Email Basics

BUPT/QMUL

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Electronic Engineering

Agenda

- Brief introduction to email
- Components of email system
- Email Standards
- Summary

Brief Introduction To Email

What is Email?

- Electronic Mail (email, e-mail)
- Provides a means to send electronic messages from one person to another asynchronously
- One of the most popular applications on the Internet and one of the most important communication methods today
  - Email Poisoning Syndrome
  - Incurs face-to-face communication impediment
- Email service can be provided by
  - ISPs: @126.com, @163.com, @sina.com, yahoo.cn, …
  - Corporations and institutes: @baidu.com, @bupt.edu.cn, @ietf.org, …
  - Bundled with other services: @139.com, @qq.com, …

History Of Email

ARPANET → Internet

1971	1982	1984-1988	1988	1988	1993	1996	1996	…
the first email in the world	RFC 821(SMTP) RFC 822	X.400 MOTIS	Eudora	POP IMAP	MIME	Outlook	Free emails	…
Ray Tomlinson	IETF	CCITT ISO	Steve Dorner	IETF	IETF	Microsoft	Hotmail etc.	…

Trends:

- Multiple data types other than text
- More Users
- More space, larger attachment
- Will email be replaced by Instant Messaging?

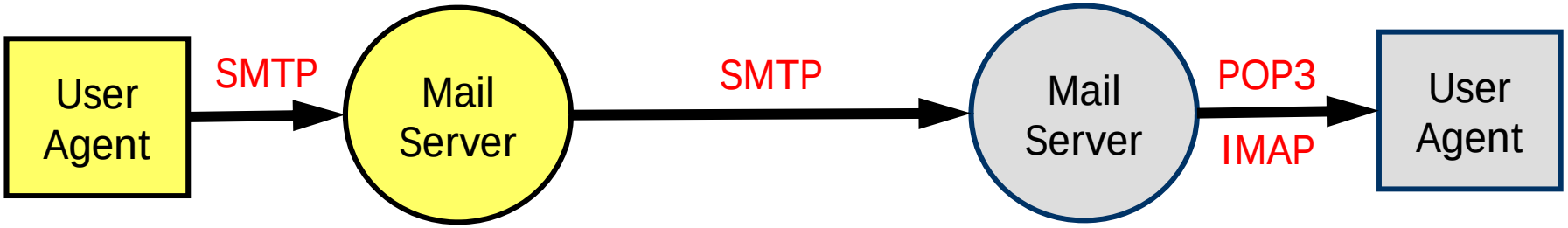
Newest development:

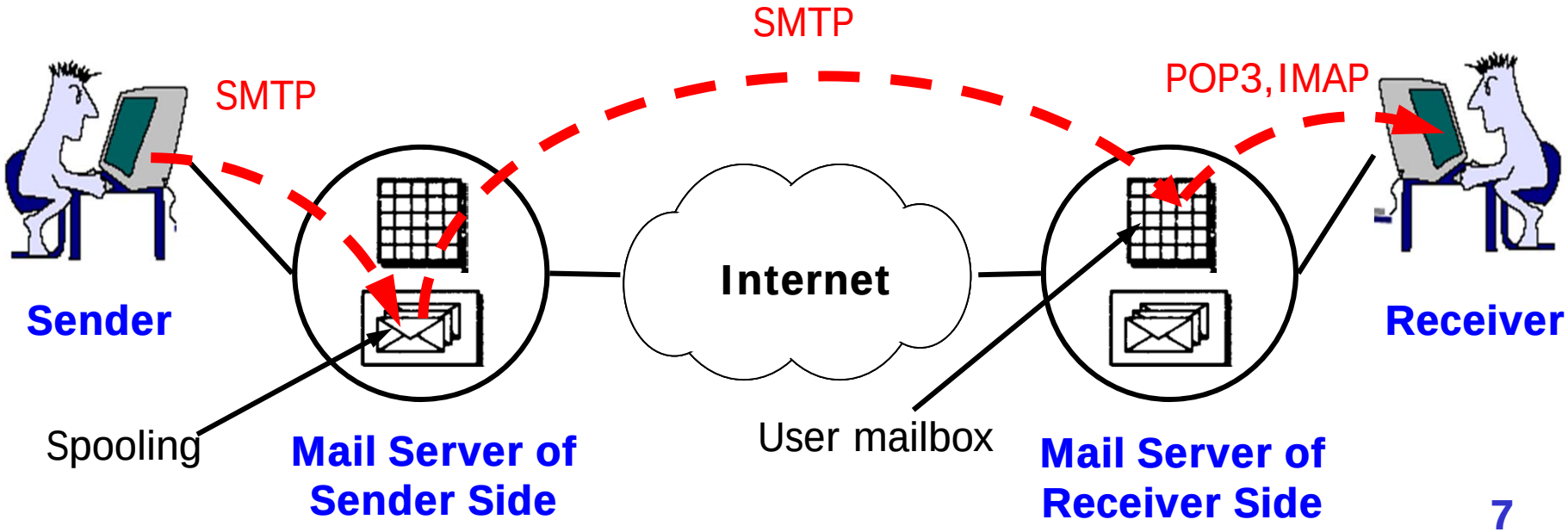
Oct. 2008

- RFC 5321 Simple Mail Transfer Protocol
- RFC 5322 Internet Message Format

Components Of Email System

Components Of Email System (1)

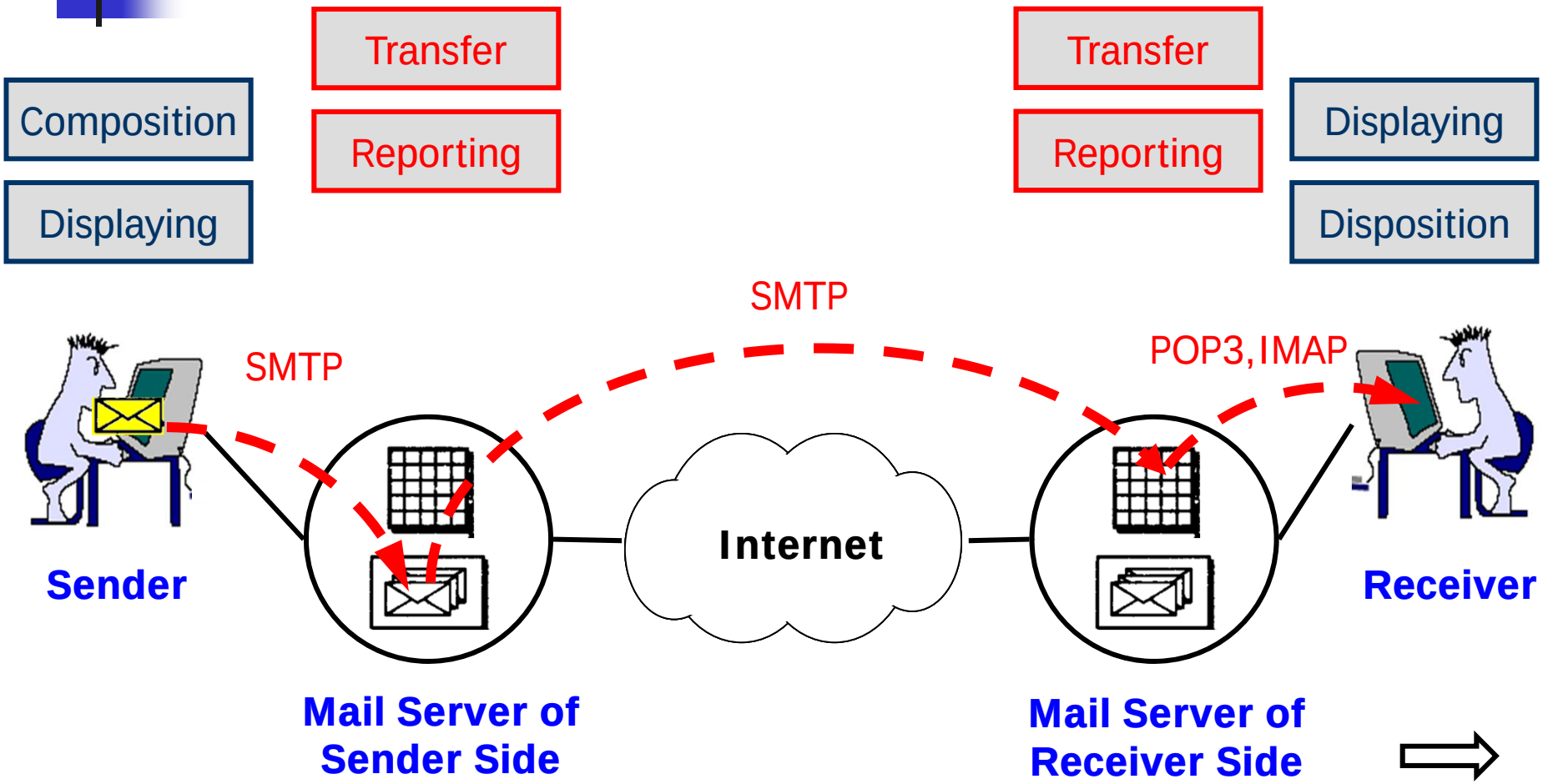




Components Of Email System (2)

- UA (User Agent)
  - end-user mail program
  - Interface between the end users and the email servers
  - E.g., outlook, foxmail, …
- Mail Server
  - Responsible for transmitting/receiving emails and reporting status information about mail transferring to the mail sender
  - **Both a client and a server**
- Email protocols
  - SMTP: used for sending an email
  - POP3/IMAP: used for receiving an email

Components Of Email System (3)



Basic Functions Of Email System

- *Composition* - refers to the process of creating messages and answers.
- *Transfer* - refers to moving messages from the originator to the recipient.
- *Reporting* - refers to the process of informing the originator what happened to the message.
- *Displaying* - means of showing the messages.
- *Disposition* - refers to what happened to the message after it has been read by the receiver.

Other Terminologies

- *Mailboxes* – created by the user to store incoming email.
- *Mailing lists* – means of sending identical emails to a group
- *MTA (Mail Transfer Agent)* – SMTP servers and clients provide a mail transport service

Email Sending

- To send an email message, a user must provide the message, the destination address and possibly some other parameters (e.g., security or security level)

- The message can be produced with a freestanding text editor, a word processor, or possibly with an editor built into the user agent

Email Address

- The destination address must be in a format that the user agent can deal with
- Many user agents expect DNS addresses of the form *mailboxname@domain*. (See RFC 2822)
- Each email address is unique on the Internet because
  - *Domain* name is unique on the Internet
  - *Mailboxname* is unique in the domain

Email Reading

- Typically, when a user agent is started up, it will look at the user's mailbox for incoming email before displaying anything on the screen

- Then it may announce the number of messages in the mailbox or display a oneline summary of each one and wait for a command

Email Standards

Email Standards

- Internet Message Format
  - RFC 5322
- SMTP (Simple Mail Transfer Protocol)
  - RFC 5321 etc.
- POP (Post Office Protocol)
  - RFC 1939 etc.
- IMAP (Internet Message Access Protocol)
  - RFC 3501 etc.
- MIME (Multipurpose Internet Mail Extension)
  - RFC 2045, RFC 2046, RFC 2049 etc.

Internet Message Format (1)

- Message envelop
  - contains whatever information is needed to accomplish transmission and delivery
- Message contents: comprise the object to be delivered to the recipient
  - Headers: from, to, subject, date, postmarks
  - Blank line
  - Body: actual message, may have many parts

Internet Message Format (2)

- Each header field consists of a single line of ASCII text containing the field name, a colon, and, for most fields, a value
  - eg. from:chengli@bupt.edu.cn
- In normal usage, the User Agent builds a message and passes it to MTA
- The MTA then uses some of the header fields to construct the actual envelope
- User provides body & key headers, while mail system provides the rest

Internet Message Format
——Example RFC 2822 Message

- The header is everything up to the blank line, and the body is everything after the blank line

Author of the message, required

Mailbox responsible for the actual transmission of the message, optional

the address(es) of the primary recipient(s) of the message

```
From: John Doe <jdoe@machine.example>
Sender: Michael Jones <mjones@machine.example>
To: Mary Smith <mary@example.net>
Subject: Saying Hello
Date: Fri, 21 Nov 1997 09:55:06 -0600
Message-ID: <1234@local.machine.example>
```

headers

```
This is a message just to say hello.
So, "Hello".
```

body

Internet Message Format
——Field Definitions

Categories	Header	Meaning
Originator fields	From:	Person or people who created the message
	Sender:	Email address of the actual sender
	Reply-to:	Email address to which replies should be sent
Destination address fields	To:	Email address(es) of primary recipient(s)
	Cc:	Email address(es) of secondary recipient(s)
	Bcc:	Email address(es) for blind carbon copies
The origination date field	Date:	The date and time the message was sent
Identification fields	Message-Id:	Unique number for referencing this message later
	References:	Other relevant Message-Ids
Information fields	Subject:	Short summary of the message for the one-line display
	Keywords:	User chosen keyword
Trace fields	Received:	Line added by each transfer agent along the route
	Return-Path:	Can be used to identify a path back to the sender

SMTP

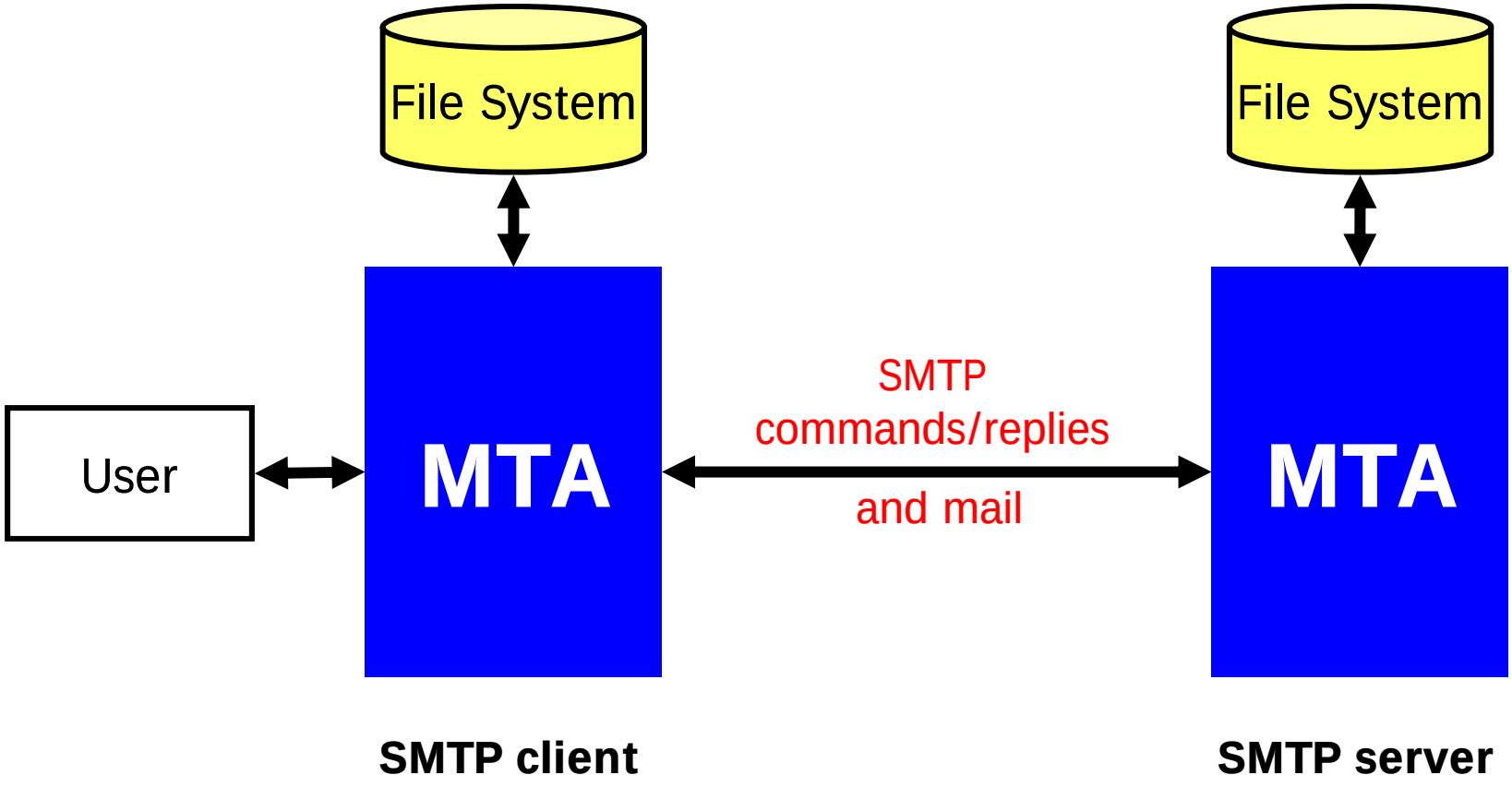
- The source machine establish a TCP connection to Port 25 of the destination machine
- Listening to this port is an email *daemon* that speaks SMTP
- This daemon accepts incoming connections and copies messages from them into the appropriate mailboxes

Daemon - A program that is not invoked explicitly, but lies dormant waiting for some condition(s) to occur. Unix systems run many daemons, chiefly to handle requests for services from other hosts on a network. Most of these are now started as required by a single real daemon, **inetd**, rather than running continuously

SMTP

- If the message cannot be delivered, an error report containing the first part of the undeliverable message is returned to the sender – eventually
- SMTP is a simple ASCII protocol
- After establishing the TCP connection to port 25, the sending machine, operating as a client, waits for the receiving machine operating as the server to talk first

SMTP Basic Model

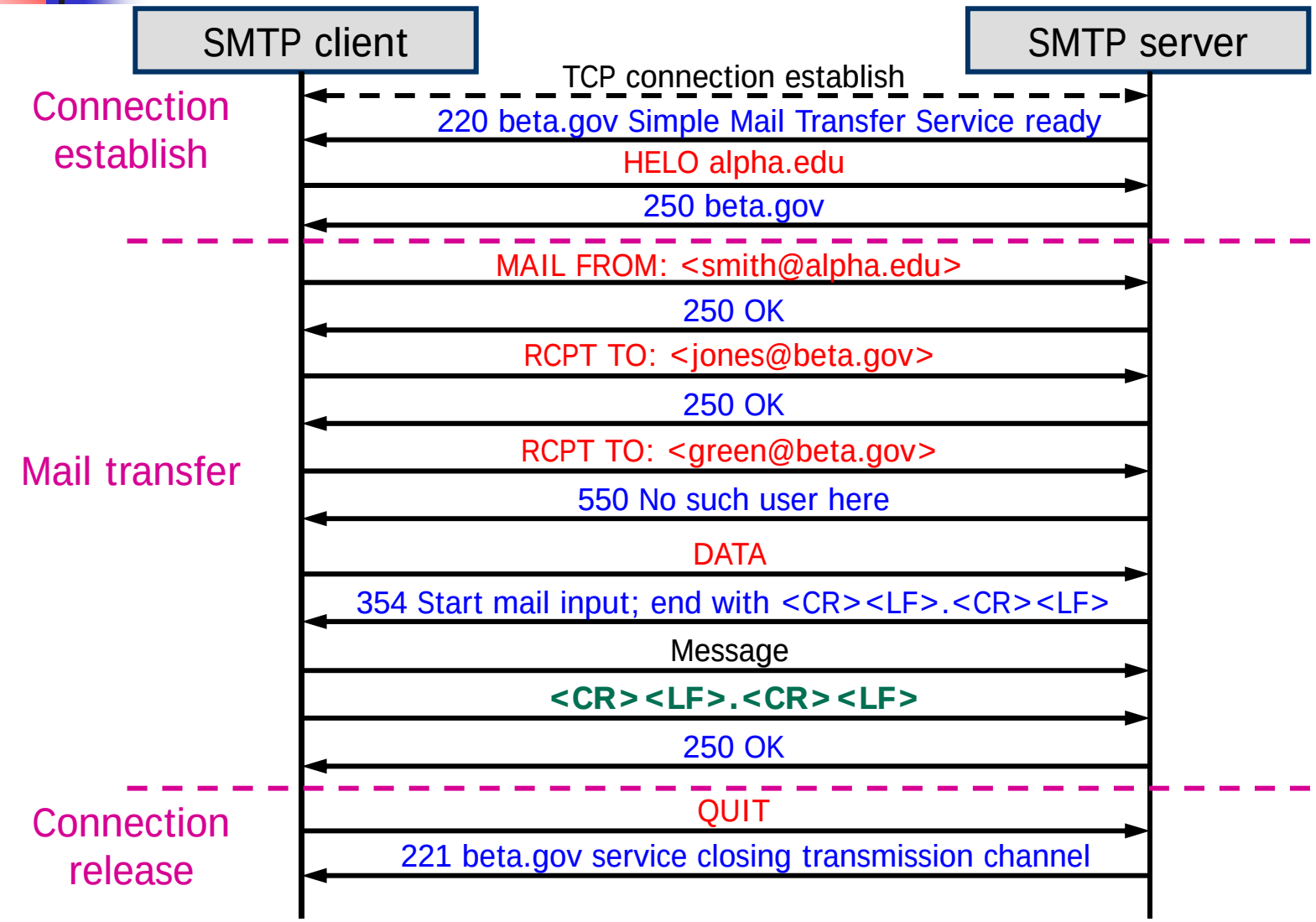


SMTP Command Sequence – stages

- Connection establish
- Mail transfer
- Connection release

SMTP Commands and Status codes – example

- smith@alpha.edu sends a mail to jones@beta.gov, green@beta.gov



SMTP Commands: Basics

commands	description
HELO	▪ identifies sender's Domain name
MAIL FROM:	▪ starts a mail transaction and identifies the mail originator
RCPT TO:	▪ identifies individual recipient. There may be multiple RCPT TO: commands
DATA	▪ body of the message. sender ready to transmit a series of lines of text, each ends with **\r\n**. A line containing only a period '**.**' indicates the end of the data
QUIT	▪ close the connection

SMTP Commands: Extras

- VRFY - confirm that a name is a valid recipient
- EXPN - expand an alias (group email address)
- TURN - switch roles (sender <-> receiver)
- SOML - Send Or Mail
  - if recipient is logged in, display message on terminal, otherwise email.
- SAML - Send and Mail
- NOOP - send back a positive reply code
- RSET - abort current transaction

SMTP: Status Codes

- The Server responds with a 3 digit code that may be followed by text info
  - 2## -- Success
  - 3## -- Command can be accepted with more information
  - 4## -- Command was rejected, but error condition is temporary
  - 5## -- Command rejected, Bad User!

Sending Email Through Telnet

```
C:\Documents and Settings\Administrator> telnet smtp.163.com 25
220 163.com Anti-spam GT for Coremail System (163com[20050206])
helo mail.163.com
250 OK
auth login
334 dXNlcm5hbWU6
Y2F0c2hpeQ==
334 UGFzc3dvcmQ6
MTIzNDU2
235 Authentication successful
mail from:<catshiy@163.com>
250 Mail OK
rcpt to:<catshiy@163.com>
250 Mail OK
data
354 Please start mail input.
subject:test email

this is only a test for sending email through telnet
.
250 Mail queued for delivery.
quit
221 Closing connection. Good bye.
失去了跟主机的连接。
C:\Documents and Settings\Administrator>
```

Base64 encoded “username:” and “Password:”

Base64 encoded username – “catshiy@163.com”

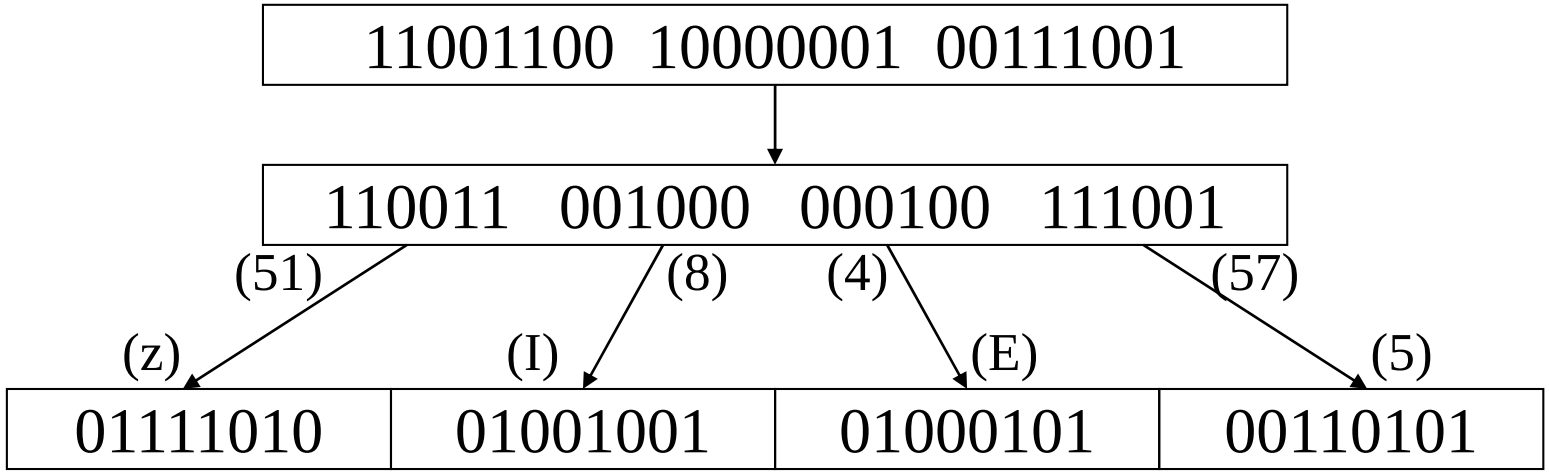
Base64 encoded password – “123456”

Blank line: boundary between headers and body

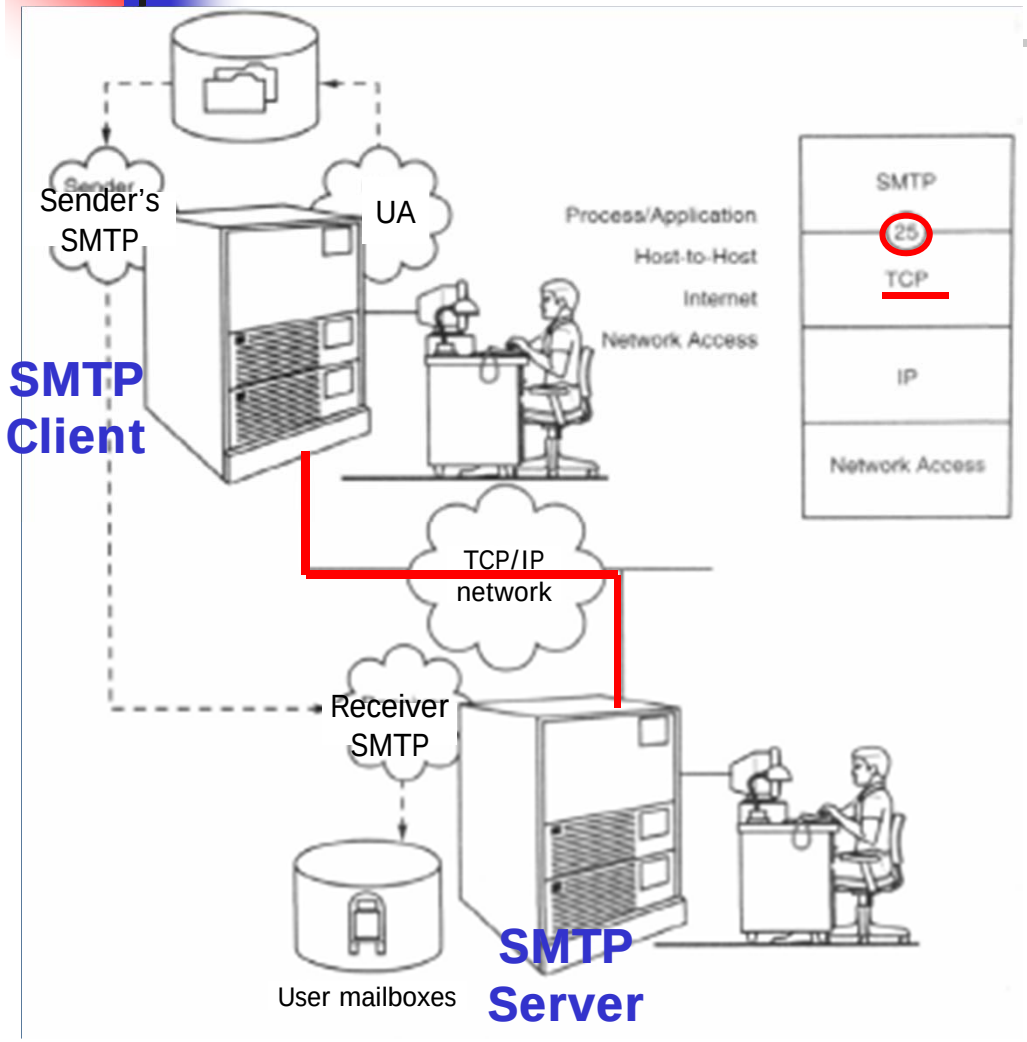
Period: end of data

Base64 Encoding

- Divides binary data into 24 bit blocks
- Each block is then divided into 6 bit chunks
- Each 6-bit section is interpreted as one character, 25% overhead

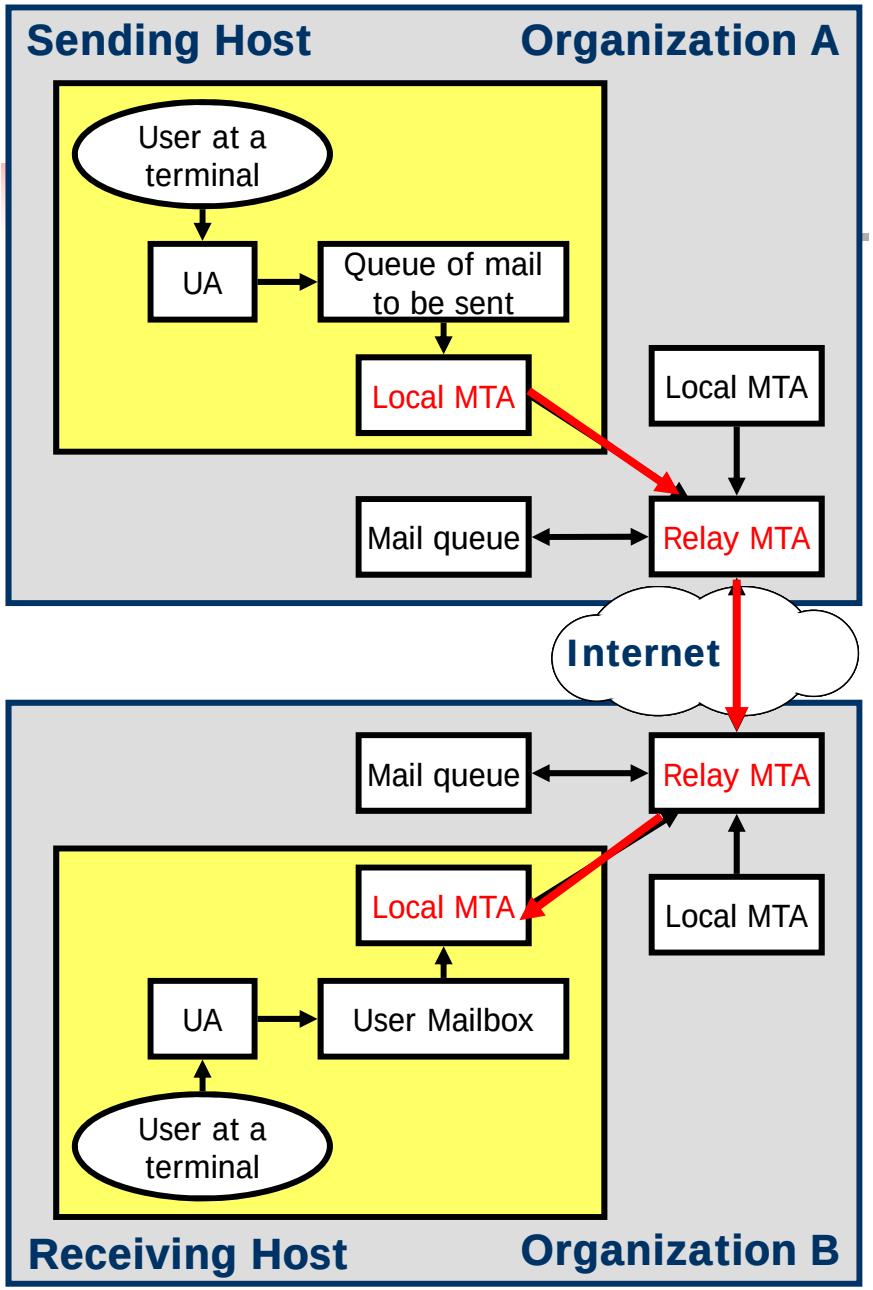


SMTP Transfer Mechanism – Eg.1



- The SMTP server listens to well-known port 25. SMTP is a reliable protocol. The reliability is achieved by using TCP as the transport layer mechanism.
- This requires a connection to be established before a message transfer can take place.
- An SMTP client will contact the destination host's SMTP server directly to deliver the mail. It will keep the mail item being transmitted until it has been successfully copied to the recipient's SMTP MTA. Eventually it may give up.

SMTP Transfer Mechanism – Eg.2



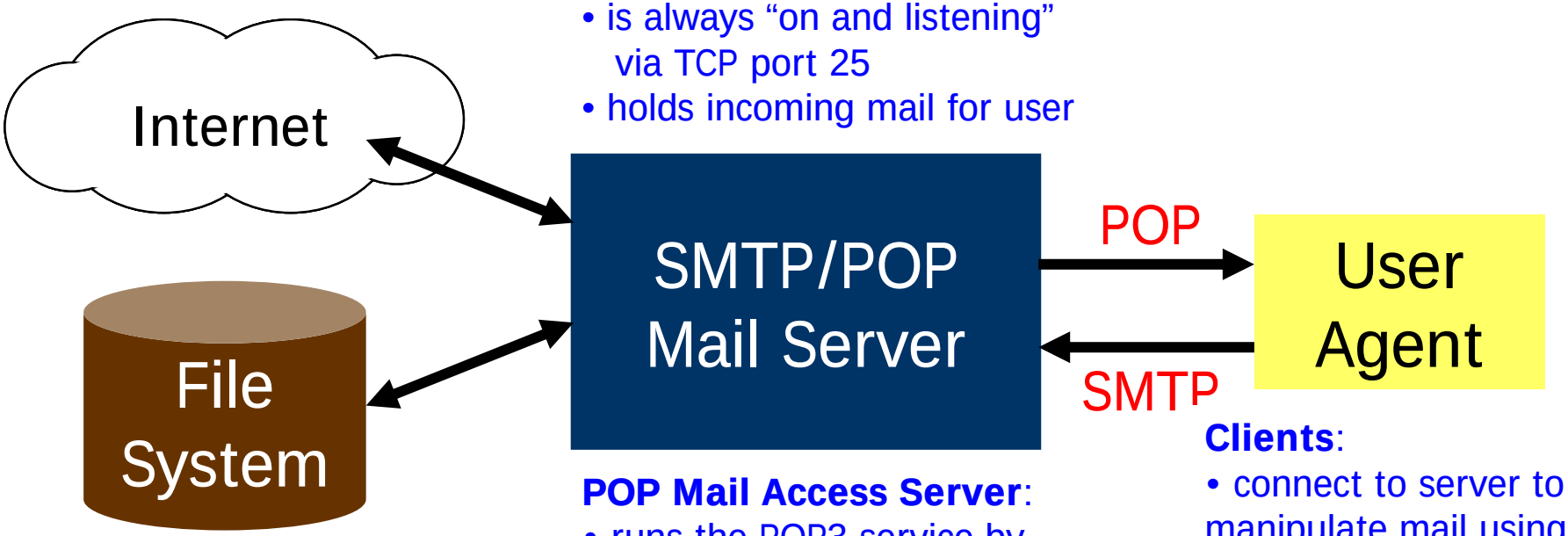
- Most systems are configured to send all non-local outgoing mail to a Relay MTA for delivery. This is done or two reasons. First, is simplifies the configuration of all MTAs other than the relay MTA. Second, it allows one system at an organization to act as the mail hub, possibly hiding all the individual systems. If the Relay MTA changes, the mail configuration of all individual systems need not change.
- In this scenario there are four MTAs between the sender and the receiver.
  - The Local MTA on the sender's host just delivers the mail to its Relay MTA across the organisation's local internet.
  - The Relay MTA in the sender's organisation sends the mail to the receiving organisation's Relay MTA across the Internet.
  - The Relay MTA in the receiver's organization then delivers the mail to the receiver's host, by communication with the Local MTA on the receiver's host.
  - All the MTAs in this example use SMTP, although other protocols could be used.

Limitations in SMTP

- Only uses NVT 7 bit ASCII format
  - How to represent other data types?
- No authentication mechanisms
- Messages are sent un-encrypted
- Susceptible to misuse (Spamming, faking sender address)

POP – Basic Model

- Used to transfer mail from a mail server to a UA



SMTP Server:
- is always "on and listening" via TCP port 25
- holds incoming mail for user

POP Mail Access Server:
- runs the POP3 service by listening on TCP port 110

Clients:
- connect to server to manipulate mail using message access protocols (POP or IMAP)

POP – Features

- Essentially store and forward. Mail is stored on the server until the client connects and then is downloaded to the client. You MAY be able to leave a copy on the server
- Simple protocol and widely used.
- Many clients available such as Eudora, foxmail, outlook
- However, very bad for mobile users or users that use multiple machines during the day
- Common used version: POP3 (POP Version 3)

POP3

- Similar to SMTP command/reply lockstep protocol
- Used to retrieve mail for a single user
  - requires authentication
- Commands and replies are ASCII lines
  - Replies start with “+OK” or “-ERR”
  - Replies may contain multiple lines

POP3 Commands

- USER - specify username
- PASS - specify password
- STAT - get mailbox status
  - number of messages in the mailbox.
- LIST - get a list of messages and sizes.
  - One per line, termination line contains '.' only
- RETR - retrieve a message
- DELE - mark a message for deletion from the mailbox
- NOOP - send back positive reply
- RSET - reset. All deletion marks are unmarked
- QUIT - remove marked messages and close the (TCP) connection

Retrieving Emails Through Telnet (1)

```
C:\Documents and Settings\Administrator>telnet pop3.126.com 110
+OK Welcome to coremail Mail Pop3 Server
(126coms[3adb99eb4207ae5256632eecb8f8b4
85s])
USER catshiy
+OK core mail
PASS 123456
+OK 1 message(s) [885 byte(s)]
STAT
+OK 1 885
LIST
+OK 1 885
1 885
.
```

Retrieving Emails Through Telnet (2)

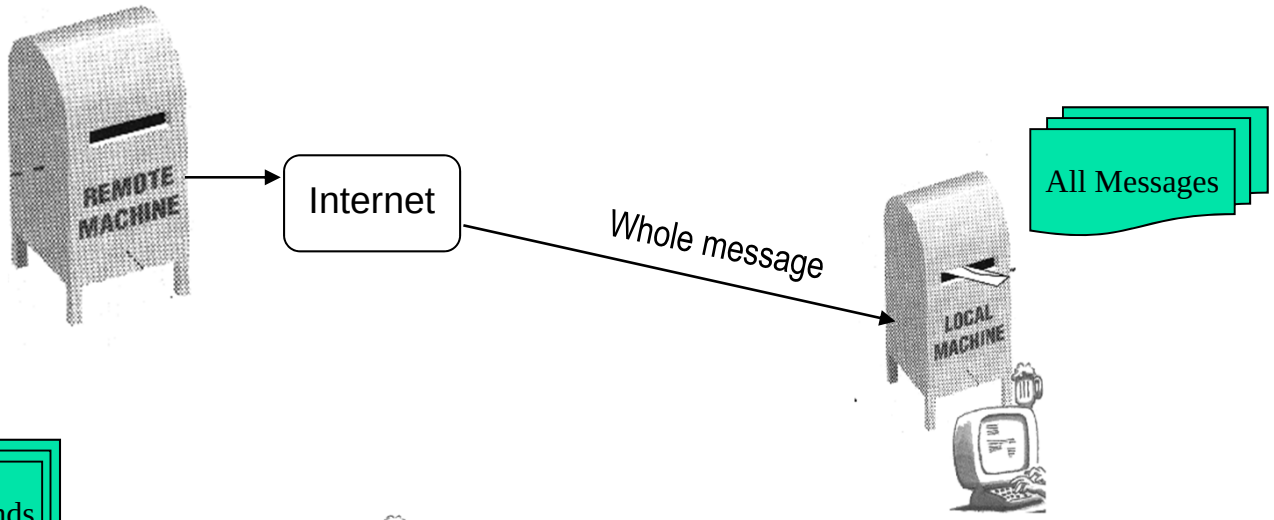
```
RETR 1
+OK 885 octets
Content-Transfer-Encoding: 8bit
MIME-Version: 1.0
Message-ID: <DQ958982777179.06131@mcard.bta.net.cn>
Date: Sun, 17 Oct 2004 22:28:20 +0800 (CST)
From: smq1234@public.bta.net.cn
To: catshiy@126.com
Cc:
Subject:

 我十一月中旬以后有空，欢迎你们过来玩。

smq
-----------------------------------------------
.
QUIT
+OK core mail

失去了跟主机的连接。

C:\Documents and Settings\Administrator>
```

IMAP (Internet Message Access Protocol)

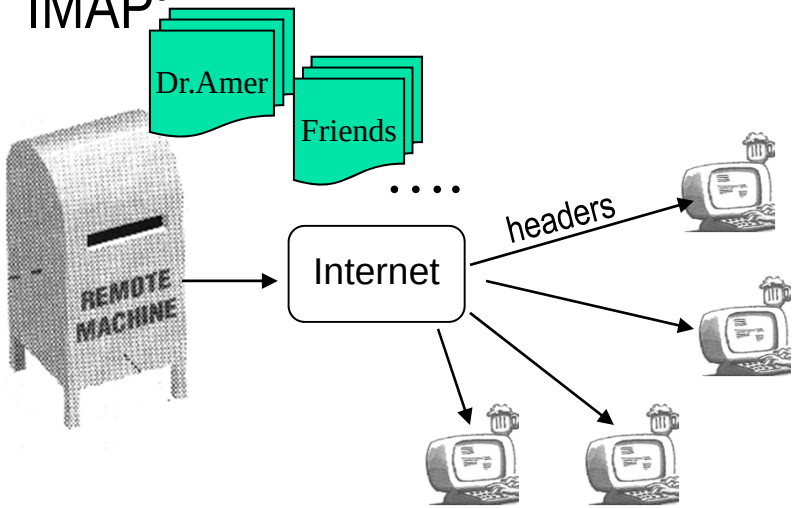
- Features
  - Folders and messages can be stored either on the server or on the local computer
  - Since folders can remain on server, it is possible to access your same mail store even using a dumb terminal character based client like Pine.
  - Much better for mobile users than POP (since mail remains on the server)
  - Can selectively copy messages from the server to the local client based on many criteria
- Gmail supports IMAP
- Interesting comparison of POP3 and IMAP
  - http://www1.umn.edu/adcs/guides/email/imapvspop.html

POP vs. IMAP

POP3:



IMAP:



Web-based Mail: HTTP

- Can deliver mail message in web page format
- More reliable to use POP and IMAP than web mail account

MIME – Motivation

- Originally, email consisted exclusively of the text messages written in English and expressed in ASCII (RFC 2822)

- Nowadays, this approach is no longer appropriate, due to:
  - Messages in languages with accents
  - Messages in non-Latin alphabets
  - Messages in languages without alphabets
  - Messages are not containing text at all -- audio/video

- MIME: Multipurpose Internet Mail Extension

MIME – Features

- Extension for multipart & multimedia email
- Additional mail headers define content
  - type (text, image, audio, video, application) and subtype within (eg text/html, image/gif)
  - encoding (ASCII , quoted printable, base64) to handle arbitrary binary data when email system can only handle normal ASCII chars
- Supports multipart message content type
  - each part has its own type and encoding
- The basic idea of MIME is to use the ASCII format (RFC 2822), but to add structure to the message body and define encoding rules for non-ASCII messages
- By not deviating from RFC 2822, MIME messages can be sent using the existing mail programs and protocols
- Widely used now

MIME – New Headers (1)

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

MIME – New Headers (2)

- *MIME-Version*: simply tells the user agent receiving the messages that it is dealing with MIME messages and which version of MIME it uses - any message not containing a MIME-version is assumed to an English plain-text message
- *Content-Description:* is an ASCII string telling what is in the message
- *Content-Id:* header uniquely identifies the content
- *Content-Transfer-Encoding:* tells how the body is wrapped for transmission - multiple schemes, from the the simplest - ASCII text, through to base64 encoding
- *Content-Type*: tells the type and subtype of the content

MIME – New Headers (3)

- Content types and subtypes

Type	Subtype	Description
Text	Plain	Unformatted text
	Richtext	Text including simple formatting commands
Image	Gif	Still picture in GIF format
	Jpeg	Still picture in JPEG format
Audio	Basic	Audible sound
Video	Mpeg	Movie in MPEG format
Application	octet-stream	An uninterpreted byte sequence
	Postscript	A printable document in PostScript
Message	RFC2822	A MIME RFC 2822 message
	Partial	Message has been split for transmission
	External-body	Message itself must be fetched over the net
Multipart	Mixed	Independent parts in the specified order
	Alternative	Same message in different formats
	Parallel	Parts must be viewed simultaneously
	Digest	Each part is a complete RFC 2822 message

MIME – Message Example (1)

```
Date: Sat, 07 Dec 2002 16:37:32 +0800
From: Adun Gaos
X-Accept-Language: zh-cn
MIME-Version: 1.0
To:  adungaos@celldoft.com
Subject: MIME message!
Content-Type: multipart/mixed;
 boundary="------------080202030206040206090704"

This is a multi-part message in MIME format.
--------------080202030206040206090704
Content-Type: text/html; charset=us-ascii
Content-Transfer-Encoding: 7bit

      This is a MIME message. Here is body.

--------------080202030206040206090704
Content-Type: application/x-gtar;
 name="binary.tgz"
Content-Transfer-Encoding: base64
Content-Disposition: inline;
 filename="binary.tgz"

H4sIABmy8T0AA+3OsQ3CMBQEUI/iEb6dBM9jhIRogpSQgu1BQhQUiCpU7zVX3BV3vMx9uadd
RYk4RKSIKG36yLcUbWrjMJQo9bmv41BTjn1vvWzrrS85p37a5nO/rt92v3oAAAAAAAAAAAD4
oweF/KCgACgAAA==
--------------080202030206040206090704--
```

MIME – Message Example (2)

- When you save the above as .eml file and open it with outlook, you can see:

Summary

Summary

- Email
  - Components of email system
  - Basic functions of email system
  - Email address
- SMTP
  - Communication procedure
  - Model
  - Commands and replies
- POP
  - Model
  - Commands and replies
  - Communication procedure
- IMAP
  - Comparison of POP and IMAP
- Message formats
  - RFC 2822
  - MIME
- What are the limitations of SMTP? How POP, IMAP and MIME used to offset the limitations of SMTP?

Useful URLs

- RFCs
  - www.ietf.org
- SMTP
  - http://helpdesk.islandnet.com/pep/smtp.php
  - http://www3.rad.com/networks/2006/smtp/intro.htm
- POP & IMAP
- Base64 encoding and decoding online
  - http://www.motobit.com/util/base64-decoder-encoder.asp