Email – Electronic Mail

Electronic mail paradigm

Most heavily used application on any network

Electronic version of paper-based office memo

Quick, low-overhead written communication

Dates back to time-sharing systems, in 1960s

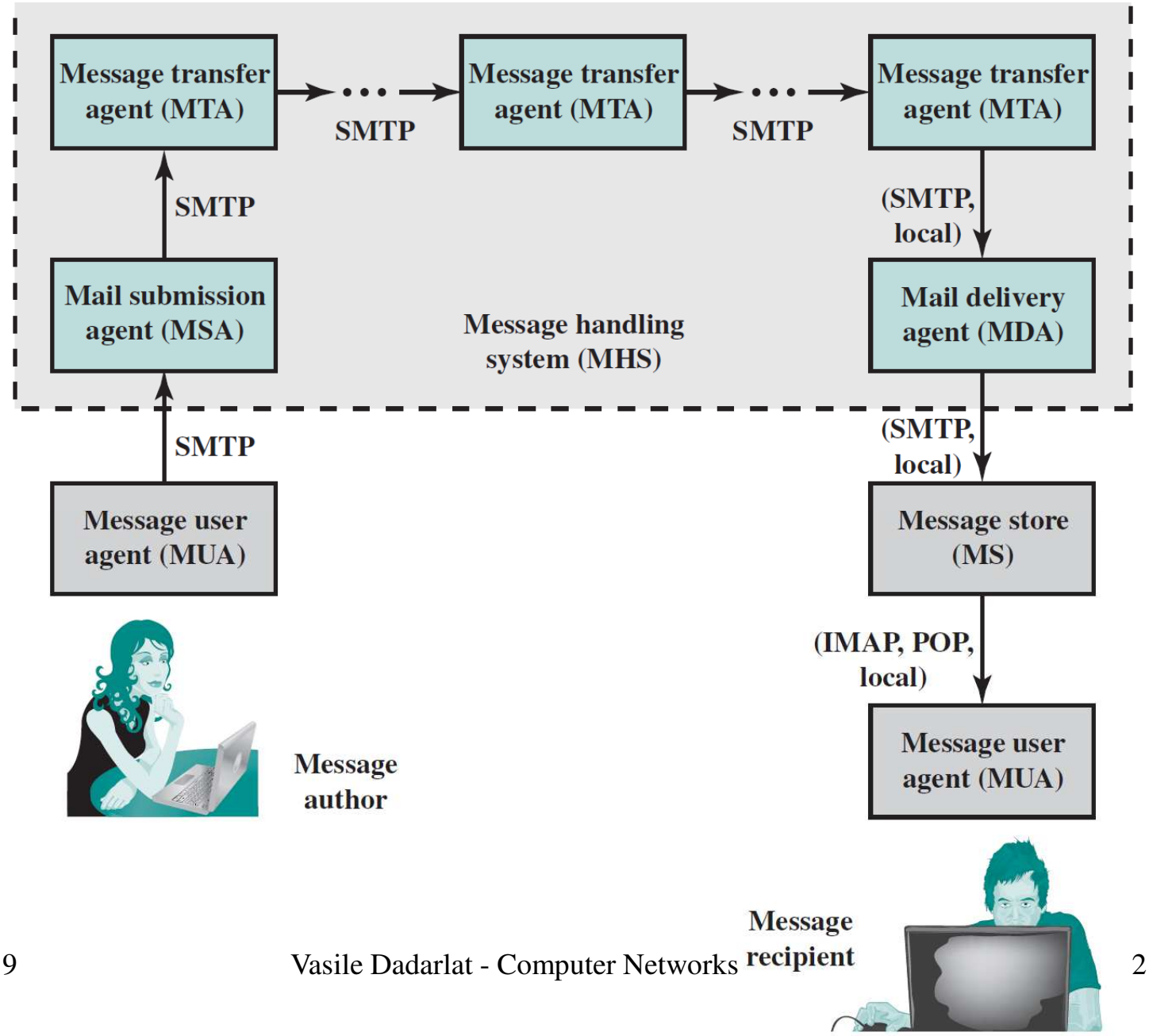
Because e-mail is encoded in an electronic medium, new forms of interaction are possible

Automatic processing - sorting, reply

Can carry other content: if basic **Simple Mail Transfer Protocol** (SMTP), based on TCP/IP, was delivering only simple text messages, by use of **Multi-purpose Internet Mail Extension** (MIME) now have delivery of other types of data (voice, images, video clips,…)

History: first standard: CCITT X.400 - too complex; base for OSI's MOTIS application; replaced by TCP/IP based standards RFC 821(transmission protocol), and RFC 822 (message format)

Email Architecture RFC 5598 (*Internet Mail Architecture*)



Email Architecture - components

Message User Agent (MUA)

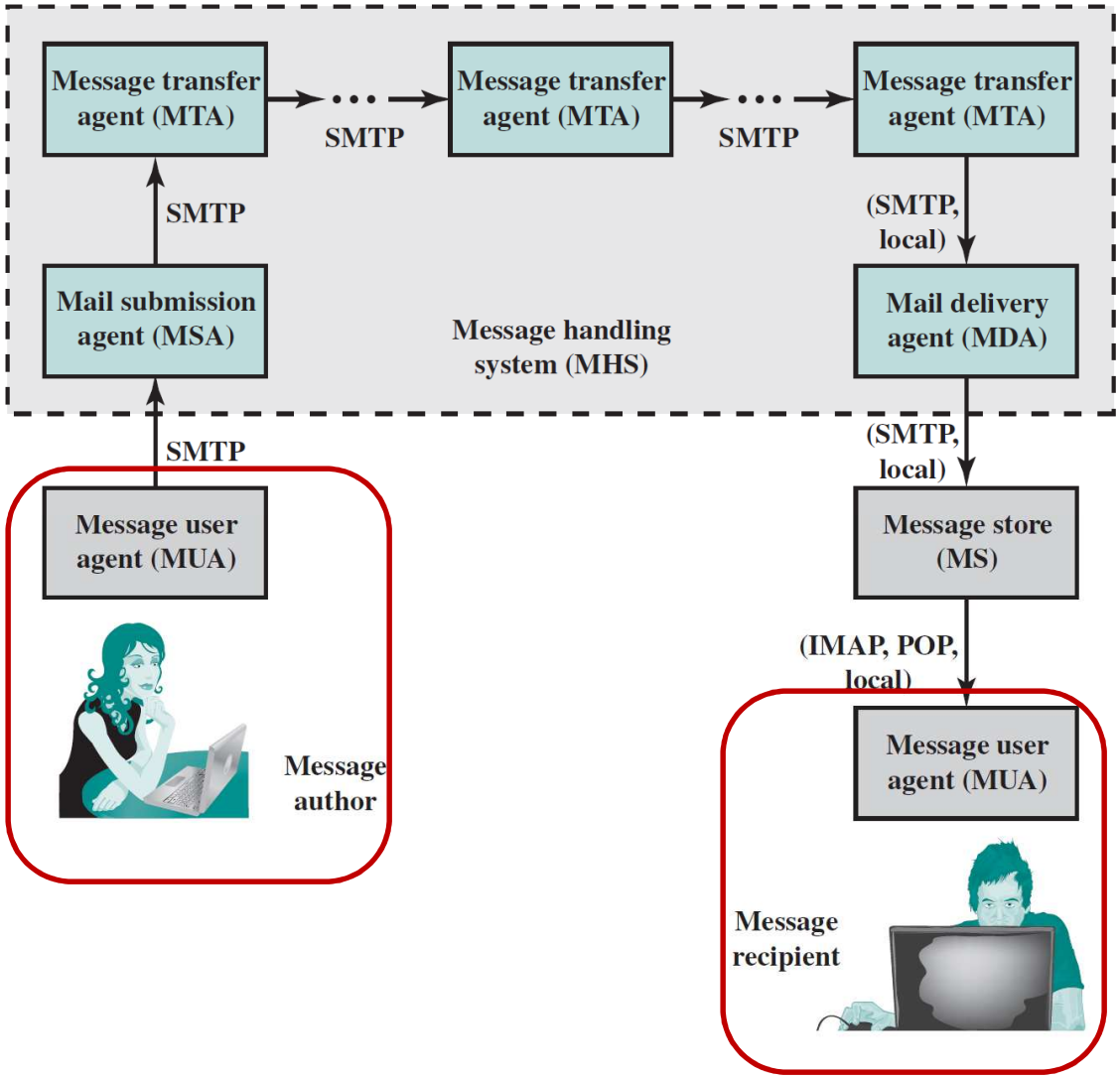
–on behalf of user actors and user applications

–client e-mail program or a local network e-mail server

–sender MUA: formats a message and performs initial submission into the MHS via an MSA

–receiver MUA: processes receive mail for storage and/or display

–Thunderbird, Outlook, Opera Mail, Mailbird, etc



Email Architecture - components

Message Handling Service (MHS)

Mail Submission Agent (MSA)

–accepts messages from MUA

–enforces the policies of the hosting domain and the requirements of Internet standards

–Simple Mail Transfer Protocol (SMTP) is used between the MUA and the MSA.

Message Transfer Agent (MTA)

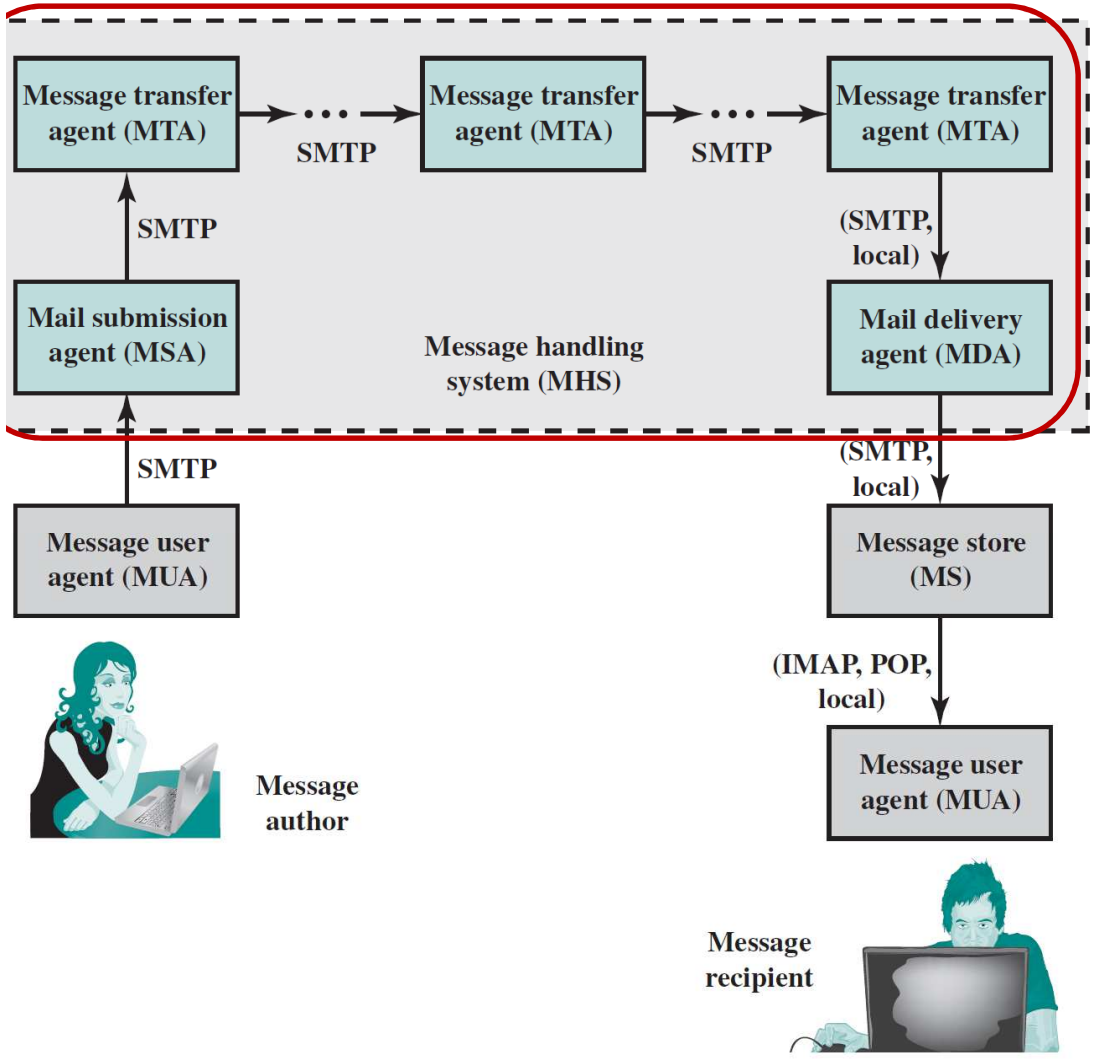
–Relays mail for one application-level hop

–SMTP is used between MTAs

–client: the sending mail server, server: receiving mail server

Mail Delivery Agent (MDA)

–transfers messages from the MHS to the MS



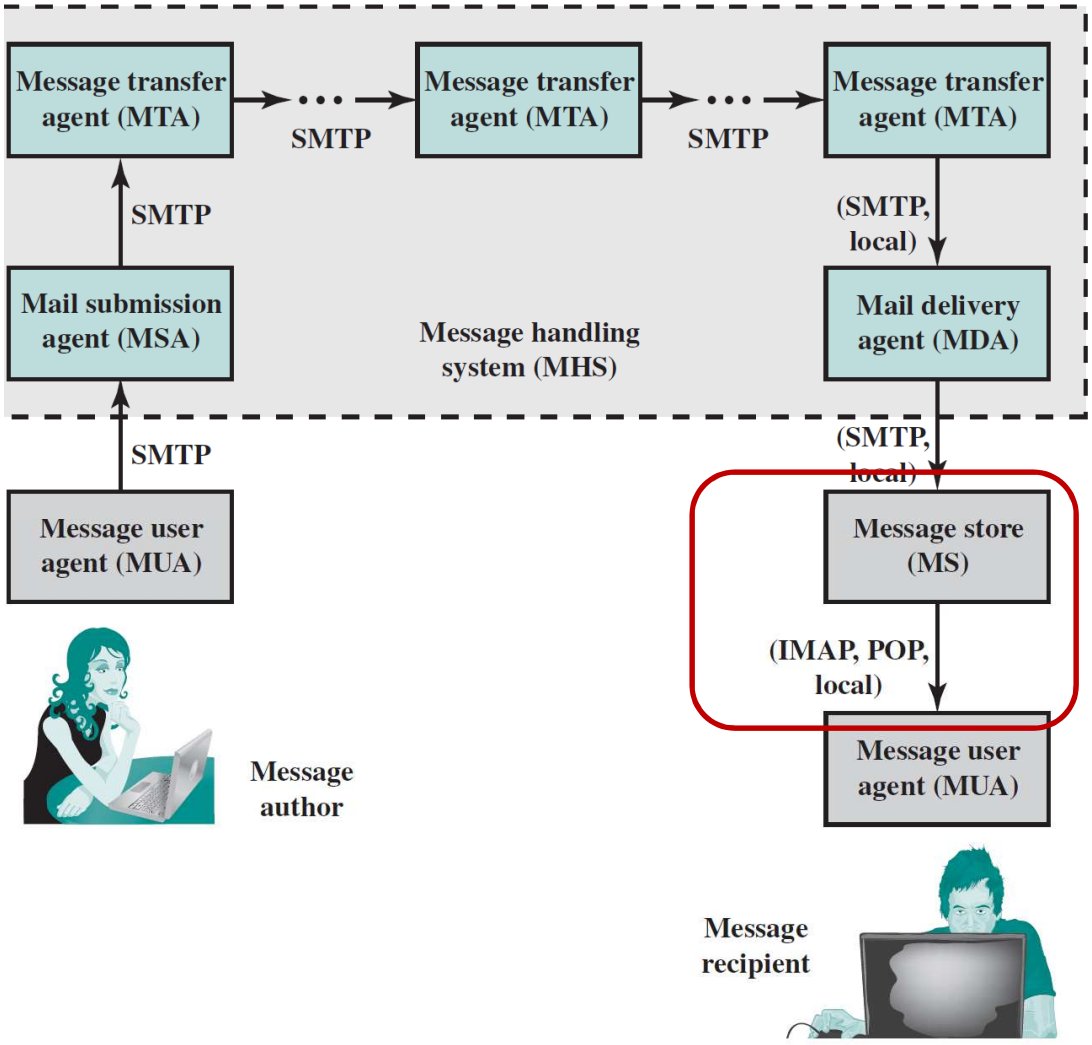
Email Architecture - components

Message Store (MS)

–located on a remote server or on the same machine as the MUA

–retrieve message from remote server using:

–POP (Post Office Protocol) or IMAP (Internet Message Access Protocol).



Post Office Protocol (POP) and Internet Message Access Protocol (IMAP)

Role: message user agent (MUA) retrives mail from message store (MS)

POP version 3 - RFC 1939; connection to server using TCP on port 110

- *Authentication state*: user ID/password or more sophisticated methods
- *Transaction state*: the client can access the mailbox to retrieve and delete messages
- *Update state*: the server passes all of the changes requested by the client's commands and then closes the connection

IMAP version 4 - RFC 3501; connection to server using TCP on port 143 or 993 over SSL

provides more functionality than POP3

Clients can:

- have multiple remote mailboxes
- specify criteria for downloading messages
- make changes both when connected and when disconnected (periodic re-synchronization)
- IMAP ***always*** keeps messages on the server and replicates copies to the clients

Email Architecture - components

Other components

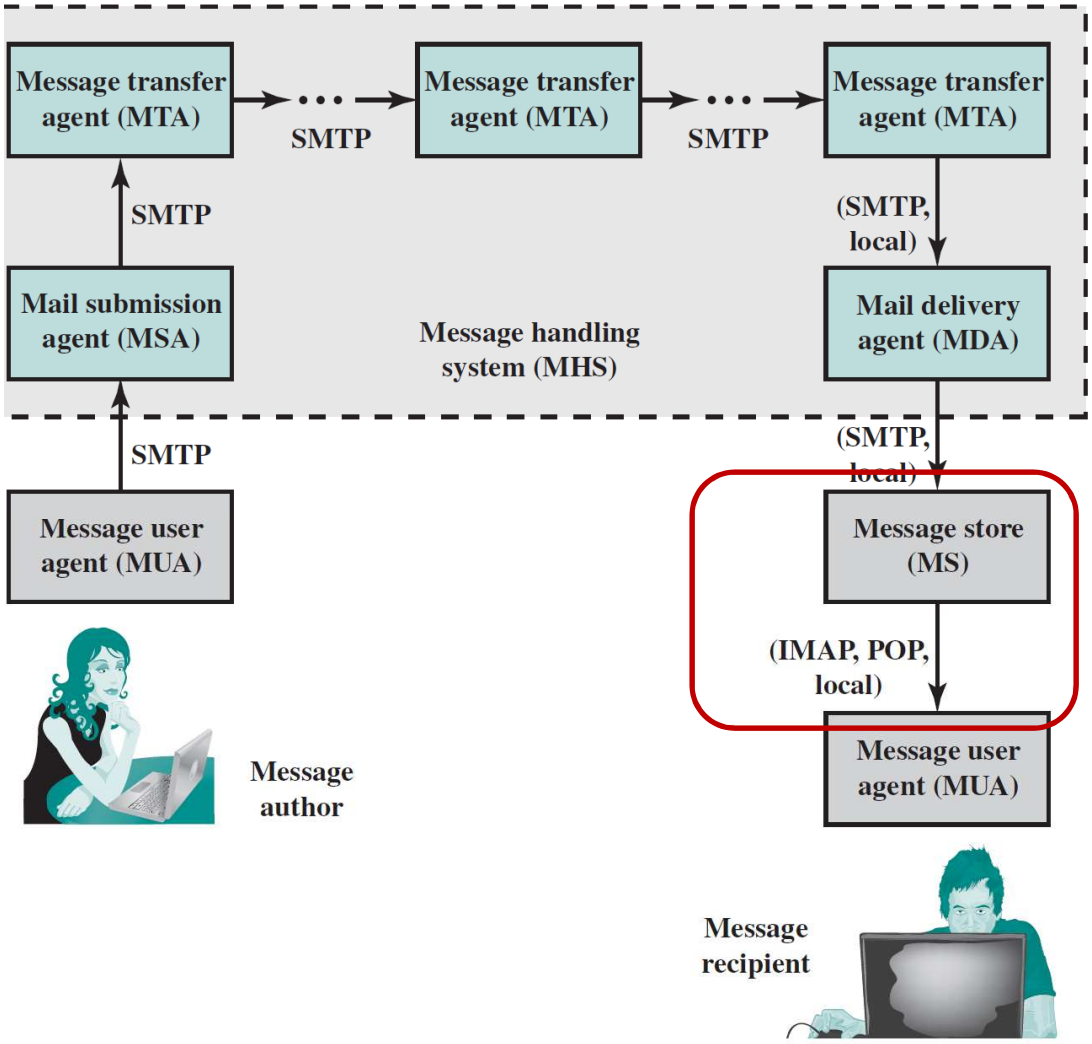
Internet e-mail provider named also Administrative management domain (ADMD)

–examples:

–IT department that operates a mail relay (local or enterprise)

–an ISP that operates a public shared e-mail service

Domain name system (DNS)



Mailbox: Electronic mailbox

E-mail users have an *electronic mailbox* into which incoming mail is deposited; identified by an *e-mail address*

User then accesses mail with a mail reader program

Usually associated with computer account (user's account ID); one user may have different electronic mailboxes

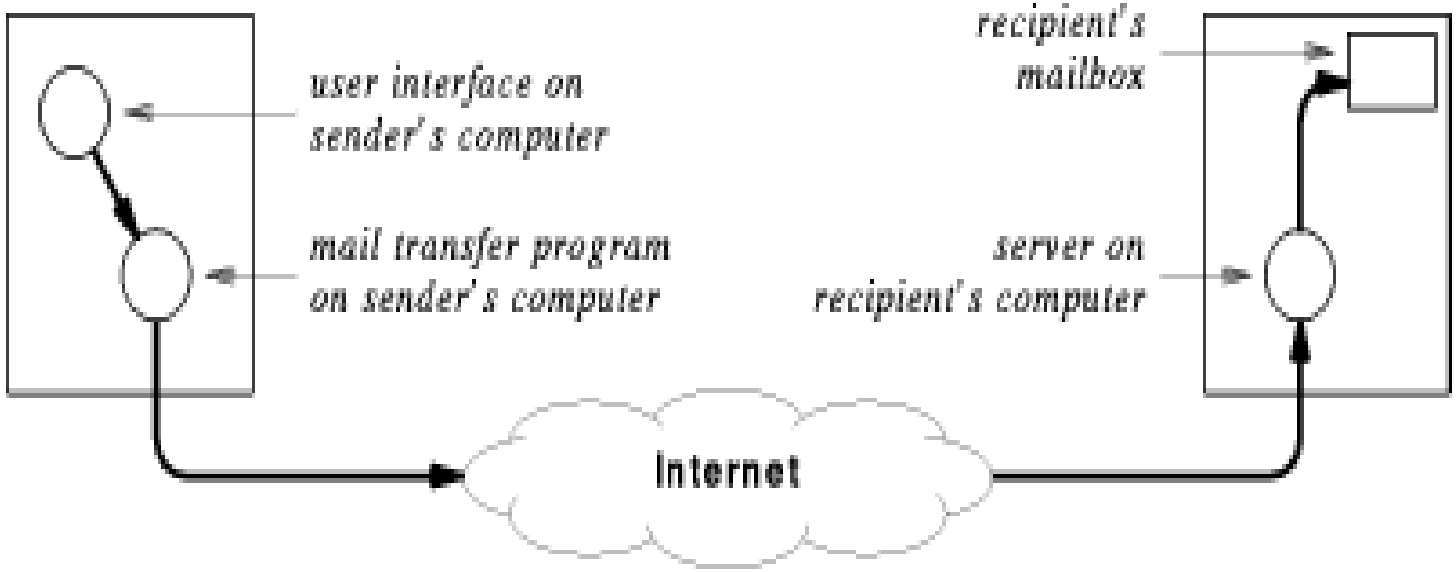
On networked multi-user computer, need to identify computer as well as *mailbox* :

e-mail address is composed of computer name and mailbox name

Mail transfer

- E-mail communication is really a two-part process:
  - User composes mail with an *e-mail interface* program
  - *Mail transfer* program delivers mail to destination
    - Waits for mail to be placed in outgoing message queues
    - Picks up message and determines recipient(s)
    - Becomes *client* and contacts *server* on recipient's computer
    - Passes message to server for delivery

Mail Transfer Illustration



Simple Mail Transfer Protocol (SMTP) is the standard application protocol for delivery of mail from source to destination (RFC 821)

•Provides reliable delivery of messages

•Uses TCP well-known port 25 for message exchange between client and server

•Command/Response interaction:

commands: ASCII text (message character set as 7-bit ASCII)

response: status code and phrase

Other functions:

E-mail address lookup & address verification

General characteristics

Three phases of transfer: handshaking, mail transfer, closure

Attempts to provide reliable service

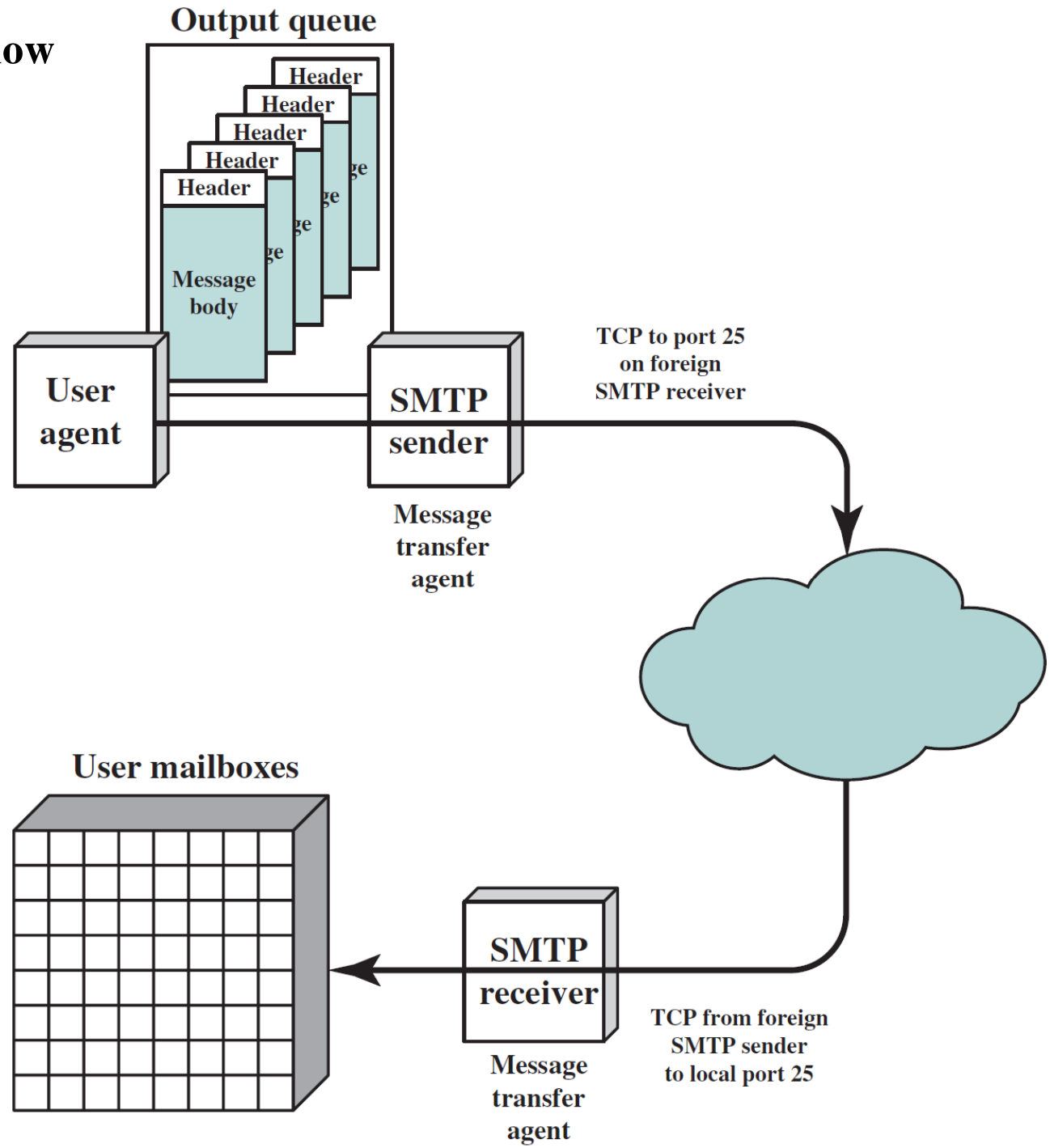
No guarantee to recover lost messages

No end to end acknowledgement to originator

Error indication delivery not guaranteed

Generally considered reliable!

SMTP Mail Flow



Mail Message Contents

Each queued message has in composition:

- Message text
  - RFC 822 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

If Blind Carbon Copies (BCC) indicated, user agent needs to prepare correct message format

SMTP Sender

Takes message from queue

Transmits to proper destination host

- Via SMTP transaction
- Over one or more TCP connections to port 25

Host may have multiple senders active

Host should be able to create receivers on demand

When delivery complete, sender deletes destination from list for that message

When all destinations processed, message is deleted

- 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
- Target user changed address
- Redirect if possible
- Inform user if not delivered

SMTP Protocol - Reliability

Used to transfer messages from sender to receiver over TCP connection

Attempts to provide reliable service

No guarantee to recover lost messages

No end to end acknowledgement to originator

Error indication delivery not guaranteed

Generally considered reliable!

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

SMTP Forwarding

Mostly direct transfer from sender host to receiver host

May go through intermediate machine via forwarding capability

- Sender can specify route
- Target user may have moved

Format for Text Messages
RFC 882

Message viewed as having envelope and contents

Envelope contains information required to transmit and deliver message

Message is sequence of lines of text

- Uses general memo framework
- Header usually keyword followed by colon followed by arguments

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

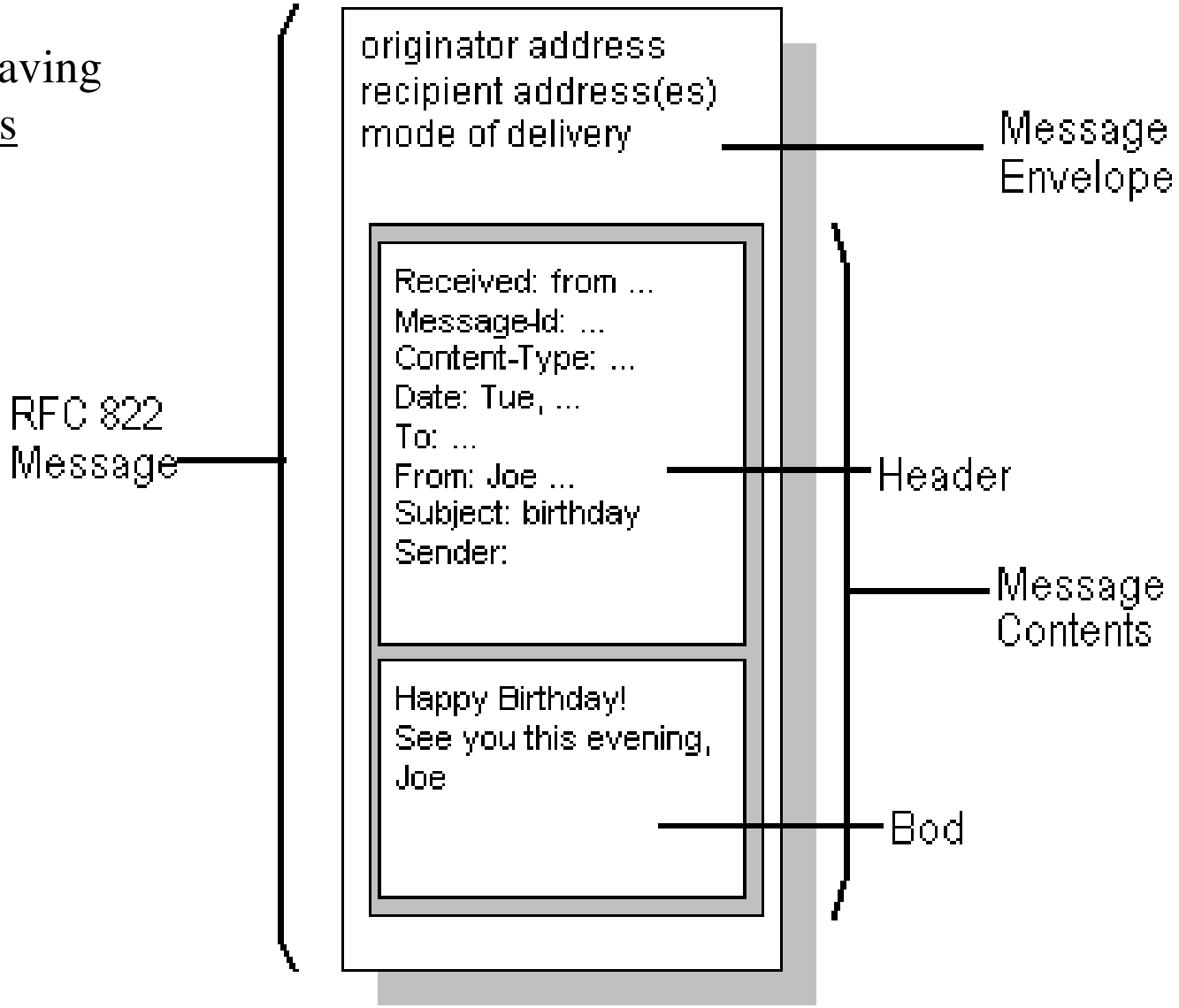
RFC 822 header fields related to message transport.

Header	Meaning
Date:	The date and time the message was sent
Reply-To:	Email address to which replies should be sent
Message-Id:	Unique number for referencing this message later
In-Reply-To:	Message-Id of the message to which this is a reply
References:	Other relevant Message-Ids
Keywords:	User chosen keywords
Subject:	Short summary of the message for the one-line display

Some fields used in the RFC 822 message header.

Format for Text Messages
RFC 882

Message viewed as having envelope and contents



Multipurpose Internet Mail Extension (MIME)

Extension to RFC 822 for message format; given in RFC 2045, 2056

Additional lines in message header declare MIME content type

Five new message header fields

MIME version

Content type

Content transfer encoding

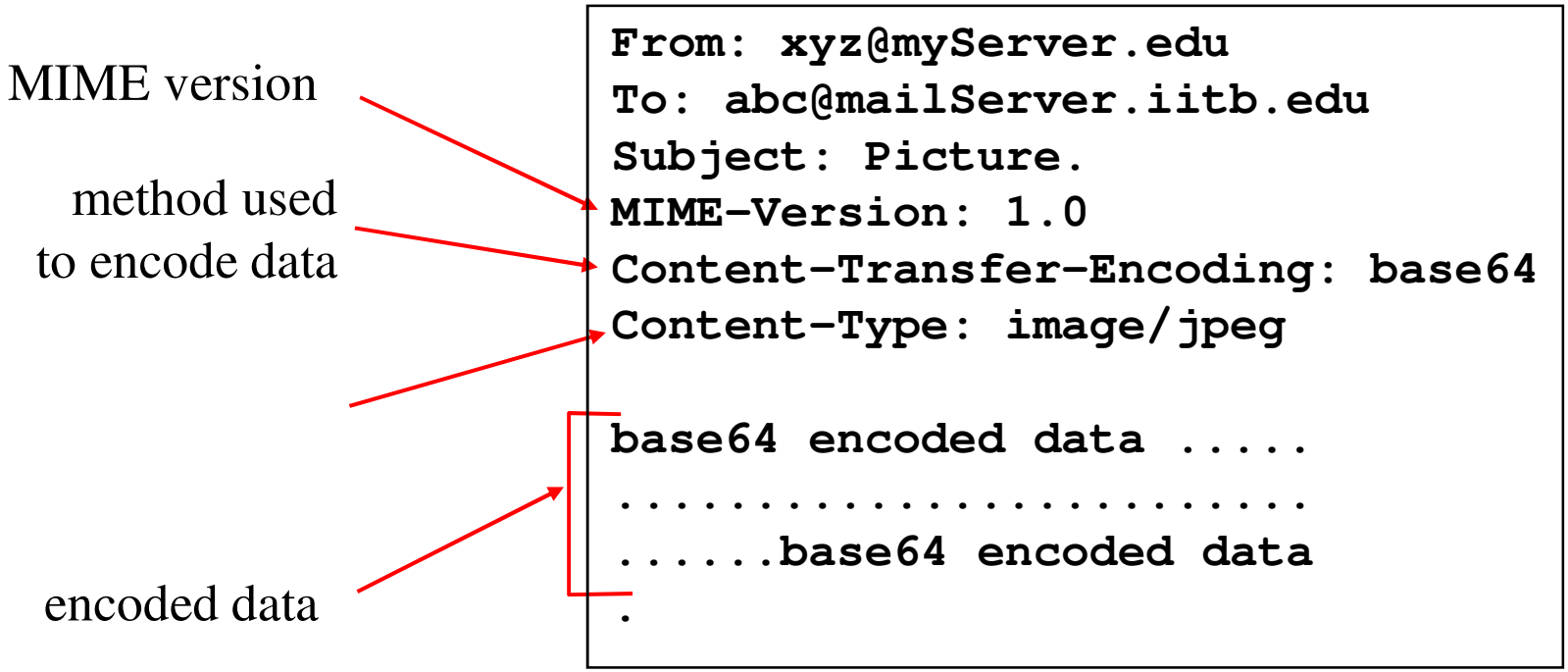
Content Description

Content Id

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:	Nature of the message

RFC 822 headers added by MIME.

Message Format: Multimedia Extensions



•Extends and automates encoding mechanisms - *Multipart Internet Mail Extensions*

•Allows inclusion of separate components - programs, pictures, audio clips - in a single mail message (see next table)

•Sending program identifies the components, so receiving program can automatically extract and inform mail recipient

•Separator line gives information about specific encoding

•MIME is extensible - sender and receiver agree on encoding scheme

•MIME is compatible with existing mail systems

•Everything encoded as ASCII

•Headers and separators ignored by non-MIME mail systems

•MIME *encapsulates* binary data in ASCII mail envelope

MIME Content Types

Type	Subtype	Description
Text	Plain	Unformatted text; may be ASCII or ISO 8859.
Multipart	Mixed	The different parts are independent but are to be transmitted together. They should be presented to the receiver in the order that they appear in the mail message.
	Parallel	Differs from Mixed only in that no order is defined for delivering the parts to the receiver.
	Alternative	The different parts are alternative versions of the same information. They are ordered in increasing faithfulness to the original and the recipient's mail system should display the "best" version to the user.
	Digest	Similar to Mixed, but the default type/subtype of each part is message/rfc822
Message	rfc822	The body is itself an encapsulated message that conforms to RFC 822.
	Partial	Used to allow fragmentation of large mail items, in a way that is transparent to the recipient.
	External-body	Contains a pointer to an object that exists elsewhere.
Image	jpeg	The image is in JPEG format, JFIF encoding.
	gif	The image is in GIF format.
Video	mpeg	MPEG format.
Audio	Basic	Single-channel 8-bit ISDN mu-law encoding at a sample rate of 8 kHz.
Application	PostScript	Adobe Postscript.
	octet-stream	General binary data consisting of 8-bit bytes.

MIME Transfer Encodings

Reliable delivery across large range of environments

Content transfer encoding field takes on six values (see next table):

Three of them (7bit, 8bit, binary): no encoding done

Provide some info about nature of data

SMTP transfer uses 7bit form

Quoted-printable

Data contains largely printable ASCII characters

Non-printing characters represented by hex code

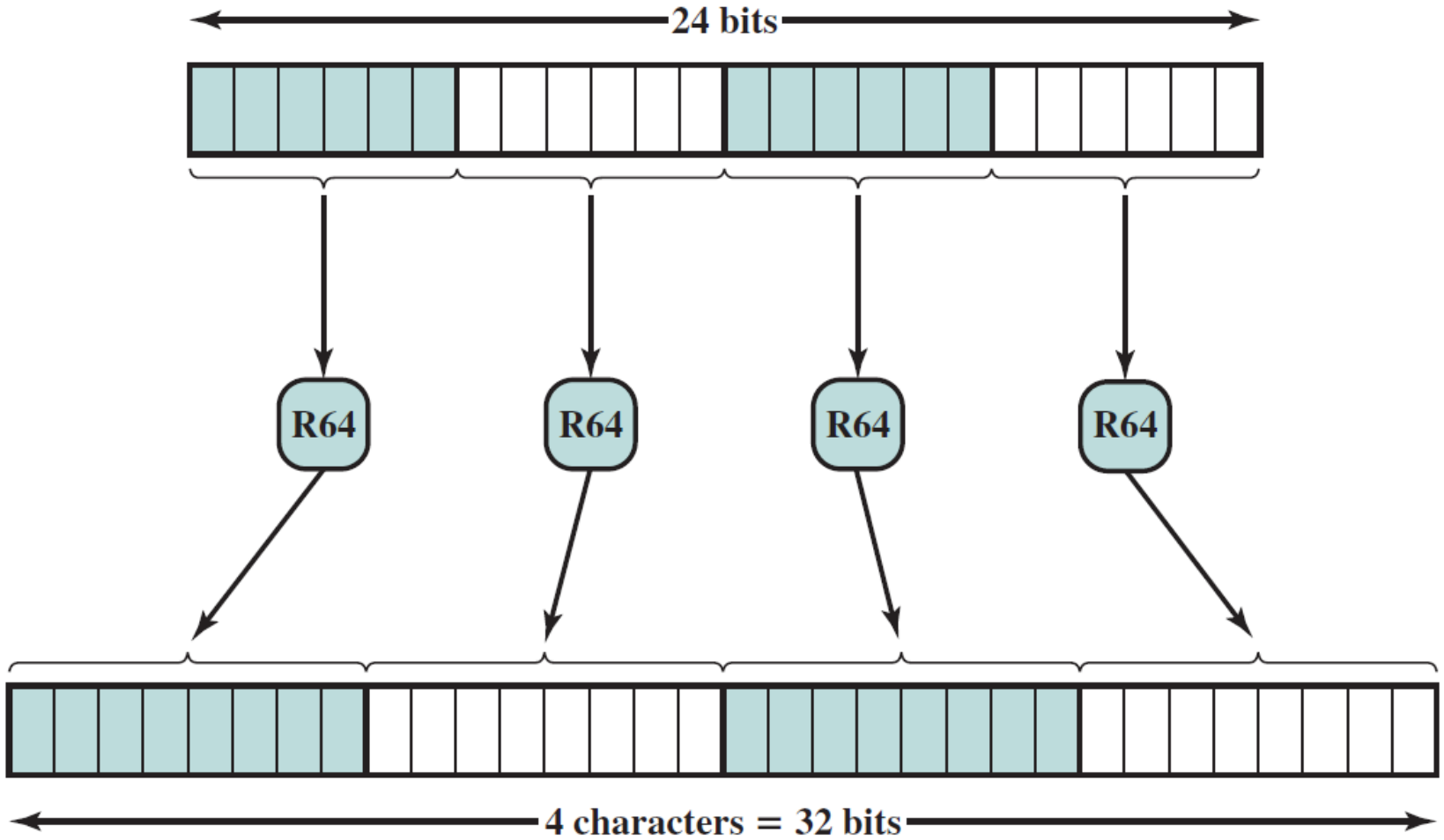
Base64 (Radix-64 Encoding)

Maps arbitrary binary input (6 bits) onto printable output 8 bit characters

X-token

Named nonstandard encoding

MIME Transfer Encodings



Binary data to Base64 encoding scheme