Email architecture in computer networks is a client-server system that uses a "store-and-forward" model to exchange digital messages. Unlike real-time communication, email does not require the sender and recipient to be online simultaneously.

Core Components

The architecture consists of three primary functional agents that handle different stages of the email lifecycle:

- **User Agent (UA):** The application or client software (e.g., Microsoft Outlook, Gmail, or Mozilla Thunderbird) that provides the interface for users to compose, read, and manage messages.
- **Message Transfer Agent (MTA):** The server-side software (e.g., Postfix or Sendmail) responsible for routing and transferring emails between servers using the **SMTP** protocol.
- **Message Access Agent (MAA):** The component that allows the recipient's UA to retrieve or pull messages from the mail server's storage (mailbox) using protocols like **POP3** or **IMAP**.

Key Protocols

- Email relies on specific Application Layer protocols within the TCP/IP suite:

Protocol	Full Name	Primary Function	Port (Default)
SMTP	Simple Mail Transfer Protocol	**Sending** and transferring mail between servers.	25 (relay), 587 (submission)
POP3	Post Office Protocol v3	**Retrieving** mail by downloading it to a local device (often deleting from server).	110
IMAP	Internet Message Access Protocol	**Accessing** and managing mail directly on the server (supports multi-device sync).	143
MIME	Multipurpose Internet Mail Extensions	Extends email to support **non-text attachments** (images, audio, video).	N/A

Operational Flow

1. **Composition & Submission:** The sender uses a **UA** to write a message. When they click "send," the UA uses **SMTP** to submit the message to the sender's mail server.
2. **Relaying:** The sender's **MTA** looks up the recipient's domain in the Domain Name System (DNS) to find its **MX (Mail Exchange) record**. It then transfers the email to the recipient's MTA via **SMTP**.
3. **Delivery & Storage:** The recipient's MTA receives the message and delivers it to a local **mailbox** (managed by a Mail Delivery Agent).
4. **Retrieval:** The recipient's UA uses **POP3** or **IMAP** to "pull" the message from the server so the user can read it.

Message Structure

A standard email is composed of three distinct parts:

- **Envelope:** Internal metadata used by MTAs for routing (sender/recipient addresses).
- **Header:** Metadata visible to the user, such as From, To, Subject, and Date.
- **Body:** The actual content of the message, which can include plain text or HTML.

WHAT IS E-MAIL

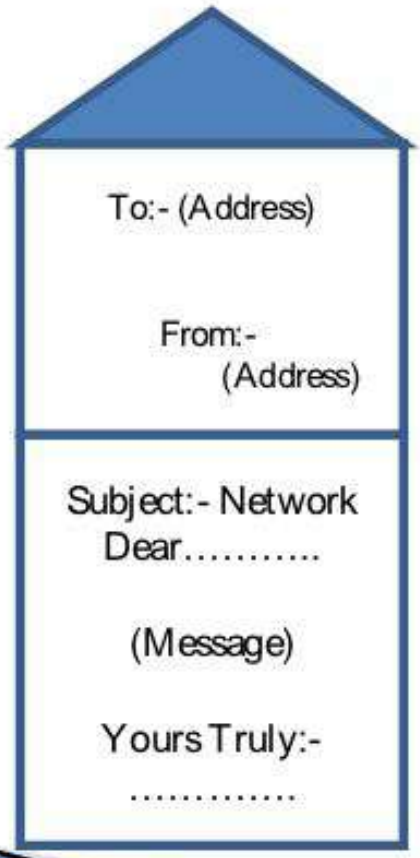
- **Electronic mail**, often abbreviated as **E-mail**, is a method of exchanging digital messages, designed primarily for human use.

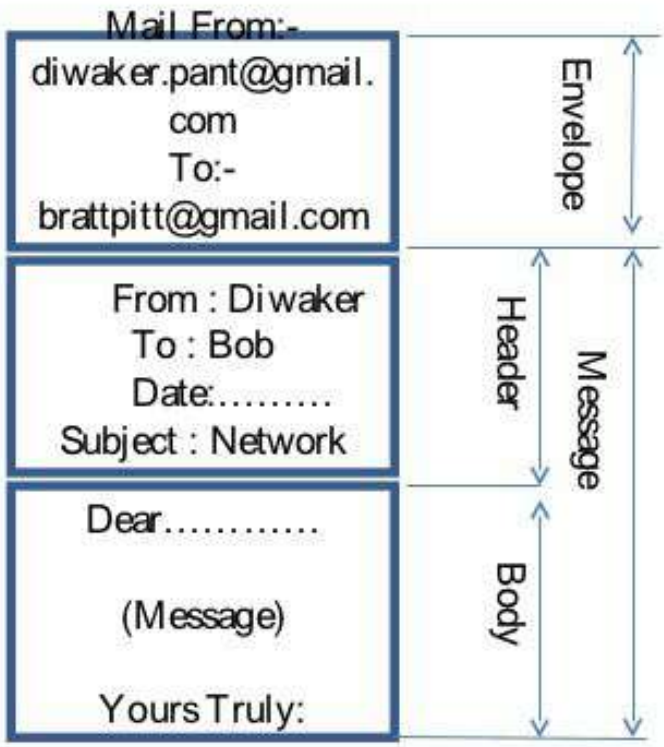
- E-mail systems are based on a ***store & forward*** model in which E-mail server systems accept, forward, deliver and store messages on behalf of users, who only need to connect to the e-mail infrastructure.

HISTORY OF E-MAIL

- The foundation for today's global Internet e-mail service was created in the early ARPANET
- Standards for encoding of messages were proposed as early as, for example, in 1973 (RFC 561).
- An e-mail sent in the early 1970s looked very similar to one sent on the Internet today.
- Network-based email was initially exchanged on the ARPANET in extensions to the (FTP), but is today carried by the (SMTP).

COMPARISION WITH POSTAL MAIL





WHY TO USE E-MAIL

- We can send a message anytime anywhere.
- We can send the same message to several peoples at same time.
- We can forward the information to coworkers without retyping it.
- We can send the messages around the world as easily as to friend in the next cabin .

WHY TO USE E-MAIL..

- We can save the time, E-mail is very fast, usually taking no more time than a few minutes to be received.
- We can mail Electronic documents and recipients can then edit and return revised versions.
- It is very fast as compare to postal mail.

STRUCTURE OF E-MAIL

An electronic mail message consists of two components

- ***Message header;*** The message header contains control information, including an originator's email address and one or more recipient addresses. Usually additional information is added, such as a subject header field.

- **Message *body*** which is the email's content.

HEADER FIELD

The message header should include at least the following fields:

- ***From*** The ***e-mail addresses***, and optionally the name of the author or sender.
- ***To***: The e-mail address of the message's recipient(s). Indicates primary recipients (multiple allowed), for secondary recipients see Cc: and Bcc.
- ***Bcc***: ***Blind carbon copy***; addresses added to the SMTP delivery list but not (usually) listed in the message data, remaining invisible to other recipients.
- ***Cc:*** ***Carbon copy***; Many e-mail clients will mark e-mail in your inbox differently depending on whether you are in the To: or Cc: list.

HEADER FIELD

- ***Date***: The local time and date when the message was written, automatically attached while sending.
- ***Subject***: A brief summary of the topic of the message.
- ***Message-ID:*** Also an automatically generated field; used to prevent multiple delivery .
- ***Attachment***: Attachment contain the name of files . That you want to send. example a world document.

E-MAIL ADDRESS

- To deliver mail ,a system must use an addressing system with unique addresses

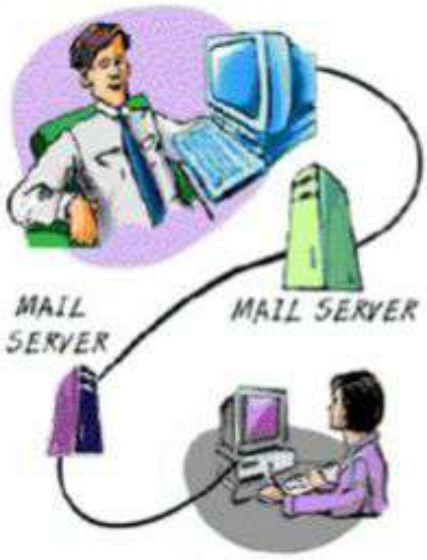
- Address consist two parts :

1. Local part
2. Domain name

- These are separated by @ sign.

E-MAIL ADDRESS

- Like a postal address, an **e-mail address** specifies the **destination** of an electronic message.
- An **Internet** e-mail address looks like this: **user name@domain name**
- The **user name** is a unique name that identifies the **recipient**.
  The **domain name** is the address. Many people can share the same domain name.



ARCHITECTURE

There are four scenario most commonly used to exchange the E-MAIL.

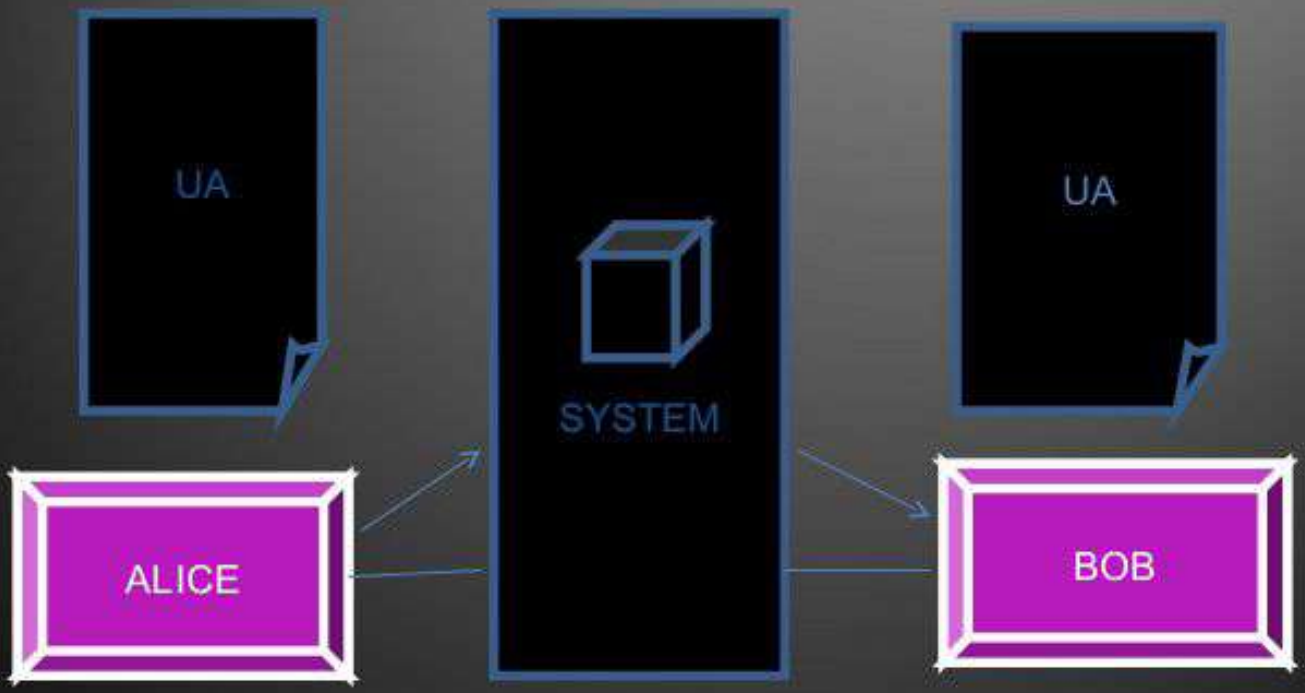
1. First scenario
2. Second scenario
3. Third scenario
4. Fourth scenario

FIRST SCENARIO

- In this the sender and the receiver of the E-mail are on the same system.
- They are directly connected to shared system.
- The administrator has created one mailbox for each user where the received messages are stored.
- Only the owner of the mailbox has access to it.
- When Alice need to send a message to Bob, Alice run the user agent (UA) program to prepare the message and store it in Bob's mailbox.

FIRST SCENARIO

UA: USER AGENT

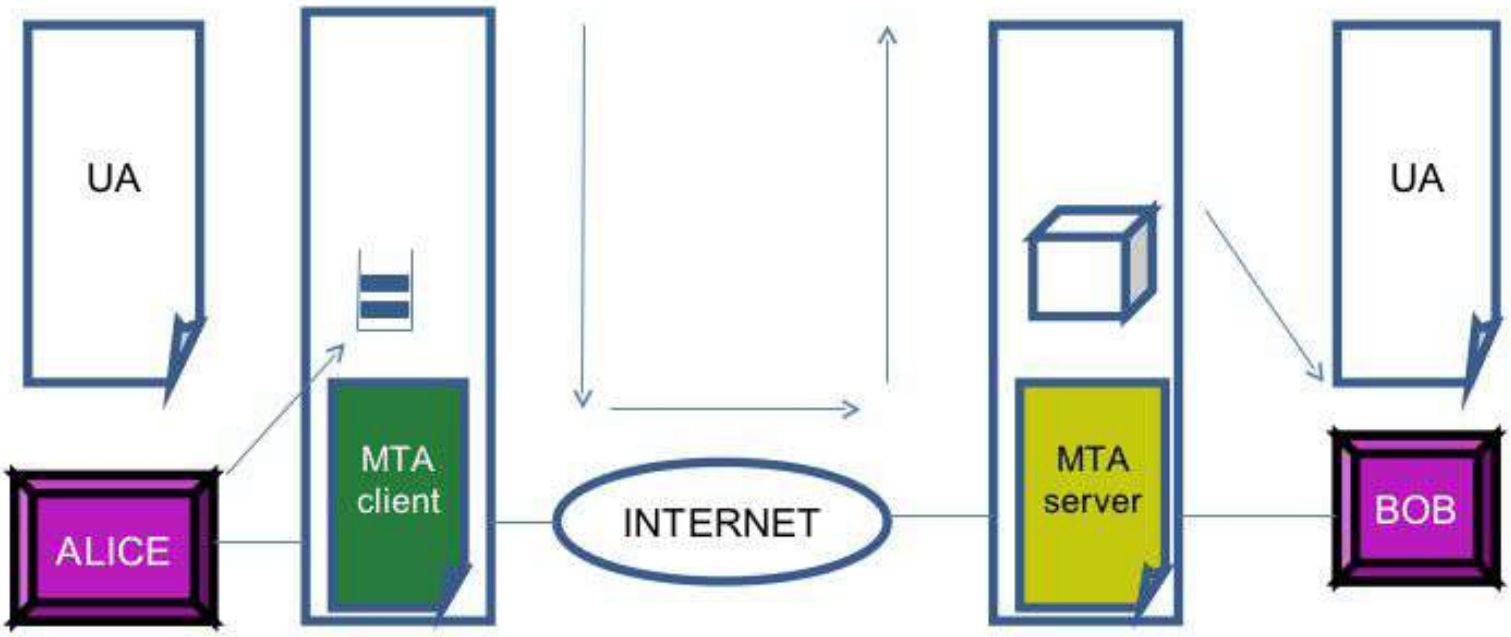


SECOND SCENARIO

- In this the sender and the receiver are users two different systems.
- The message needs to be send over the internet.
- Here we need UAs and MTAs.
- The sender needs to use a UA program to send her message to the system at her own site.
- The recipient needs a UA program to retrieve messages.
- Here two MTA are needed, one client and one server.

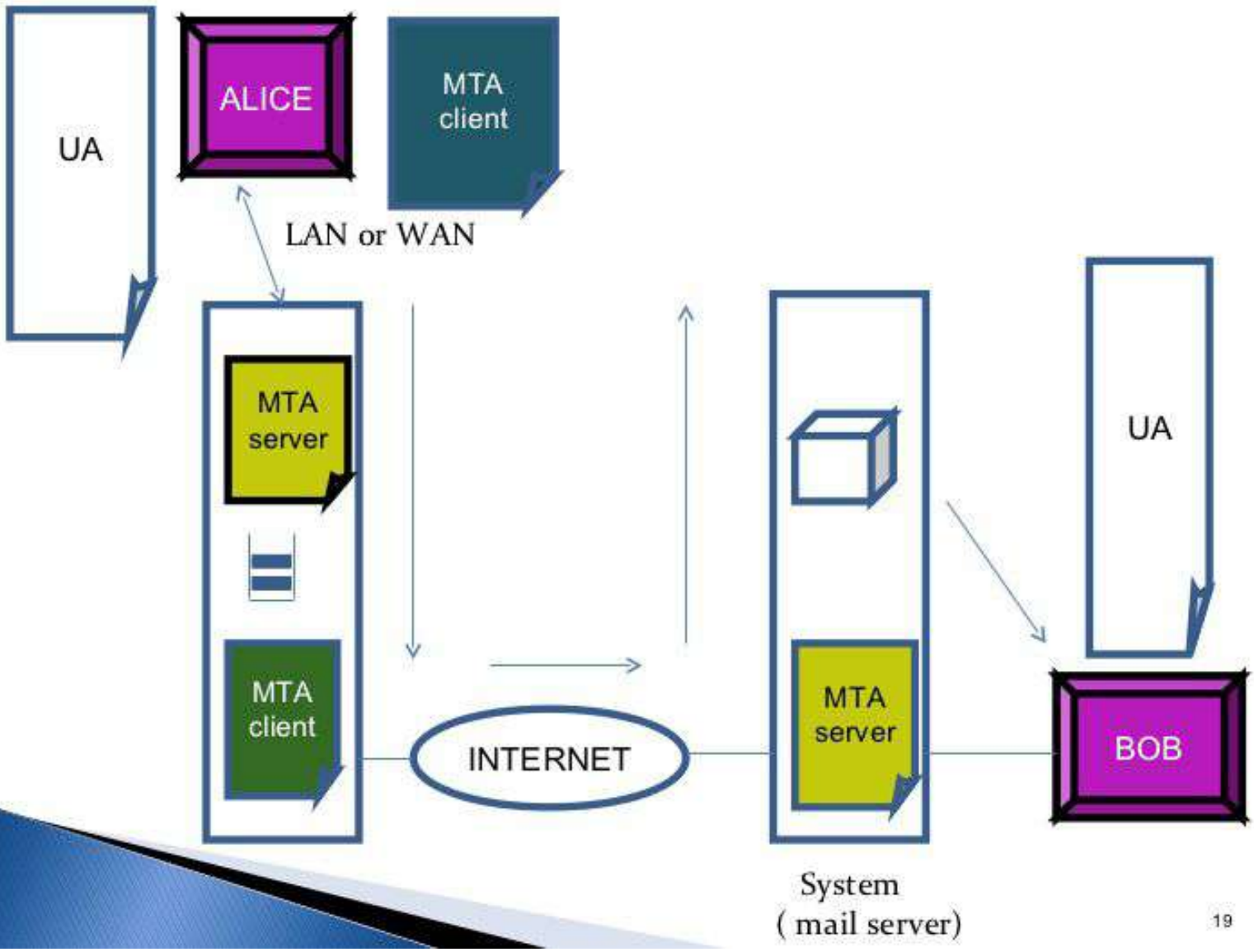
SECOND SCENARIO

MTA: message transfer agent



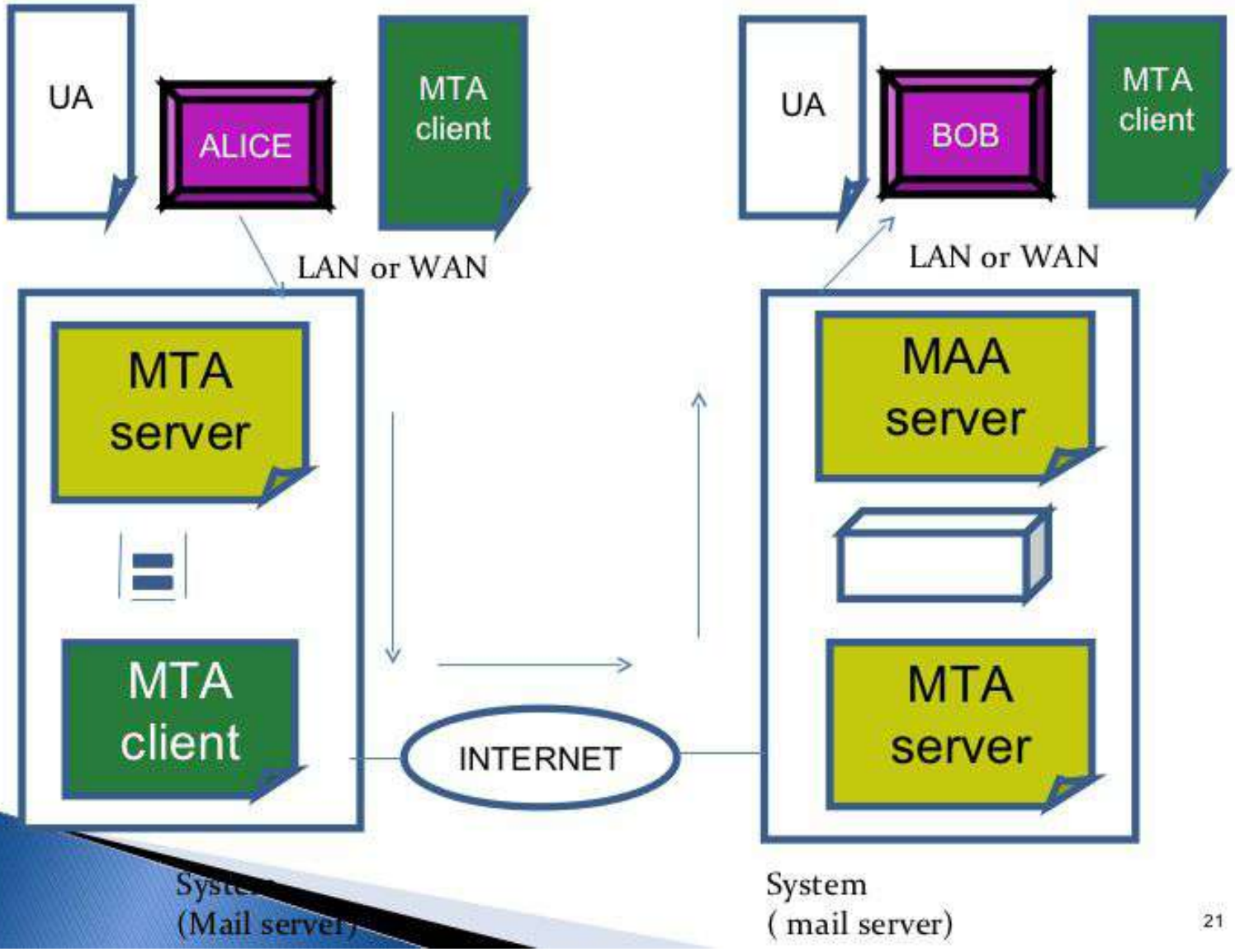
THIRD SCENARIO

- In this the recipient as in the second scenario is directly connected to his system.
- Sender is connected to the system via point to point WAN such as dial-up modem, or a cable modem.
- Sender still needs a UA(User Agent) to prepare the message.
- Then through a pair of MTA(Mail Transfer Agent), send the message through the LAN or WAN.


UA
ALICE
MTA client
LAN or WAN
MTA server
MTA client
INTERNET
MTA server
UA
BOB
System
(mail server)

FOURTH SCENARIO

- In this the recipient is also connected to his mail server by WAN or LAN.
- After the message has arrived, recipient need to retrieve it.
- Here we need another set of client or server agent (MAAs). Recipient uses an MAA client to retrieve his messages.
- The client sends a request to the MAA(Mail access Agent) server and request the transfer of the messages.
- we need two UAs, two pair of MTAs and a pair of MAAs. This is the most common situation today.


UA
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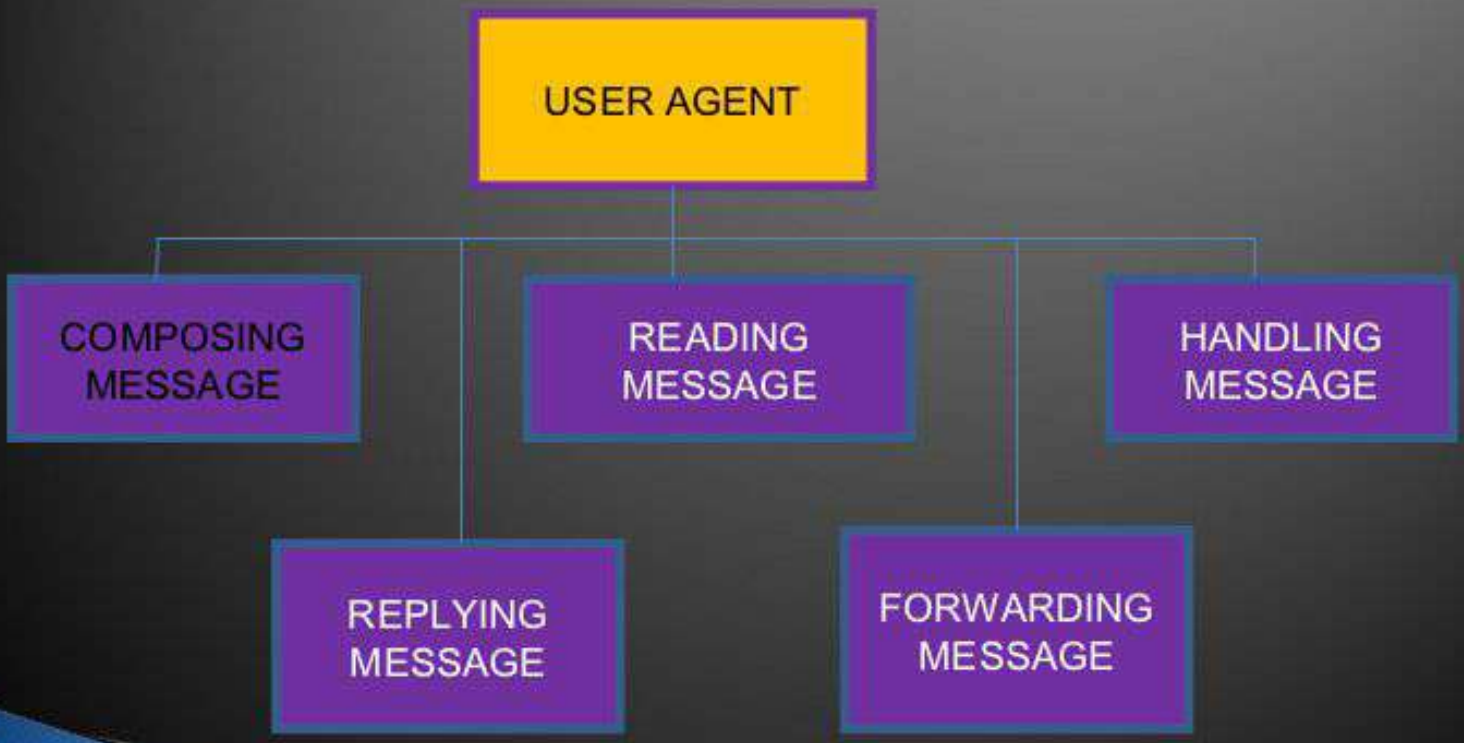
MTA client
INTERNET
UA
BOB
MTA client
LAN or WAN
MAA server
MTA server
System
(mail server)

USER AGENT

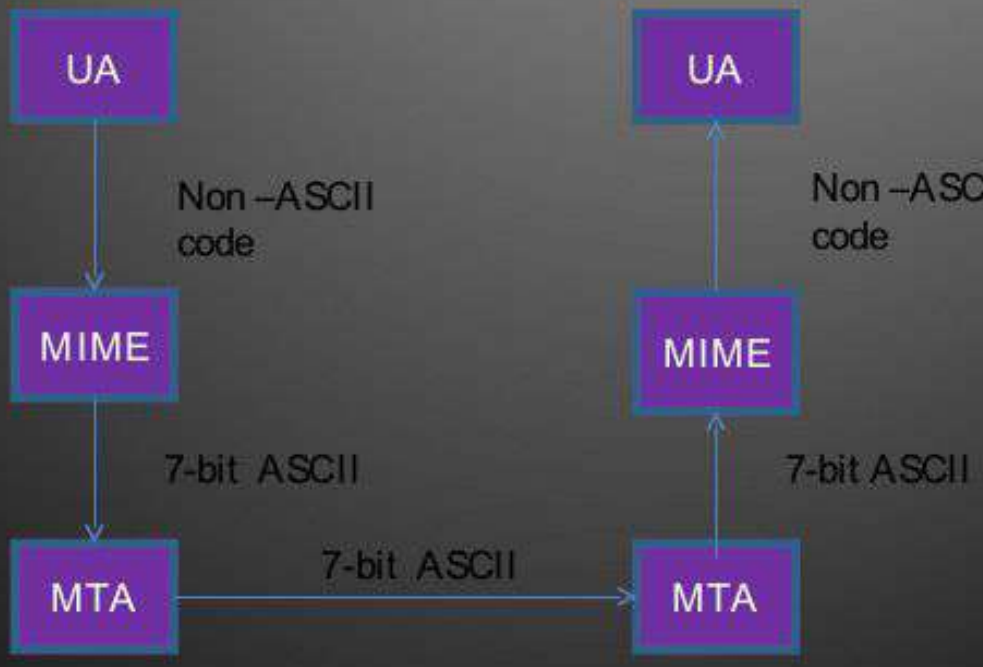
- The first component of E-mail is user agent(UA).
- It provide the services to user to make the process of sending & receiving a message easier.
- A UA is a software package(Program) that composes, read, replies to and forward messages.
- It also handles the Mailboxes.

SERVICES PROVIDED BY USER AGENT



FUNCTION OF UA & MIME

MIME (Multipurpose Internet Mail Extensions) Protocol

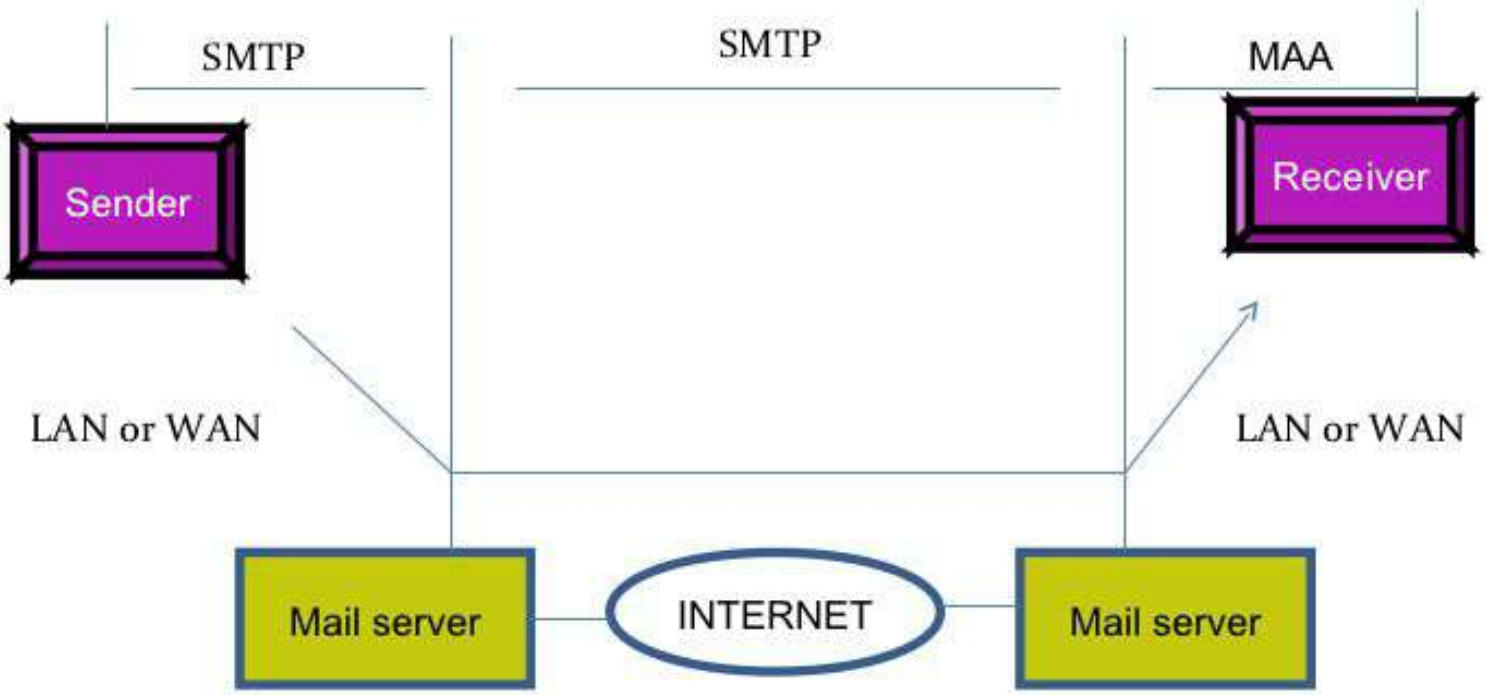


MESSAGE TRANSFER AGENT

- The actual mail transfer is done through MTA.
- To send mail , a system must have client MTA.
- To receive mail ,a system must have server MTA.
- The protocol that define the MTA client & server in the internet is called SMTP (simple mail transfer protocols).
- SMTP define how commands & response must be sent back & forth.

MAIL ACCESS AGENT

- The first and the second stages of mail delivery use SMTP.
- SMTP is a PUSH protocols.
- On the other hand, the third stage needs a pull protocol ; the client must pull messages from the server . The direction of the bulk data is from the server to the client . At this stage Message Access Agent is use.


SMTP
SMTP
MAA
Sender
Receiver
LAN or WAN
LAN or WAN
Mail server
INTERNET
Mail server

SUMMARY

- UA prepares the messages, creates the envelopes, and puts the message in the envelope.
- Mail address is like localpart@domainname.
- Multipurpose Internet Mail Extensions (MIME) allows the transfer of multimedia messages.
- MTA transfer the mail across internet, a LAN or a WAN.

SUMMARY..

- SMTP uses commands and responses to the transfer messages between an MTA client and MTA server.
- Post Office Protocol, Version 3 (POP 3) and Internet Mail Access Protocol, Version 4 (IMAP 4) are used for pulling messages from a mail server.