networks: A collection of interconnected devices, such as computers, servers, and routers.
2. Protocols: Standardized rules that govern communication between devices on the Internet, such as TCP/IP, HTTP, and FTP.
3. Servers: Powerful computers that store and manage data, applications, and services, such as web servers, email servers, and file servers.
4. Clients: Devices that access and use services provided by servers, such as web browsers, email clients, and file transfer clients.

How the Internet Works

1. Data Transmission: Data is transmitted over the Internet using packets, which are routed through multiple networks and devices.
2. IP Addressing: Each device on the Internet is assigned a unique IP address, which is used to route packets to the correct destination.
3. Domain Name System (DNS): DNS translates human-readable domain names into IP addresses, making it easy for users to access websites and services.
4. Internet Service Providers (ISPs): ISPs provide users with access to the Internet, typically through a physical connection, such as a cable or fiber-optic link.

Internet Services and Applications

1. World Wide Web (WWW): A system of interlinked hypertext documents that can be accessed via web browsers.
2. Email: A service that allows users to send and receive electronic messages.
3. File Transfer Protocol (FTP): A protocol that allows users to transfer files between devices.
4. Remote Access: A service that allows users to access and control remote devices, such as servers and computers.
5. Online Communities: A platform that allows users to interact with each other, such as social media, forums, and chat rooms.

World Wide Web (WWW)

- The World Wide Web (WWW) is a system of interlinked hypertext documents that can be accessed via the Internet.
- The WWW was invented by Tim Berners-Lee in 1989.
- The WWW uses the Hypertext Transfer Protocol (HTTP) to transfer data between web servers and web browsers.

Hypertext Transfer Protocol (HTTP)

- HTTP is a request-response protocol used for transferring data between web servers and web browsers.
- HTTP uses a client-server architecture, where the client (web browser) sends a request to the server, and the server responds with the requested data.
- HTTP uses methods such as GET, POST, PUT, and DELETE to perform different actions on the server.
- HTTP uses status codes such as 200 OK, 404 Not Found, and 500 Internal Server Error to indicate the result of a request.

File Transfer Protocol (FTP)

- FTP is a protocol used for transferring files between devices over the Internet.
- FTP uses a client-server architecture, where the client (FTP client) sends a request to the server, and the server responds with the requested file.
- FTP uses commands such as GET, PUT, and DELETE to perform different actions on the server.
- FTP uses a username and password to authenticate users and control access to files.

Simple Network Management Protocol (SNMP)

- SNMP is a protocol used for managing and monitoring network devices such as routers, switches, and servers.
- SNMP uses a client-server architecture, where the client (SNMP manager) sends a request to the server, and the server responds with the requested data.
- SNMP uses commands such as GET, SET, and TRAP to perform different actions on the server.
- SNMP uses a community string to authenticate users and control access to devices.

Here's a comparison of the four protocols:

Protocol	Purpose	Architecture	Authentication
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WWW	Hypertext document transfer	Client-server	None
HTTP	Request-response protocol for web transfer	Client-server	None
FTP	File transfer	Client-server	Username/password
SNMP	Network management and monitoring	Client-server	Community string

Communication Services

1. Email: Allows users to send and receive electronic messages.
2. Instant Messaging: Enables real-time text-based communication between users.
3. Video Conferencing: Allows users to communicate remotely through video and audio.
4. VoIP (Voice over Internet Protocol): Enables voice communication over the internet.

Information Services

1. World Wide Web (WWW): A system of interlinked hypertext documents.
2. Search Engines: Help users find information on the internet.
3. Online Libraries: Provide access to digital books, articles, and other resources.
4. News Services: Offer online news articles, updates, and alerts.

Entertainment Services

1. Streaming Services: Allow users to stream music, videos, and movies.
2. Online Gaming: Enables users to play games with others over the internet.
3. Virtual Reality (VR) and Augmented Reality (AR): Provide immersive entertainment experiences.
4. Podcasting: Allows users to listen to audio content on demand.

E-commerce Services

1. Online Shopping: Enables users to purchase products and services online.
2. Digital Payment Systems: Allow users to make online transactions securely.
3. Online Banking: Enables users to manage their bank accounts online.
4. Online Auctions: Allow users to bid on products and services.

Education and Research Services

1. Online Courses: Provide access to educational content and courses.
2. Virtual Classrooms: Enable remote learning and collaboration.
3. Research Databases: Offer access to academic journals, articles, and research papers.
4. Online Tutorials: Provide interactive learning resources and tutorials.

Other Services

1. Cloud Computing: Enables users to store and access data online.
2. Social Media: Allows users to connect and share content with others.
3. Online Storage: Provides users with secure online storage for their files.
4. Web Hosting: Enables users to host their websites online.

Types of Email Services

1. Free Email Services: Provide free email accounts with limited storage and features, e.g., Gmail, Yahoo Mail, (link unavailable)
2. Paid Email Services: Offer premium email accounts with additional storage, features, and support, e.g., Google Workspace, Microsoft 365.

3. **Business Email Services:** Designed for businesses, offering custom email addresses, increased storage, and advanced features, e.g., Google Workspace, Microsoft 365.
4. **Encrypted Email Services:** Provide secure, encrypted email communication, e.g., ProtonMail, Tutanota.

Email Service Features

1. **Email Accounts:** Create and manage email accounts, including custom addresses and aliases.
2. **Storage:** Store and manage email messages, attachments, and files.
3. **Security:** Implement security measures, such as spam filtering, virus scanning, and encryption.
4. **Organization:** Offer features like folders, labels, and filters to organize email messages.
5. **Composition:** Provide tools for composing and editing email messages, including formatting options and attachments.
6. **Search:** Enable searching for specific email messages, contacts, or attachments.
7. **Notifications:** Send notifications for new email messages, calendar events, or tasks.
8. **Integration:** Integrate with other services, such as calendars, contacts, and productivity apps.

Email Protocols

1. **SMTP (Simple Mail Transfer Protocol):** Used for sending email messages between servers.
2. **POP3 (Post Office Protocol version 3):** Used for retrieving email messages from a server to a client.
3. **IMAP (Internet Message Access Protocol):** Used for accessing and managing email messages on a server.

Popular Email Services

1. Gmail: A free email service provided by Google.
2. (link unavailable): A free email service provided by Microsoft.
3. Yahoo Mail: A free email service provided by Yahoo.
4. ProtonMail: A secure, encrypted email service.
5. Google Workspace: A paid email service for businesses, offering custom email addresses and advanced features.

Types of WWW Services

1. Web Hosting: Provides storage and accessibility for websites, e.g., Bluehost, HostGator.
2. Website Builders: Offers tools and platforms to create and design websites, e.g., Wix, Squarespace.
3. E-commerce Platforms: Enables online shopping and payment processing, e.g., Shopify, Magento.
4. Blogging Platforms: Provides tools and hosting for creating and publishing blogs, e.g., WordPress, Blogger.
5. Web Application Services: Offers platforms for developing and deploying web applications, e.g., Heroku, Google Cloud.

WWW Service Features

1. Domain Name Registration: Registers and manages domain names for websites.
2. Web Space: Provides storage for website files, images, and databases.
3. Bandwidth: Offers data transfer capacity for website traffic.
4. Email Hosting: Provides email accounts and management tools.
5. Security: Implements security measures, such as SSL certificates and firewalls.
6. Scalability: Allows websites to scale with traffic and user demand.

7. Analytics: Provides tools for tracking website traffic, engagement, and conversion.

Popular WWW Services

1. (link unavailable): A website builder and hosting platform.
2. Wix: A website builder and hosting platform.
3. Shopify: An e-commerce platform for online stores.
4. Google Cloud: A web application platform for developing and deploying web apps.
5. Bluehost: A web hosting platform for websites and blogs.

Benefits of WWW Services

1. Global Reach: Enables businesses and individuals to reach a global audience.
2. Increased Visibility: Enhances online presence and visibility.
3. Improved Communication: Facilitates communication with customers, partners, and stakeholders.
4. E-commerce Opportunities: Enables online shopping and payment processing.
5. Cost-Effective: Reduces costs associated with traditional marketing and communication methods.

Types of Search Services

1. Web Search Engines: Index and retrieve web pages, e.g., Google, Bing, Yahoo.
2. Specialized Search Engines: Focus on specific topics or industries, e.g., Google Scholar, PubMed.
3. Enterprise Search: Searches within an organization's internal networks and databases.
4. Desktop Search: Searches files and data on a user's local computer.

Search Service Features

1. Query Processing: Analyzes and interprets user search queries.
2. Indexing: Creates a database of web pages, documents, or files.
3. Retrieval: Retrieves relevant results based on the search query.
4. Ranking: Orders search results by relevance, importance, or popularity.
5. Filtering: Allows users to narrow down search results using filters.
6. Faceted Search: Enables users to refine search results using multiple filters.

Popular Search Services

1. Google: A web search engine and advertising platform.
2. Bing: A web search engine developed by Microsoft.
3. DuckDuckGo: A private search engine that doesn't track user data.
4. Google Scholar: A search engine for scholarly literature.
5. StartPage: A private search engine that uses Google's search results.

Benefits of Search Services

1. Information Retrieval: Quickly finds relevant information from a vast amount of data.
2. Time-Saving: Saves users time by providing fast and accurate search results.
3. Improved Productivity: Enhances productivity by enabling users to find information efficiently.

4. **Access to Knowledge:** Provides access to a vast amount of knowledge and information.
5. **Personalization:** Offers personalized search results based on user preferences and behavior.