Networking Applications

Dr. Ayman A. Abdel-Hamid

College of Computing and Information Technology

Arab Academy for Science & Technology and Maritime Transport

Electronic Mail

Outline

- Introduction
- SMTP
- MIME
- Mail Access Protocols

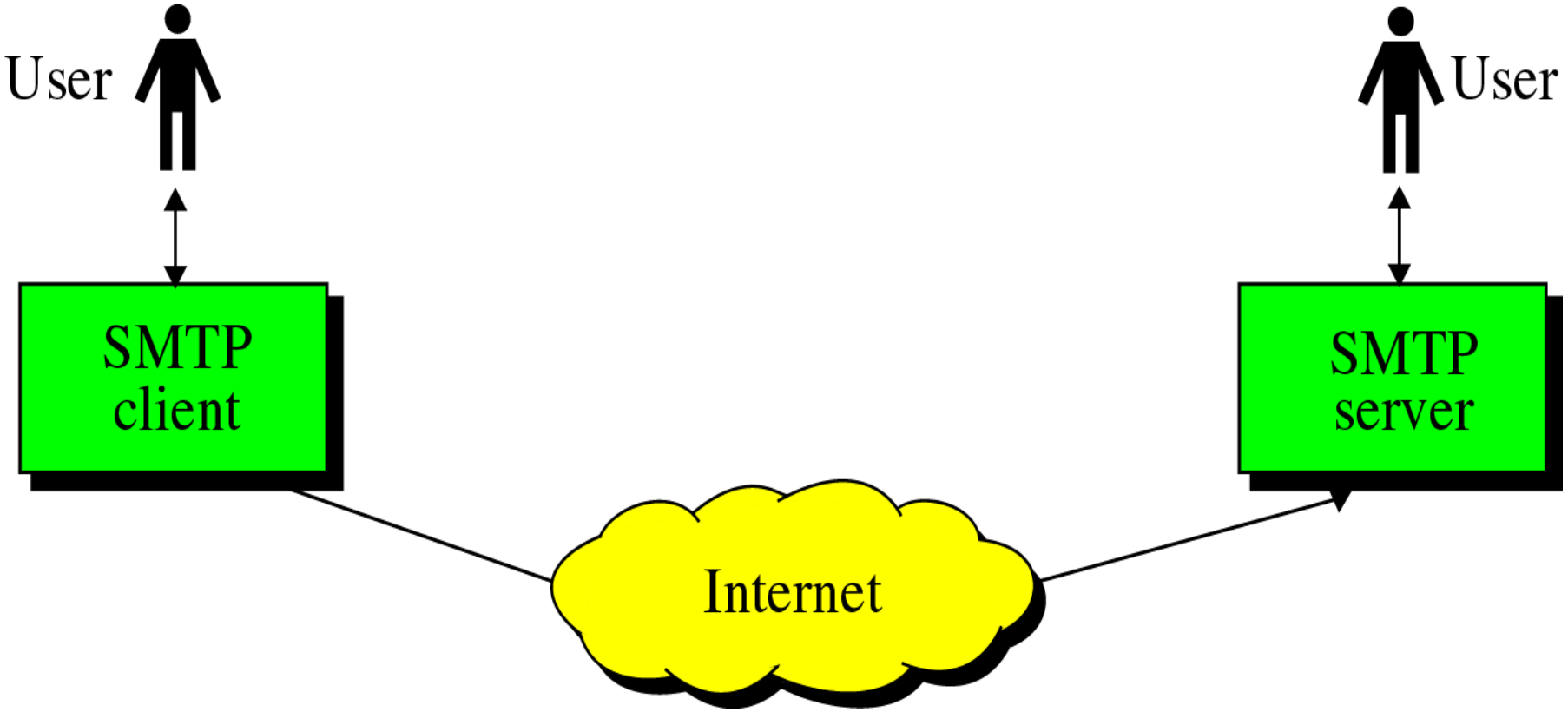
Introduction

- Email from user to user (or a group of users)
- Email from user to a mailing list
- SMTP (Simple Mail Transfer Protocol) is the standard mechanism for email in the Internet
- Analogy to postal mail (envelope and message (header and body))
- Email addresses in the form <local-part@domain-name>
  - Local-part: address of user mailbox on local site
  - Domain-name: destination domain name
    - Recall MX resource record in DNS database

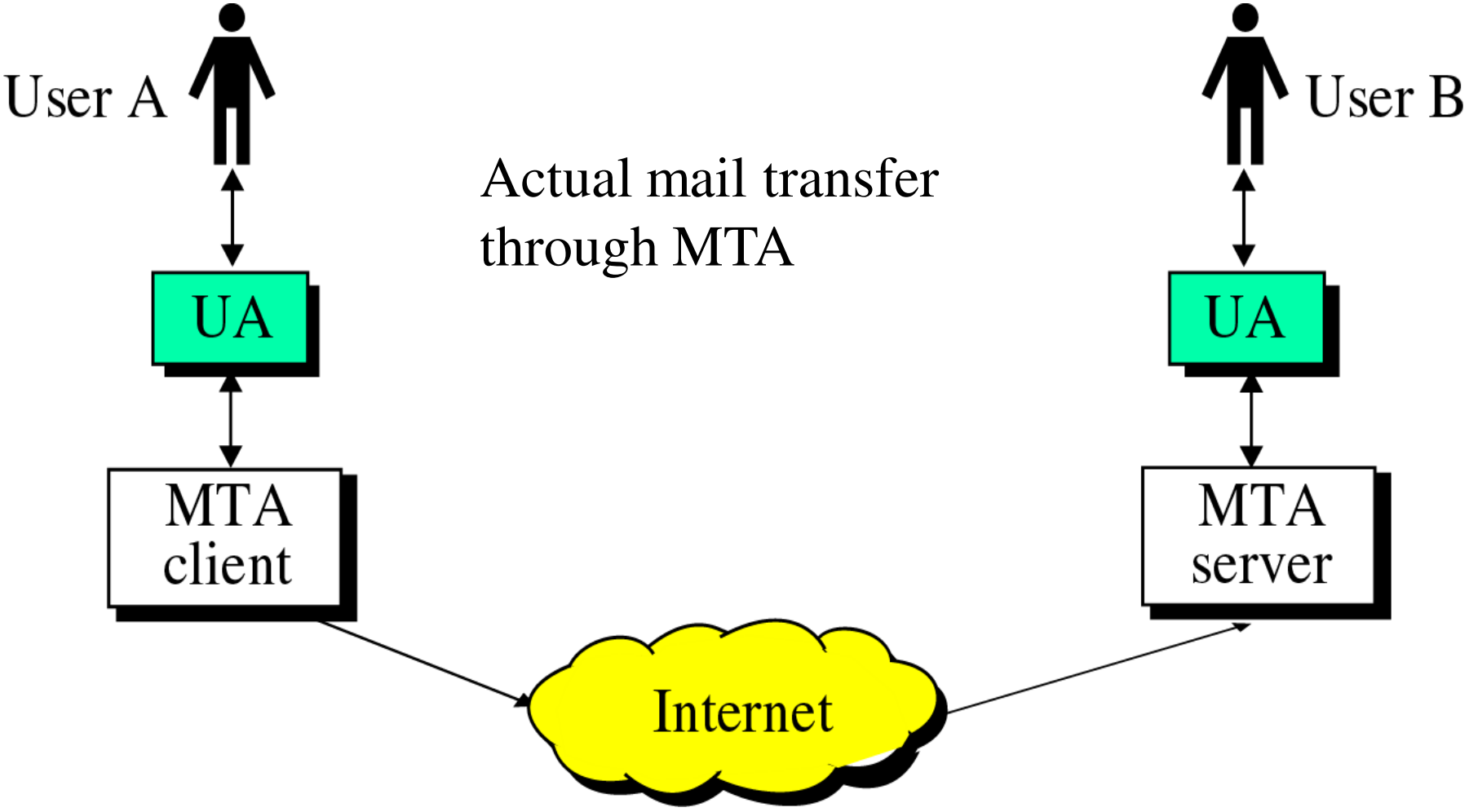
Architecture and Protocols

- A client-server architecture
  - *Email client* accepts mail and delivers to *email server* in destination domain
  - End-to-end delivery
  - *Store and forward* mechanism
- Simple Mail Transfer Protocol (SMTP)
  - TCP/IP
  - Delivery of simple text messages (7-bit ASCII format)
- Multi-purpose Internet Mail Extension (MIME)
  - An extension to SMTP → Delivery of other types of data (e.g., languages not supported by 7-bit ASCII, Voice, images, or video clips)

Client-Server Architecture



User Agent and Mail Transfer Agent



User Agent (UA)

- Software that does the following
  - *Composing messages*: provides a template to be filed
  - *Reading messages*: When UA is invoked, it checks for mail in the incoming mail box
  - *Replying to messages*
  - *Forwarding messages*
  - *Handles mailboxes:* Inbox, sent, and others
- Could be command-driven (pine or mail) or GUI-based (Eudora or Outlook)

Mail Transfer Phases

- Connection Establishment
  - SMTP client makes a TCP connection to well-known port 25
  - SMTP server starts the connection phase
- Message Transfer
- Connection Termination

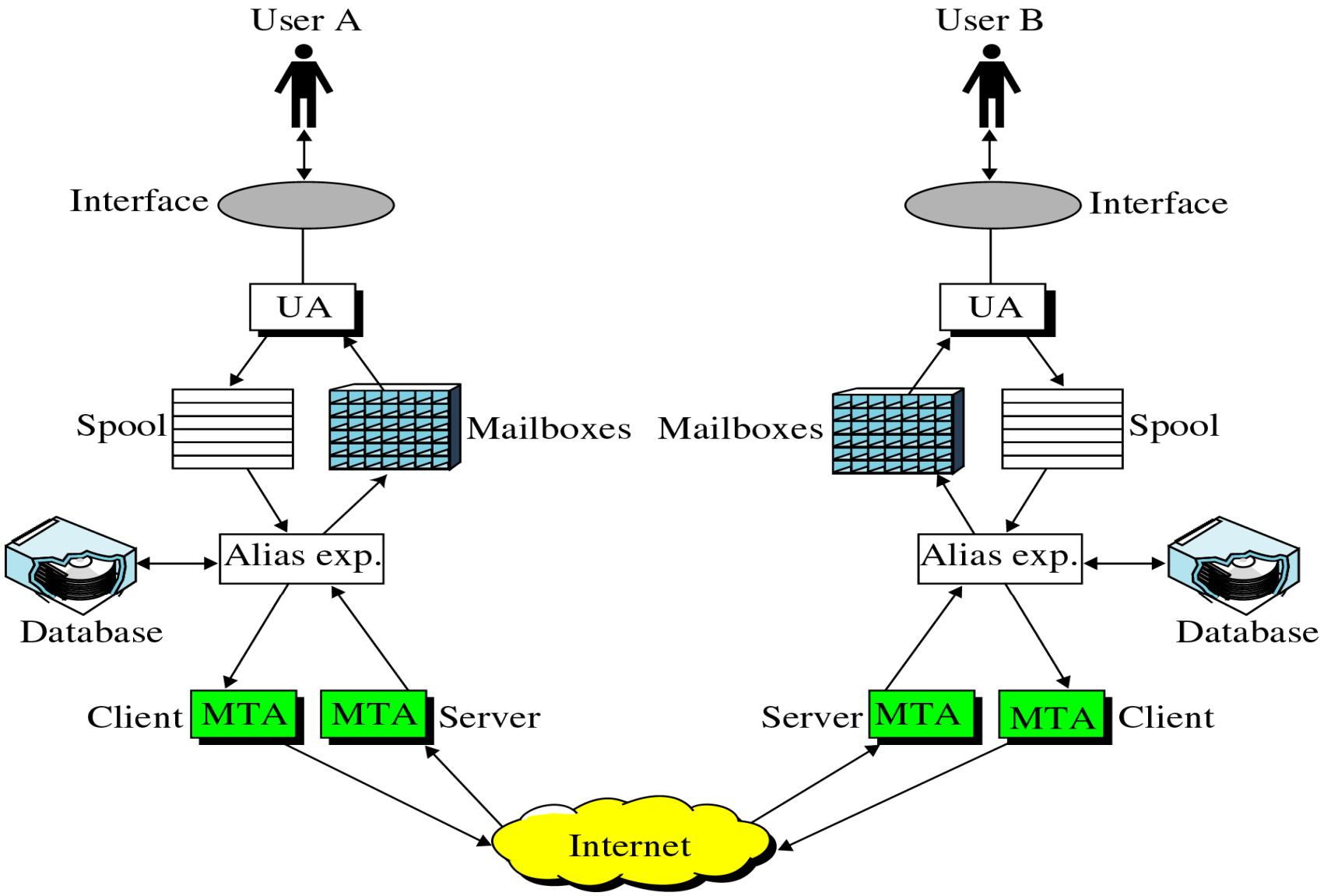
Mail Delivery From Sender to Receiver 1/3

- **Stage 1**
  - Email goes from UA to local server (MTA client)
  - Mail stored in local server until it can be sent (spooled)
  - UA uses SMTP client software and local server uses SMTP server software
  - Why not deliver email directly to remote server?
- **Stage 2**
  - Local MTA performs a DNS lookup to obtain the *mail exchange servers* for the destination domain

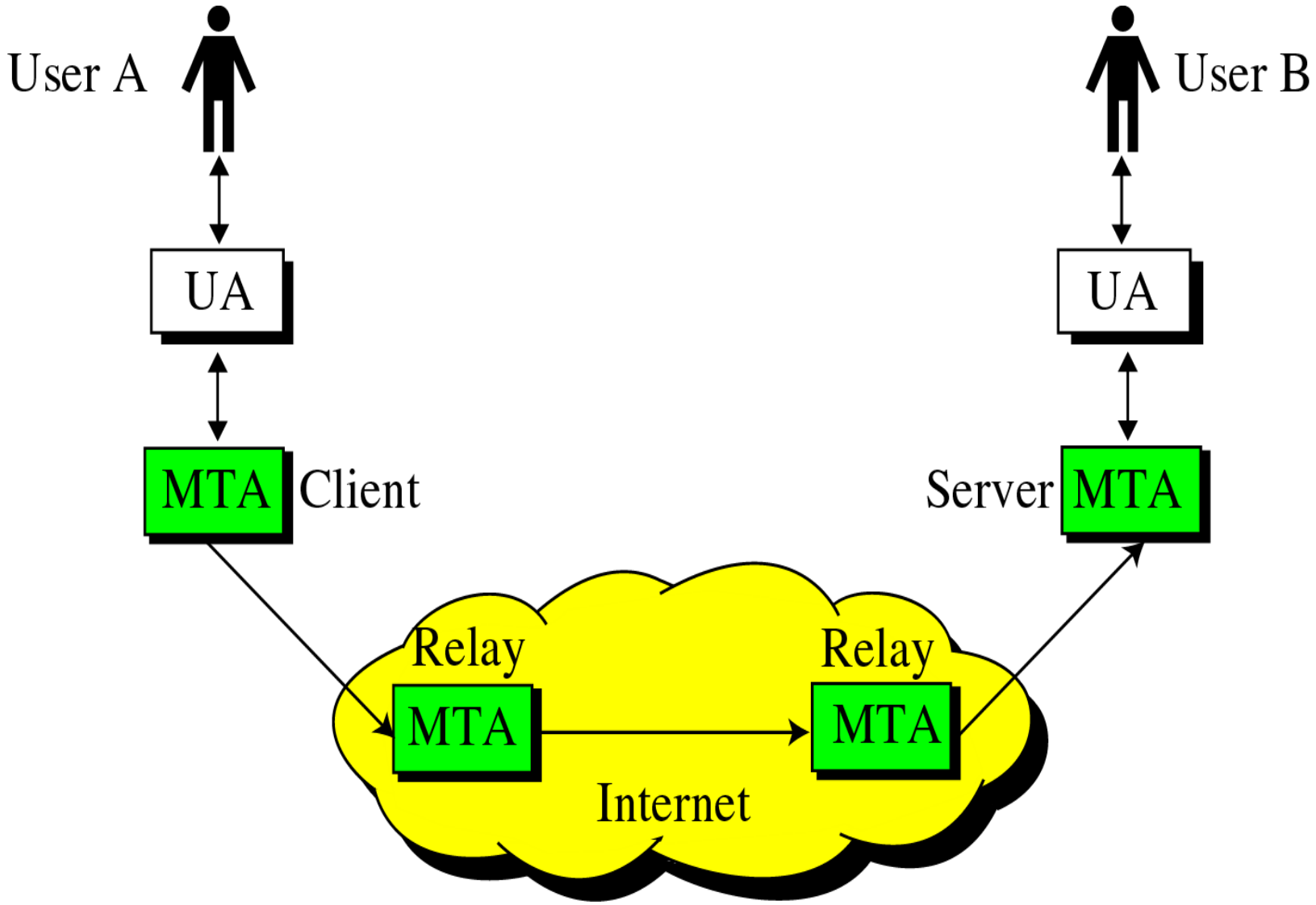
Mail Delivery From Sender to Receiver 2/3

- **Stage 3**
  - ➢*Push Operation*: local MTA (SMPT client) relays email to remote server (SMTP server) Why not deliver to remote UA?
  - ➢Email received by mail server and stored in the user mailbox for later retrieval
- **Stage 4**
  - ➢Remote UA employs a *mail access protocol* to access the mailbox and obtain her/his email (pull protocols)
    - ❑Post Office Protocol: POP3
    - ❑Internet Mail Access Protocol: IMAPv4

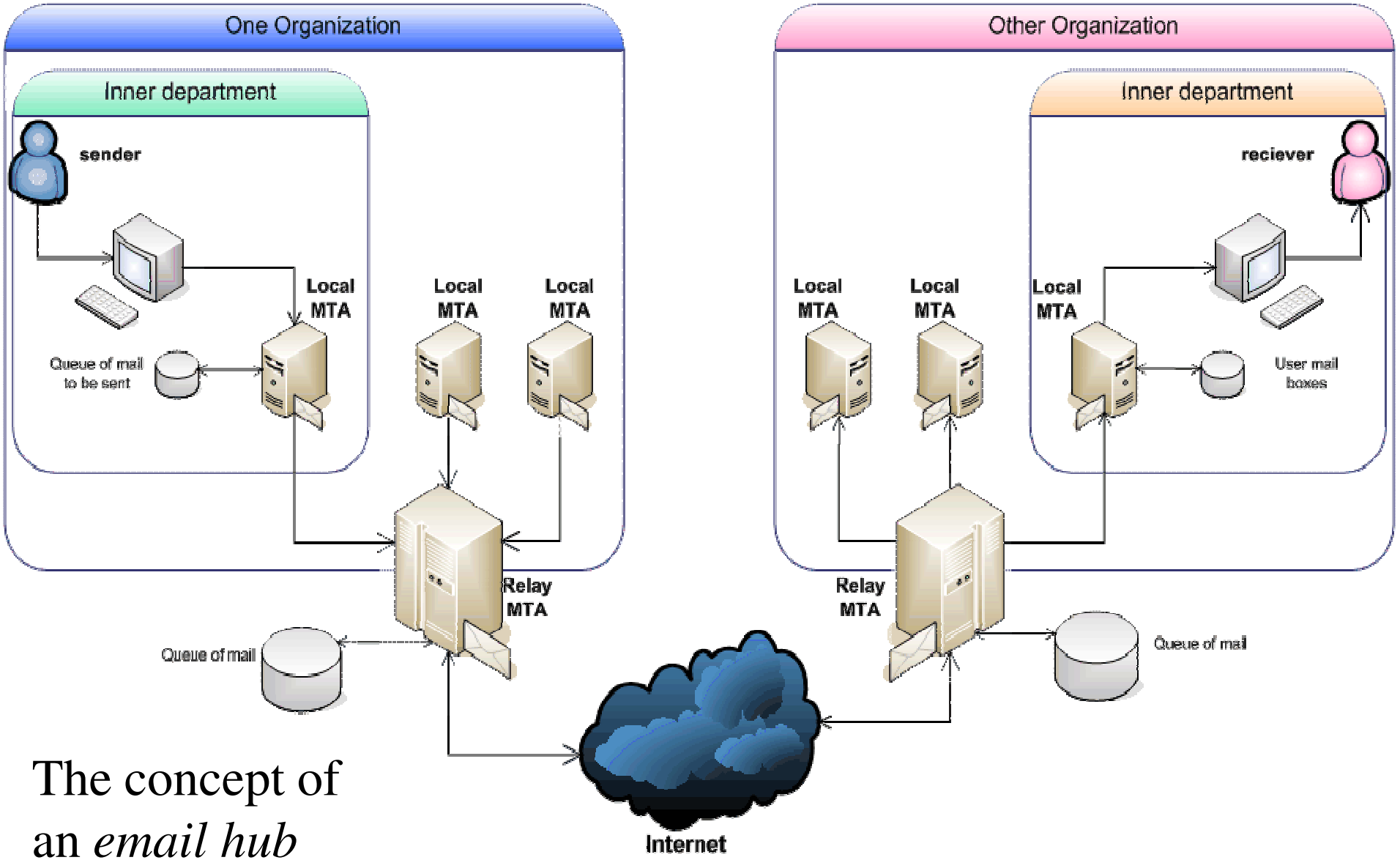
Mail Delivery From Sender to Receiver 3/3



Relay MTA 1/2



Relay MTA 2/2



The concept of an *email hub*

SMTP

SMTP Sequence of Events

- Source connects
- Target responds → 220 Ready for mail
- Source sends `HELO`
- Target responds with identification
- Source sends from and to fields
- Target accepts
- Source sends one or more messages
- Target closes connection when complete

Mail Message Contents

- Each queued message has:
  - Message text
    - header with message envelope and list of recipients
    - Message body, composed by user
  - A list of mail destinations
    - Derived by user agent from header
    - May be listed in header
    - May require expansion of mailing lists
    - May need replacement of mnemonic names with mailbox names

Mail Sending Optimization

- If message destined for multiple users on a given host, it is sent only once
  - Delivery to users handled at destination host
- If multiple messages ready for given host, a single TCP connection can be used
  - Saves overhead of setting up and dropping connection

Possible Errors

- Host unreachable
- Host out of operation
- TCP connection fail during transfer
- Sender can re-queue mail
  - ➢Give up after a period
- Faulty destination address
  - ➢User error

SMTP Receiver

- Accepts arriving message
- Places in user mailbox or copies to outgoing queue for forwarding
- Receiver must:
  - Verify local mail destinations
  - Deal with errors
    - Transmission
    - Lack of disk space
- Sender responsible for message until receiver confirm complete transfer
  - Indicates mail has arrived at host, not user

E-mail Headers

- Lines of text in format *keyword: information*
- *keyword* identifies information; information can appear in any order
- Essential information:
  - To: list of recipients
  - From: sender
  - Cc: list of copy recipients
- Useful information
  - Reply-to: different address than From:
  - Received-by: for debugging

Data in Email

- Original Internet mail carried only 7-bit ASCII data
  - Couldn't contain arbitrary binary values; e.g., executable program
  - Can not be used for languages that are not supported by 7-bit ASCII (e.g., French, German, Chinese, and Japanese)

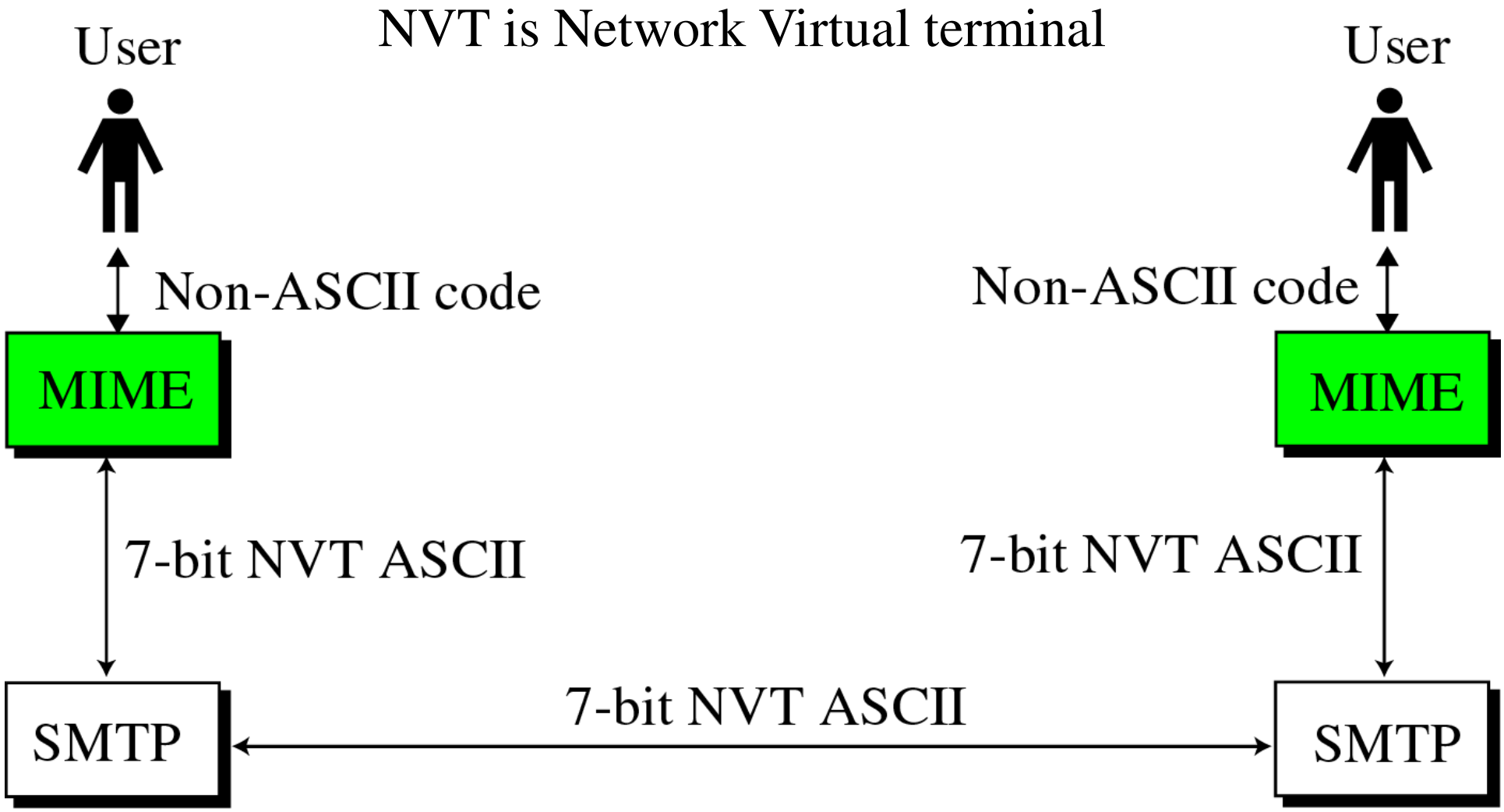
MIME

(Multipurpose Internet Mail Extensions)

MIME Introduction

- Transforms non-ASCII data at sender site to ASCII data and delivers to client SMTP
- Server SMTP at receiving side receives ASCII data and delivers to MIME
- MIME at receiver transforms to original data

MIME: From Non-ASCII to ASCII



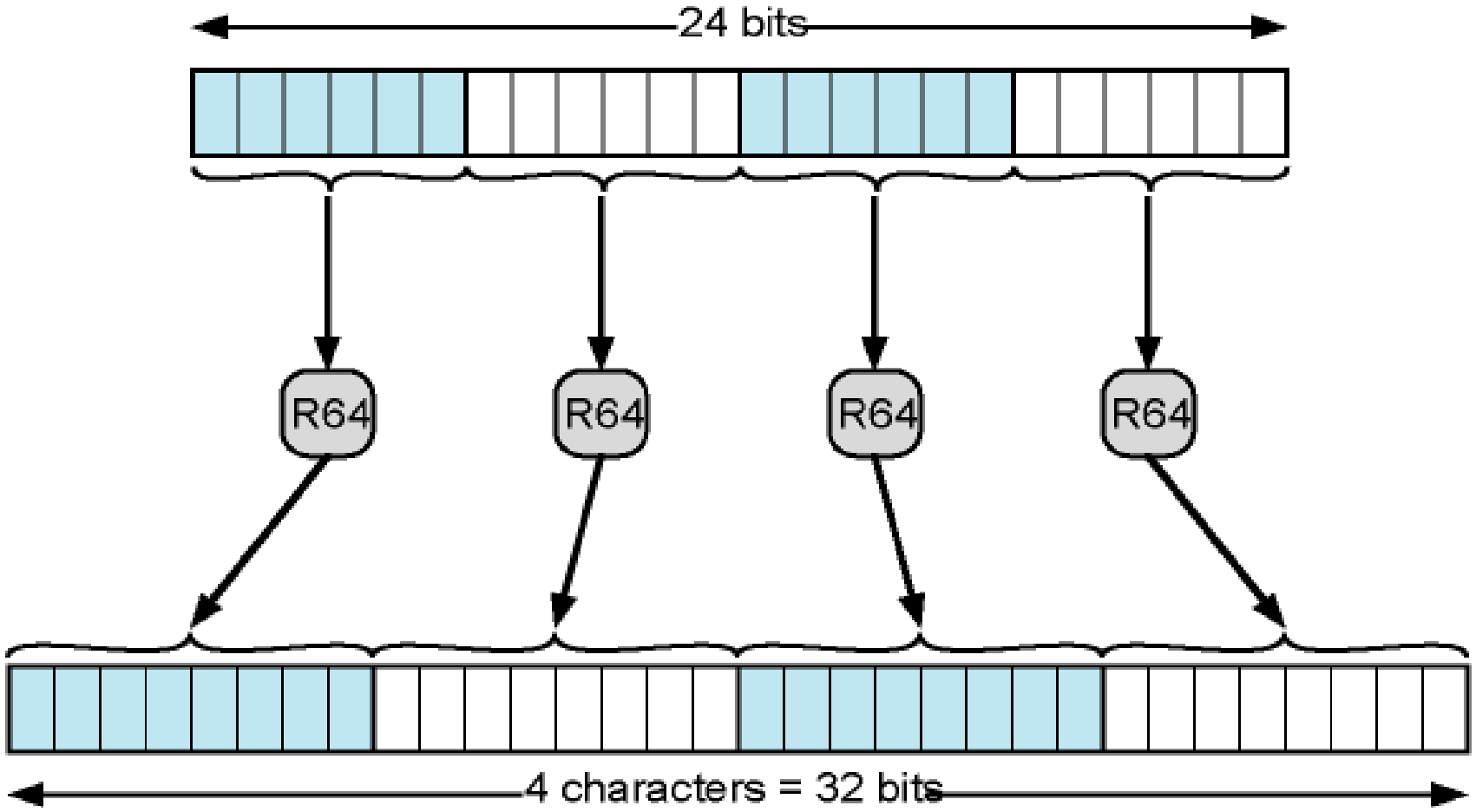
MIME Headers 1/3

- 5 headers can be added to original SMTP header to define transformation parameters
  - MIME-version: 1.0 or 1.1
  - Content-Type
    - Type of data used in body of message
    - Content-Type: <type /subtype/parameters>
    - Text (plain), Multipart, Message, Image, Video, Audio, and Application

MIME Headers 2/3

- 5 headers can be added to original SMTP header to define transformation parameters
  - Content-Transfer Encoding
    - 7bit, 8bit, Binary, Base64 (6-bit blocks encoded into 8-bit ASCII characters), and Quoted-printable (Non-ASCII characters encoded as an equal sign followed by an ASCII code. ASCII is sent as is)
  - Content-Id
    - Identify whole message in a multiple message environment
  - Content-Description

MIME Headers 3/3



Binary data into Radix-64 format

A Base 64 encoding table is used to interpret 6-bit into one char

Mail Access Protocols

- POP3
- IMAPv4
- Web-based email

POP3

- Client POP3 installed on recipient computer
- Server POP3 installed on main server
- User needs to download email from mailbox on the mail server
- UA opens a connection with server on TCP port 110
- Sends user name and password
- User can list and retrieve messages
- Delete and keep mode

IMAP4

- POP3 does not allow user to organize mail on server (user can not have different folders on server)
- POP3 does not allow user to partially check the contents of the mail before downloading
- IMAP offers the following
  - User checks email header prior to downloading
  - User can search contents of email for a search string before downloading
  - User can create, delete, or rename mailboxes on mail server
  - User can create folders for email storage

Web-based Email

- Mail transfer from User browser to mail server performed through HTTP
- Transfer of message from sending mail server to receiving mail server through SMTP
- Message from receiving server to recipient's browser performed through HTTP
- Need for Webmail software

Further Information

- RFC 821: Simple Mail Transfer Protocol, August 1982
- RFC 822, ARPA Internet Text Messages, August 1982
- RFC 1521: MIME – Part 1, September 1993
- RFC 1522: MIME-Part 2, September 1993
- RFC 1939: POP3, May 1996
- RFC 3501, IMAP4, March 2003