UNIT – V APPLICATION LAYER

1. **Domain name system(DNS)**
2. **SNMP**
3. **Electronic Mail**
4. **TELNET & SSH**
5. **The World WEB**
6. **HTTP**
7. **Streaming audio and video.**

1. Application Layer Protocols

Common Application Layer Protocols

1. Domain Name Service (DNS)
2. HyperText Transfer Protocol (HTTP)
3. Simple Mail Transfer Protocol (SMTP)
4. Post Office Protocol (POP)
5. File Transfer Protocol (FTP)

Domain Name System (DNS)

The Domain Name System (DNS) is a hierarchical and decentralized naming system for computers, services, or other resources connected to the Internet or a private network.

The Internet maintains two principal name spaces:

- The domain name hierarchy
- The Internet Protocol (IP) address space

DNS is primarily used for mapping host and email destinations to IP addresses, but it can also be used for other purposes.

Working of DNS

1. To map a name onto an IP address, an application program calls a library procedure called a Resolver, passing it the name as a parameter.
2. The Resolver sends a UDP packet to a local DNS server, which looks up the name and returns the IP address to the resolver.
3. The Resolver then returns the IP address to the calling program.
4. Armed with the IP address, the program can then establish a TCP connection with the destination or send it UDP packets.

Main Components of DNS

a. The DNS Namespace
b. Resource Records
c. Name Servers

a. DNS Namespace Structure

- ➢ The Internet is divided into several hundred top-level domains, where each domain covers any hosts.
- ➢ Each domain is partitioned into subdomains, and these are further divided into smaller subdomains, and so on.
- ➢ All these domains can be represented by a tree structure, in which the leaves represent domains that have no subdomains.

- A leaf domain may contain a single host, or it may represent a company containing thousands of hosts**.**
- Each domain is named by the path upward from it to the root, and the components are separated by periods (dots) — pronounced as “dot”.

Example:

Sun Microsystems Engineering Department: eng.sun.com

Where:

- eng → represents the Engineering Department (subdomain)
- sun → represents the organization (Sun Microsystems)
- com → represents the top-level domain (commercial)

Types of Top-Level Domains (TLDs)

Top-level domains come in **two main categories**:

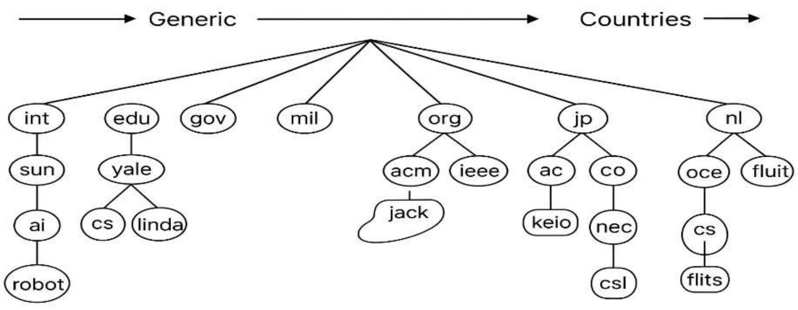
1. **Generic Top-Level Domains (gTLDs):**

   i. .com → Commercial organizations
   ii. .edu → Educational institutions
   iii. .mil → U.S. Armed Forces and government
   iv. .int → Certain international organizations
   v. .net → Network providers
   vi. .org → Non-profit organizations

2. **Country Code Top-Level Domains (ccTLDs):**

   i. Include one entry for each country

      - .in for India,
      - .uk for the United Kingdom,
      - .jp for Japan).



b. Resource Records:

- Every domain can have a set of resource records associated with it.
  For a single host, the most common resource record is just its IP address.
- When a resolver gives a domain name to the DNS, it gets back the resource records associated with that name.
  Thus, the real function of DNS is to map domain names into resource records.
- A resource record is a 5-tuple, and its format is as follows:

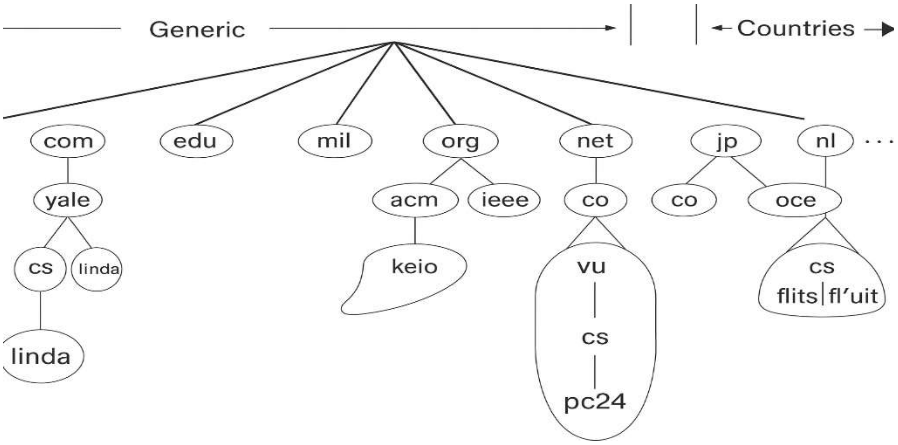
Domain Name	Time to Live (TTL)	Type	Class	Value
The domain to which this record applies	Indicates how long the record is valid before it should be refreshed	Specifies the type of record (e.g., A, MX, NS, CNAME, etc.)	Specifies the protocol family (usually **IN** for Internet)	Contains the actual data for the record (e.g., IP address, domain name, or other information)

The value field is as follows:

Type	Meaning	Value
SOA	Start of Authority	Parameters for this zone
A	IP address of a host	32-bit integer
MX	Mail exchange	Priority, domain willing to accept e-mail
NS	Name Server	Name of a server for this domain
CNAME	Canonical name	Domain name
PTR	Pointer	Alias for an IP address
HINFO	Host description	CPU and OS in ASCII
TXT	Text	Uninterpreted ASCII text

c. Name Server:

It contains the entire database and responds to all queries about it.
The DNS name space is divided into non-overlapping zones, where each zone contains a specific part of the tree.
Each zone also has name servers that hold the authoritative information about that zone.



When a Resolver Has a Query:

When a resolver has a query about a domain name, it passes the query to one of the local name servers**.**

1. If the domain being sought falls under the jurisdiction of the name server**,** it returns the authoritative resource records (these come from the authority that manages the record and are always correct).
2. If the domain is remote and no information about the requested domain is available locally, the name server sends a query message to the top-level name server for the domain requested.

Example:
A resolver of flits.cs.vu.nl wants to know the IP address of the host linda.cs.yale.edu.

Steps in Recursive Query:

Step 1: The resolver sends a query containing the domain name sought, along with the type and class, to the local name server cs.vu.nl.

Step 2: Suppose the local name server knows nothing about it. It asks a few other nearby name servers.If none of them know, it sends a UDP packet to the server for edu-server.net.

Step 3: This server knows nothing about linda.cs.yale.edu or cs.yale.edu,so it forwards the request to the name server for yale.edu.

Step 4: The yale.edu name server then forwards the request to cs.yale.edu,which must have the authoritative resource records**.**

Steps 5 to 8: The resource record requested works its way back through the chain (steps 5–8). This query method is known as a Recursive Query.

ELECTRONIC MAIL

Architecture and Services:

E-mail systems consist of **two subsystems**. They are:

1. **User Agents (UA):** Allow people to read and send e-mail.
2. **Message Transfer Agents (MTA):** Move messages from the source to the destination.

E-mail systems support five basic functions:
a. Composition
b. Transfer
c. Reporting
d. Displaying
e. Disposition

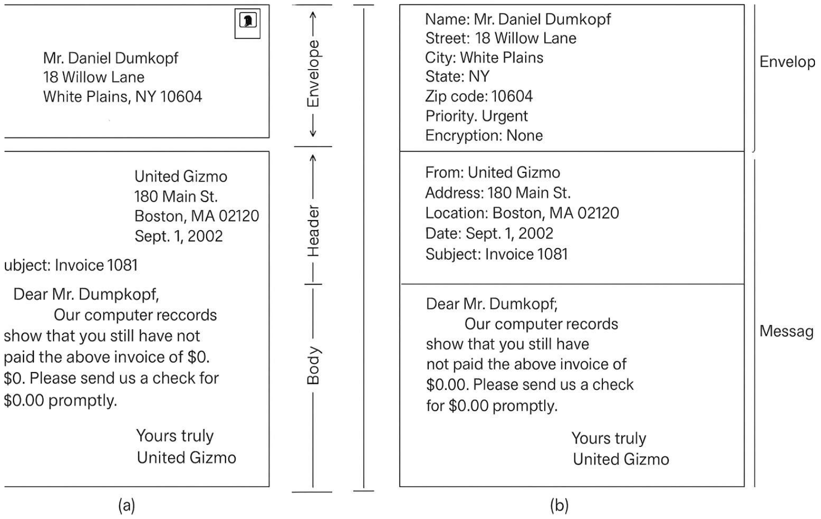
a) Composition: It refers to the process of creating messages and replies. Any text editor can be used for writing the body of the message, while the system itself can provide assistance with addressing and adding header fields to each message.
b) Reporting: It deals with informing the sender about what happened to the message — whether it was delivered, rejected, or lost.
c) Transfer: It refers to moving messages from the originator to the recipient.
d) Displaying: Incoming messages are to be displayed so that users can read their e-mail.
e) Disposition:It concerns what the recipient does with the message after receiving it.

Possibilities include:

- Deleting it before or after reading
- Saving it for later use, and so on.

Most e-mail systems allow users to create mailboxes to store incoming mail.
Commands are provided to:

- Create and delete mailboxes
- Inspect mailbox contents
- Insert or delete messages from mailboxes
- Manage stored messages efficiently



Envelopes and messages. (a)Paper mail. (b)Electronic mail.

The User Agent

A User Agent (UA) is normally a program (sometimes called a mail reader**)** that accepts a variety of commands for composing, receiving, and replying to messages, as well as for manipulating **mailboxes**.

Sending E-mail:

To send an e-mail message, a user must provide:

- The message content
- The destination address
- Possibly some other parameters

The message can be created using:

- A text editor,
- A word processing program, or
- A specialized editor built into the user agent.

The destination address must be in a format that the user agent can process.
Most user agents expect addresses in the form:
☞ user@dns-address

Reading E-mail:

When a user agent starts, it first checks the user's mailbox for incoming messages before displaying anything on the screen.
It may then:

- Announce the number of messages in the mailbox, or
- Display a one-line summary of each message,
  and then wait for the user's command.

Message Formats — RFC 822

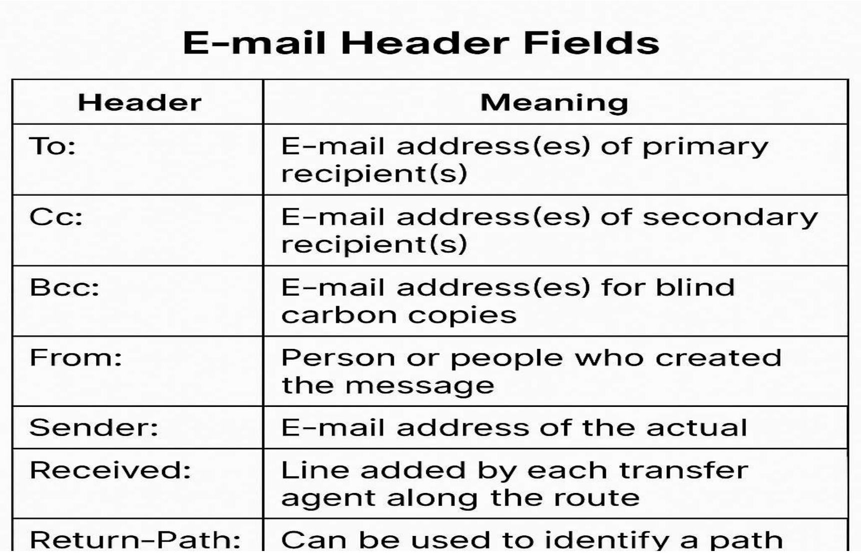
Messages consist of:

- A primitive envelope (described in RFC 821),
- Some number of header fields,
- A blank line, and

- The message body.

Each header field consists of a single line of ASCII text containing:

- The field name,
- A colon (:)**,** and
- For most fields, a value.



E-mail Header Fields

Header	Meaning
To:	E-mail address(es) of primary recipient(s)
Cc:	E-mail address(es) of secondary recipient(s)
Bcc:	E-mail address(es) for blind carbon copies
From:	Person or people who created the message
Sender:	E-mail address of the actual
Received:	Line added by each transfer agent along the route
Return-Path:	Can be used to identify a path

MIME — The Multipurpose Internet Mail Extensions

RFC 822 specified the headers but left the content entirely up to the users.
Nowadays, on the worldwide Internet, this approach is no longer adequate.

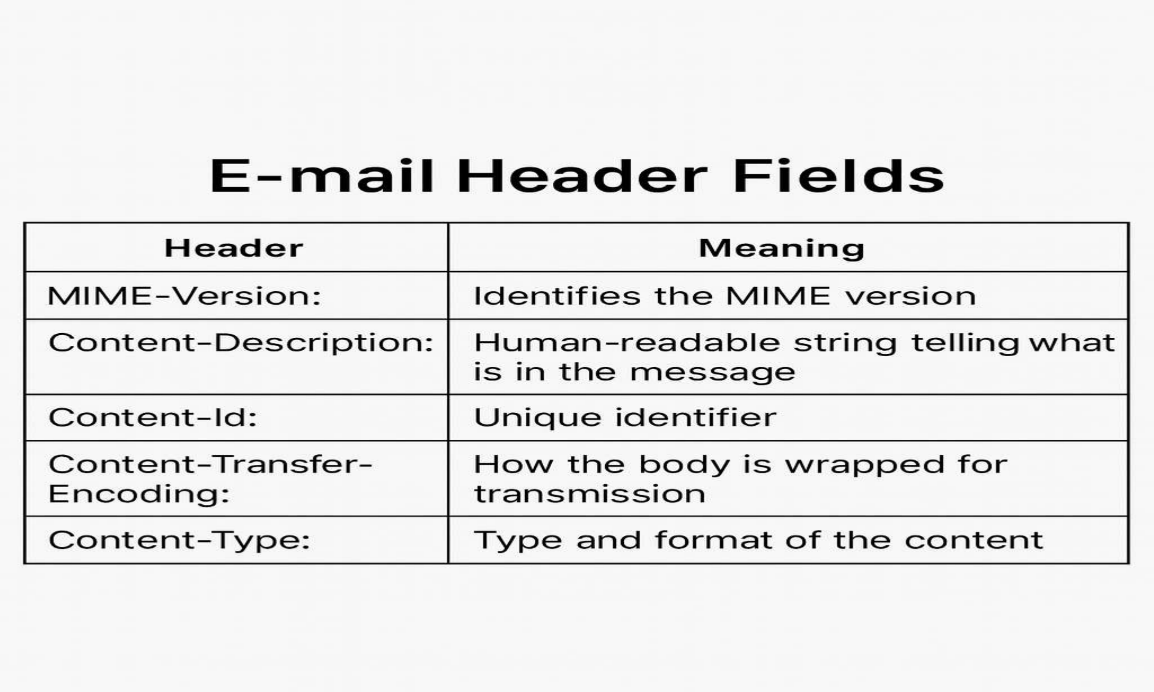
The problems include sending and receiving:

1. Messages in languages with accents (e.g., French and German).
2. Messages in non-Latin alphabets (e.g., Hebrew and Russian).
3. Messages in languages without alphabets (e.g., Chinese and Japanese).
4. Messages not containing text at all (e.g., audio or images).

A solution was proposed in RFC 1341, called MIME **(**Multipurpose Internet Mail Extensions**)**.

The basic idea of MIME is to continue using the RFC 822 format,
but to add structure to the message body and define encoding rules for non-ASCII messages.

By not deviating from RFC 822, MIME messages can be sent using the existing mail programs and protocols.
All that needs to be changed are the sending and receiving programs, which users can update themselves.



E-mail Header Fields

Header	Meaning
MIME-Version:	Identifies the MIME version
Content-Description:	Human-readable string telling what is in the message
Content-Id:	Unique identifier
Content-Transfer-Encoding:	How the body is wrapped for transmission
Content-Type:	Type and format of the content

MESSAGE TRANSFER

The message transfer system is concerned with relaying messages from the originator to the recipient.
The simplest way to do this is to establish a transport connection from the source machine to the destination machine, and then transfer the message.

SMTP — The Simple Mail Transfer Protocol

SMTP (Simple Mail Transfer Protocol) is a simple **ASCII-based protocol**.

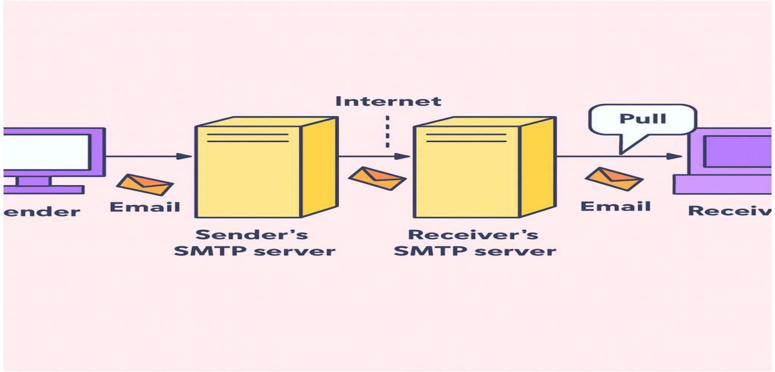
After establishing a TCP connection to port 25, the sending machine (operating as the client) waits for the receiving machine (operating as the server) to talk first.

The **server** begins by sending a line of text that:

- Gives its identity, and
- Indicates whether it is prepared to receive mail.

If the server is not ready, the client releases the connection and tries again later.

Even though the SMTP protocol is completely well-defined, a few problems can still arise.



Problems in SMTP Message Transfer

One problem relates to message length.
Some older implementations cannot handle messages exceeding 64 KB.

Another problem relates to timeouts.
If the client and server have different timeout values, one of them may give up while the other is still busy, unexpectedly terminating the connection.

Finally, in rare situations, infinite mail storms can be triggered.
For example, if Host 1 holds mailing list A and Host 2 holds mailing list B, and each list contains an entry for the other,
then a message sent to either list could generate a never-ending loop of e-mail traffic unless someone checks for it.

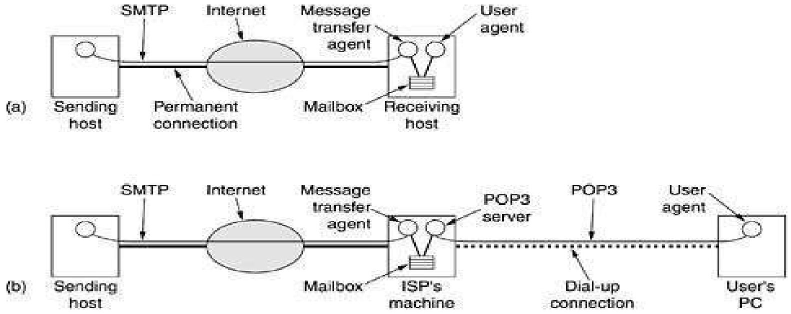
Final Delivery

With the advent of people who access the Internet by calling their ISP over a modem, direct delivery often breaks down.

One solution is to have a Message Transfer Agent (MTA) on an ISP machine that accepts e-mail for its customers and stores it in their mailboxes on the ISP server.
Since this agent can remain online 24 hours a day, e-mail can be received at any time.

POP3

POP3 (Post Office Protocol Version 3) is used by users to retrieve e-mail from their mailboxes on the server to their local machines.



POP3 (Post Office Protocol Version 3)

POP3 begins when the user starts the mail reader.
The mail reader calls up the ISP (unless there is already a connection) and establishes a TCP connection with the Message Transfer Agent (MTA) at port 110.

Once the connection has been established, the POP3 protocol goes through three states in sequence**:**

1. Authorization
2. Transaction
3. Update

Authorization State: This state deals with having the user log in**.**
Transaction State: This state deals with the user collecting e-mails and marking them for deletion from the mailbox.
Update State: This state actually causes the marked e-mails to be deleted from the server.

IMAP (Internet Message Access Protocol)

In POP3, all stored messages are normally downloaded at each contact.
As a result, the user's e-mail often gets spread across multiple machines, sometimes even on devices that are not the user's own.

This disadvantage led to the development of an alternative protocol — IMAP (Internet Message Access Protocol).

Features of IMAP:

- IMAP assumes that all e-mails remain on the server indefinitely in multiple mailboxes.
- It provides extensive mechanisms for reading messages or even parts of messages.
- This feature is especially useful when using a slow modem connection, allowing users to read the text portion of a multipart message without downloading large audio or video attachment