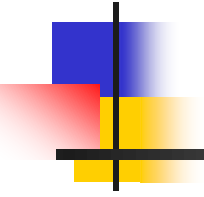
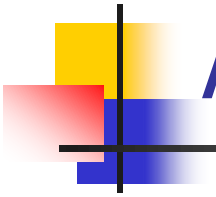


Email Basics

BUPT/QMUL

2021-05-06



Agenda

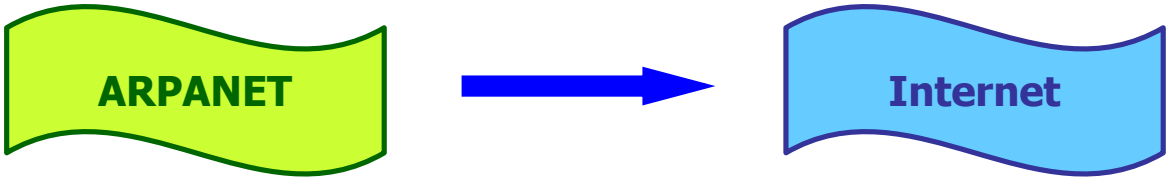
- Brief introduction to email
- Components of email system
- Email Standards
- Summary

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 (不同时的)
- One of the most popular applications on the Internet and one of the most important communication methods today
- 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



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

Newest development:

Oct. 2008

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

What kind of methods for you to check email?

A

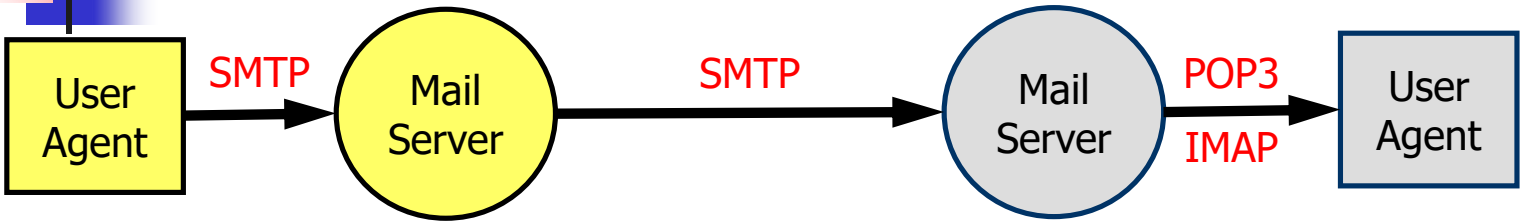
- Web
  - Browser

B √

- User Agent
  - Foxmail
  - Outlook
  - Netease

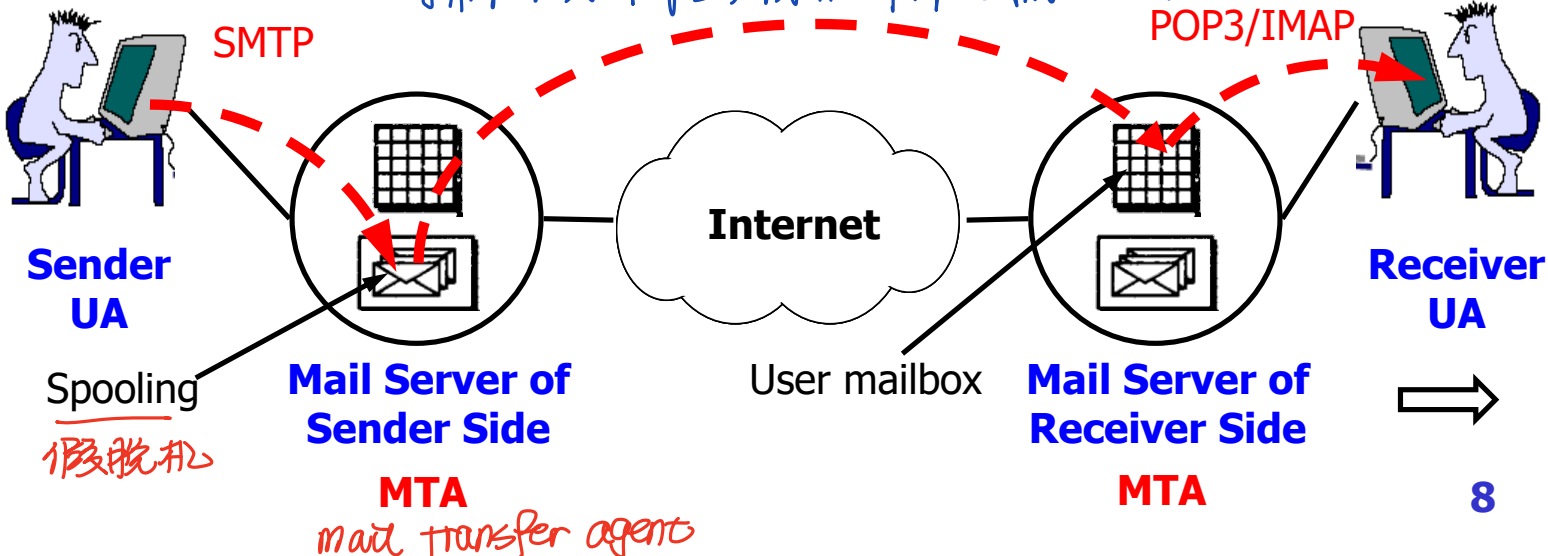
Components Of Email System

Components Of Email System (1)



Spooling：处理延迟交付的问题。

将用户以发邮件方式的邮件传输到开。

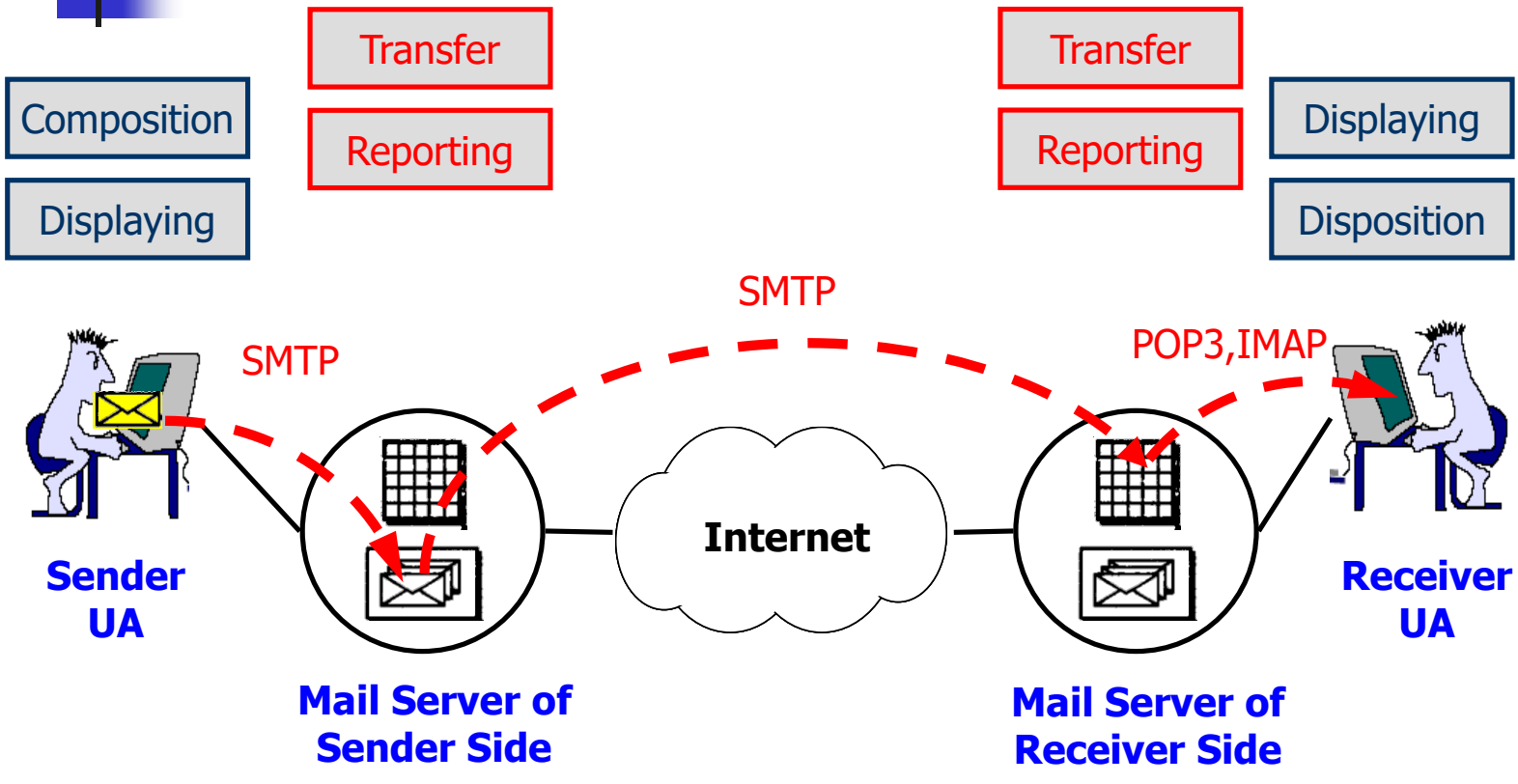


Components Of Email System (2)

- 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.

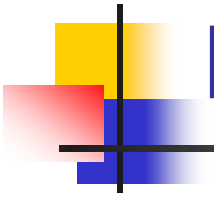
Other Terminologies

- *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)

- Email Address
  - Many user agents expect DNS addresses of the form *mailboxname@domain*. (See RFC 5322)
  - 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 one-line summary of each one and wait for a command

Email Standards

Email Standards

- Internet Message Format
  - RFC 5322 etc.
- 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 2045-2049 etc.

Internet Message Format (1)

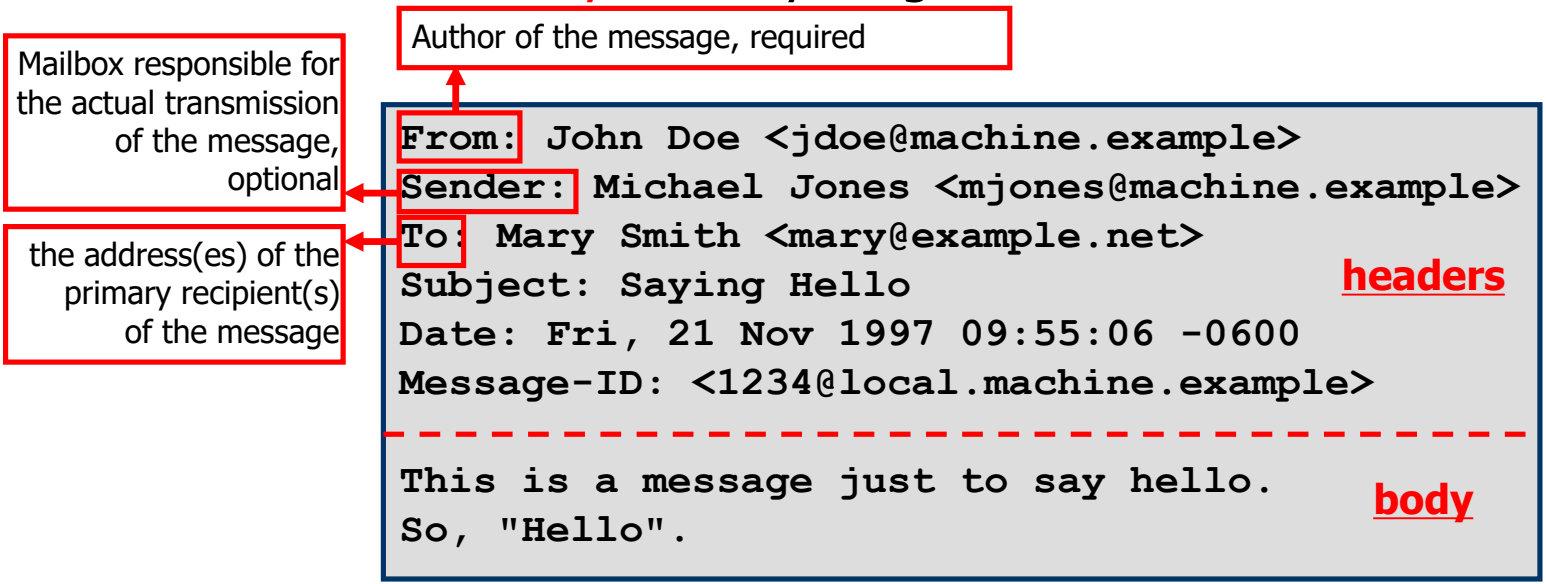
- Message envelop
  - contains whatever information is needed to accomplish transmission and delivery
- Message contents: comprise the object to be delivered to the recipient
  - Headers: from, to, subject, date, postmarks
  - Blank line 区分 Headers 和 Body
  - Body: actual message, may have many parts

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:abc@gmail.com ⇐ value
    field name
- 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 5322 Message

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



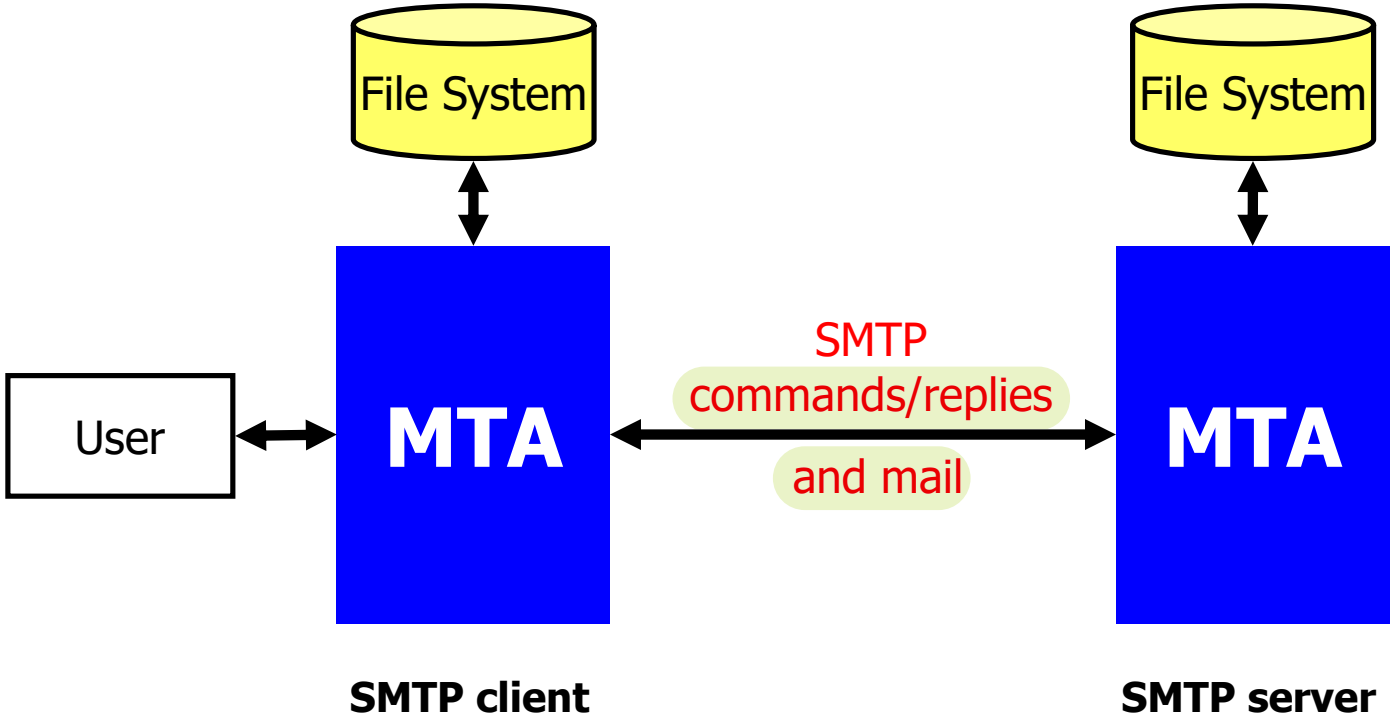
Internet Message Format ——Field Definitions

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 establishes a TCP connection to Port 25 of the destination machine
- Listening to this port is a SMTP server
  - Accepts incoming connections
  - Receives messages over the connections
  - If the message cannot be delivered, an error report containing the first part of the undeliverable message is returned to the sender
- 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: 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	▪ Sender ready to transmit body of the message. 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

一行只包含"."（句号）的代表data的结尾

SMTP Commands: Extras

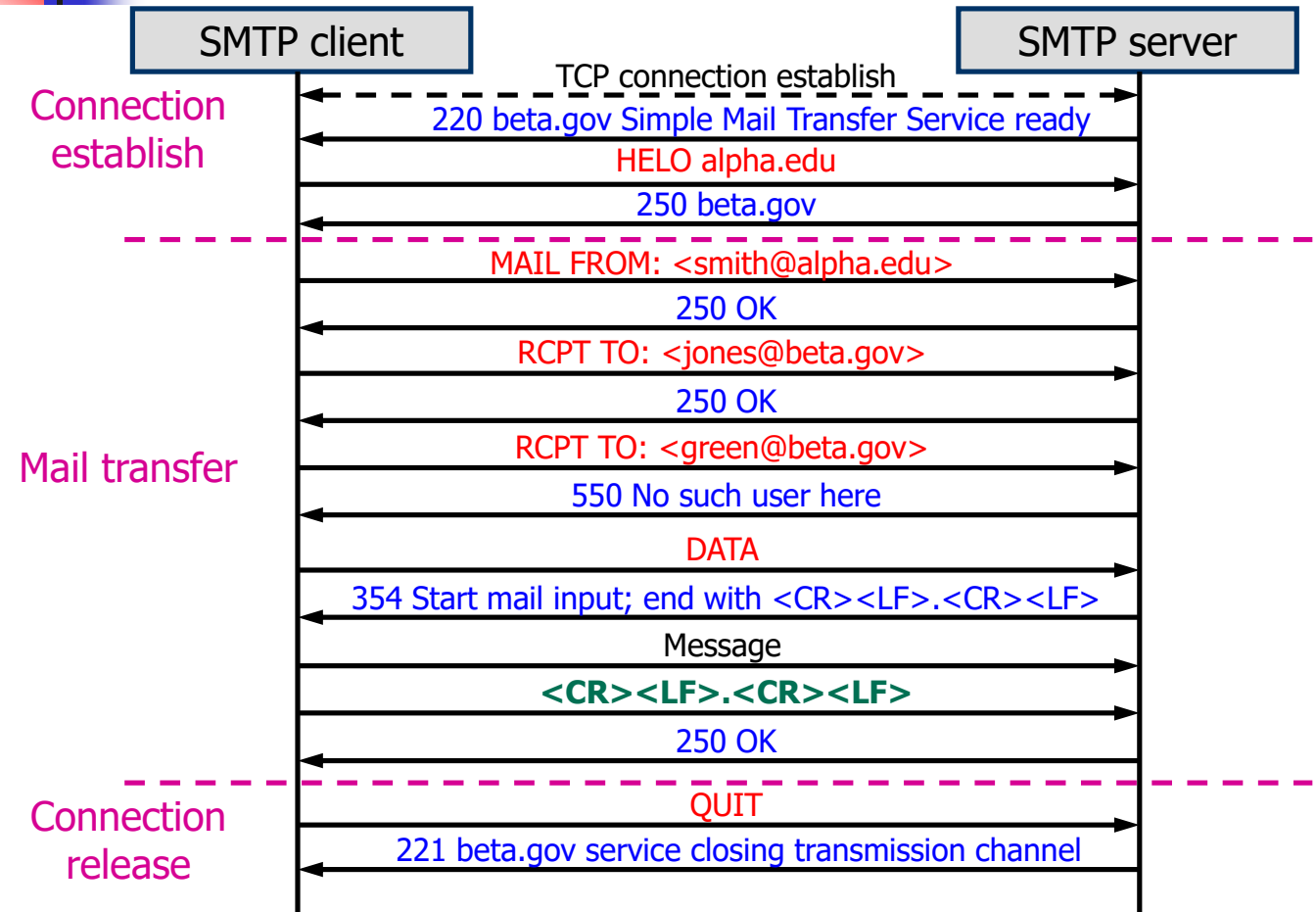
- EHLO (Extended Hello) – Same function with HELO. But, in addition to domain name, address literal (eg. IPv4 address) is also supported
- VRFY - confirm that a name is a valid recipient
- EXPN - expand an alias (group email address)
- NOOP - send back a positive reply code
- RSET - abort current transaction
- HELP - cause the server to send helpful information to the client

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, and the error condition is permanent, eg. Bad User!

SMTP Commands and Status codes – example

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



Sending Email Through Telnet

```
C:\Documents and Settings\Administrator> telnet smtp.163.com 25
220 163.com Anti-spam GT for Coremail System (163com[20141201])
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 Bye.
失去了跟主机的连接。
C:\Documents and Settings\Administrator>
```

Base64 encoded "username:" and "Password:"

Base64 encoded username – "catshiy"

Base64 encoded password – "123456"

Blank line: boundary between headers and body

Period: end of data

Online Base64 encoding and decoding:

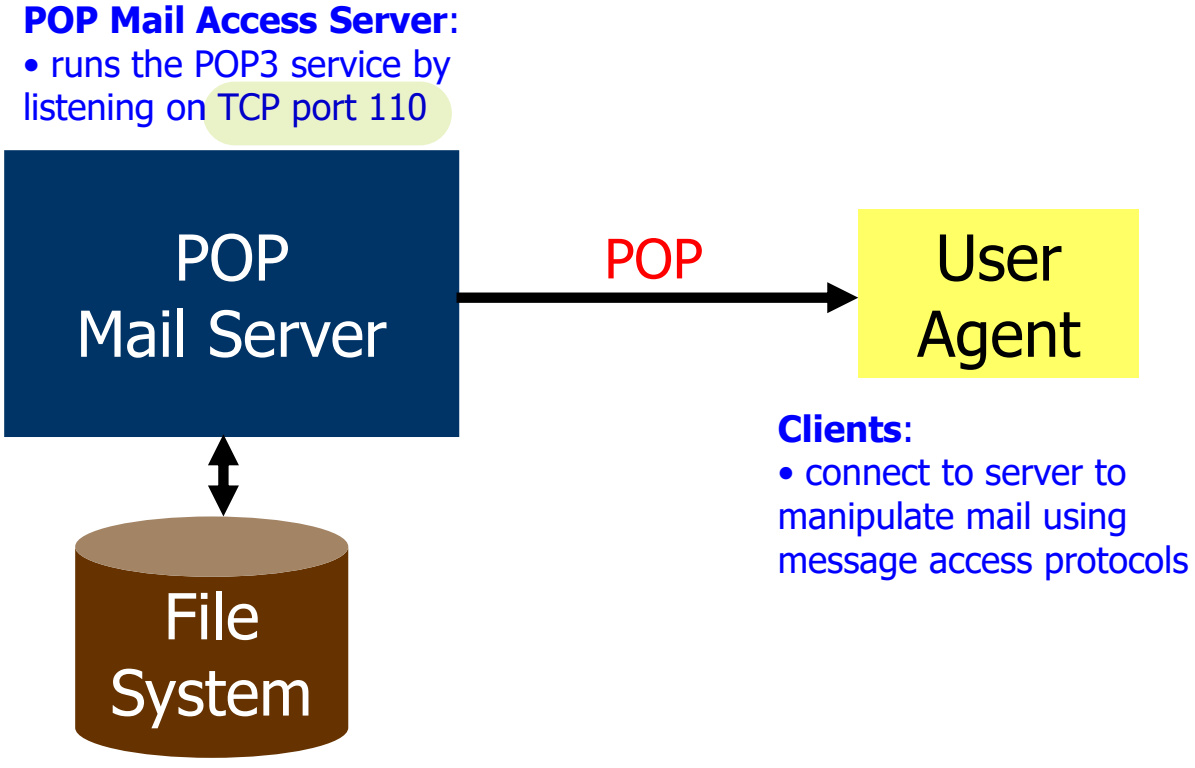
http://tools.jb51.net/tools/base64_decode-gb2312.php

Limitations in SMTP

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

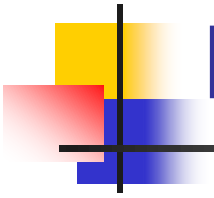
POP/IMAP – Basic Model

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



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[3adb99eb4207ae5256632eecb8f8b485s])
USER catshiy
+OK core mail
PASS 123456
+OK 1 message(s) [885 byte(s)]
STAT
+OK 1 885
LIST
+OK 1 885
1 885
.
```

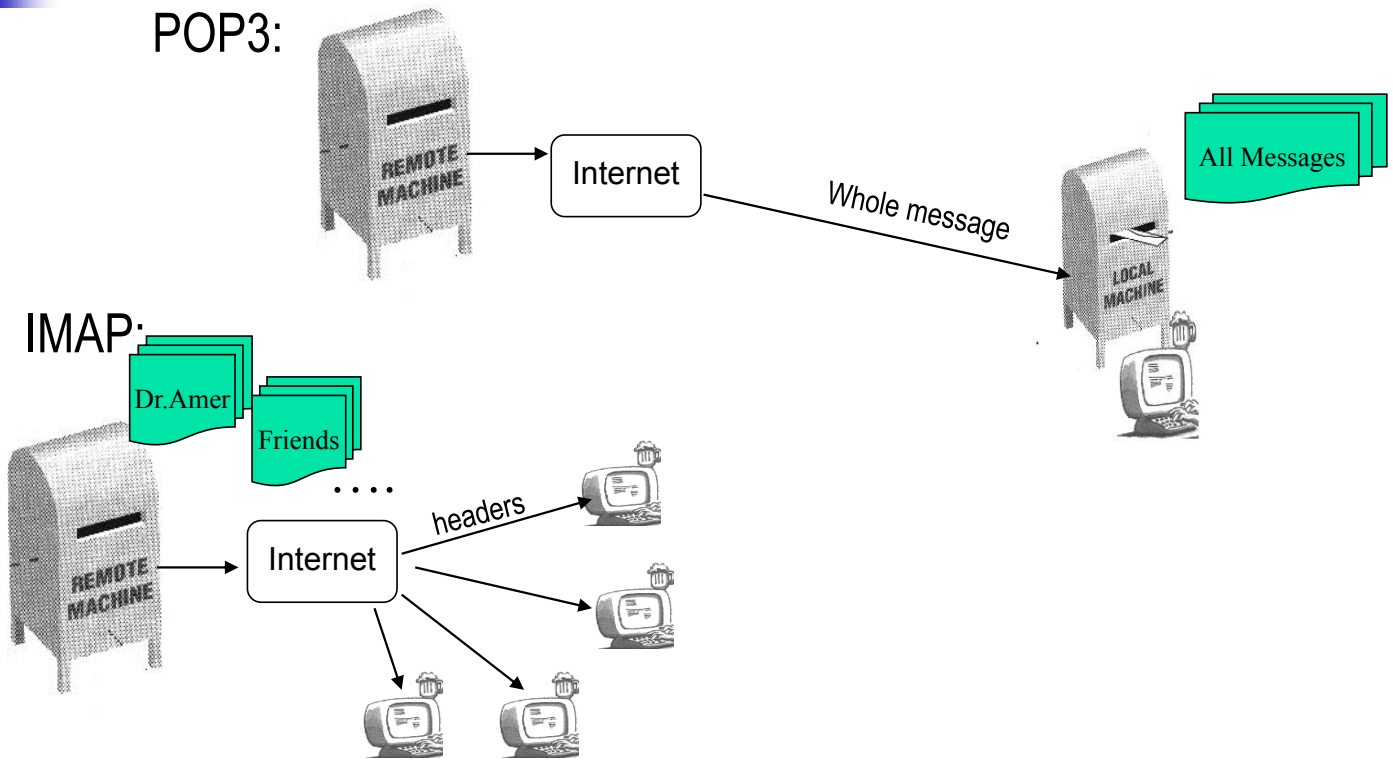
Retrieving Emails Through Telnet (2)

```
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: shp1234@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。

shp
-----------------------------------------------
.
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 (part of) messages from the server to the local client based on many criteria
- QQ/163/gmail supports both IMAP and POP3
- Comparison of POP3 and IMAP
  - https://www.diffen.com/difference/IMAP_vs_POP3

POP vs. IMAP


POP3:
REMOTE MACHINE
Internet
Whole message
All Messages
LOCAL MACHINE
IMAP:
Dr.Amer
Friends
REMOTE MACHINE
Internet
headers

POP vs. IMAP(2)

Feature	POP3	IMAP
Where is protocol defined?	RFC 1939	RFC 2060
Which TCP port is used?	110	143
Where is email stored?	User's PC	Server
Where is email read?	Off-line	On-line
Mail Syncing	No	Yes
Direction	One-direction	Bi-directional
Good for mobile users?	No	Yes
Partial message downloads?	No	Yes
Speed	Fast	Low

Web-based Mail: HTTP

- Can deliver mail message in web page format

https://mail.bupt.edu.cn/

MIME – Motivation

- Originally, email consisted exclusively of the text messages written in English and expressed in ASCII (RFC 5322)

- Nowadays, this approach is no longer appropriate, due to:
  - Messages in languages with accents (e.g. ö, ç, ğ)
  - 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 5322), but to add structure to the message body and define encoding rules for non-ASCII messages
- By not deviating from RFC 5322, 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-Type:	Nature of the message
Content-Transfer-Encoding:	How the body is wrapped for transmission

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

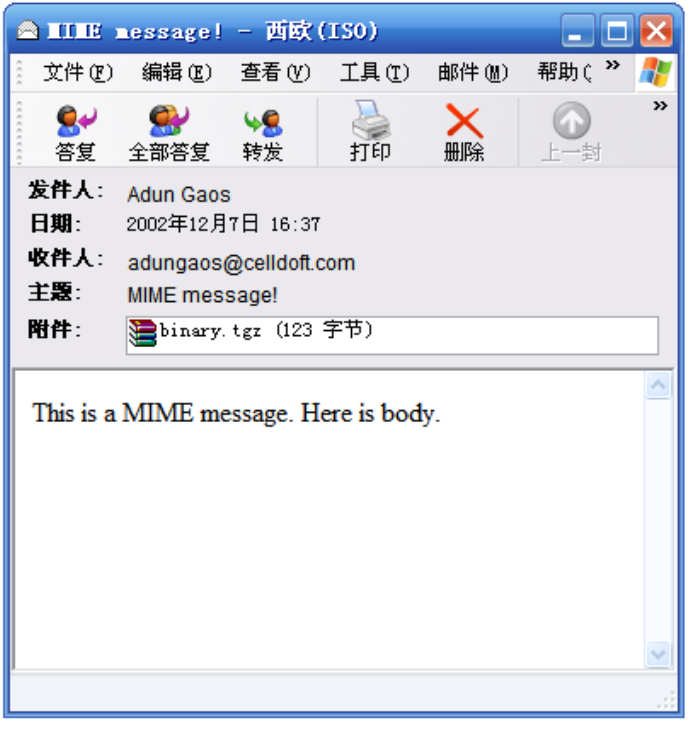
Type	Subtype	Description
Text	Plain	Unformatted text
	Richtext	Text including simple formatting commands
Image	Gif	Still picture in GIF format
	Jpeg	Still picture in JPEG format
Audio	Basic	Audible sound
Video	Mpeg	Movie in MPEG format
Application	octet-stream	An uninterpreted byte sequence
	Postscript	A printable document in PostScript
Message	RFC822	A MIME RFC 822(current RFC5322) 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 5322 message

MIME – Message Example (1)

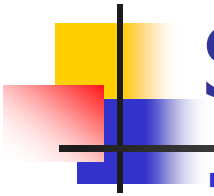
```
Date: Sat, 07 Dec 2002 16:37:32 +0800
From: Adun Gaos
X-Accept-Language: zh-cn
MIME-Version: 1.0
To:  adungaos@celldoft.com
Subject: MIME message!
Content-Type: multipart/mixed;
 boundary="------------080202030206040206090704"

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/rt92v3oAAAAAAAAAAD4
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 5322
  - MIME
- What are the limitations of SMTP? How are MIME and SSL used to offset the limitations of SMTP?

Useful URLs

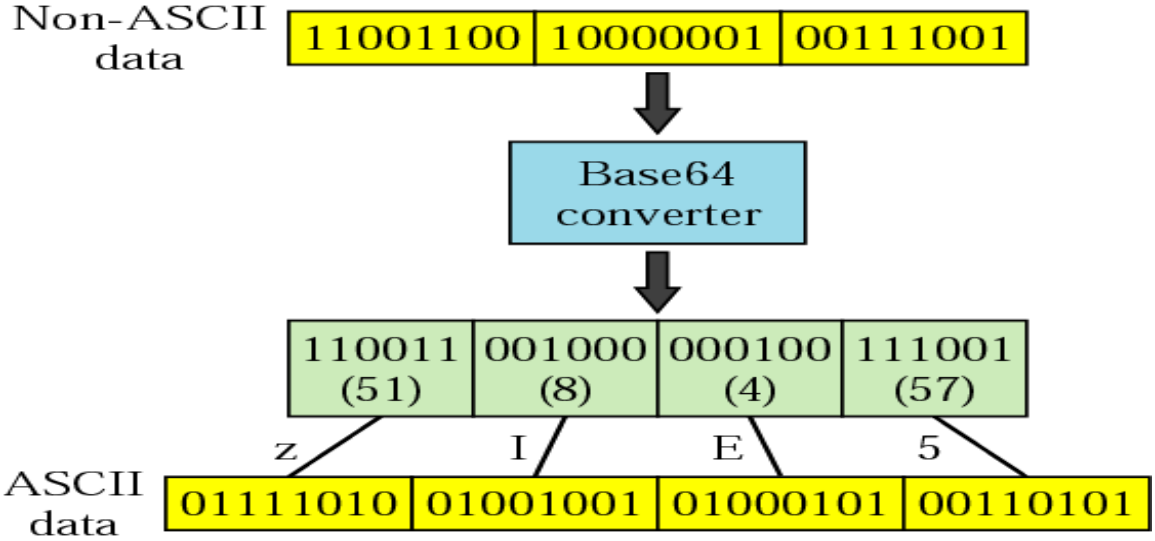
- RFCs
  - www.ietf.org
- SMTP, POP & IMAP
  - http://whatismyipaddress.com/email-basics
- Base64 encoding and decoding online
  - http://tools.jb51.net/tools/base64_decode-gb2312.php

Abbreviations

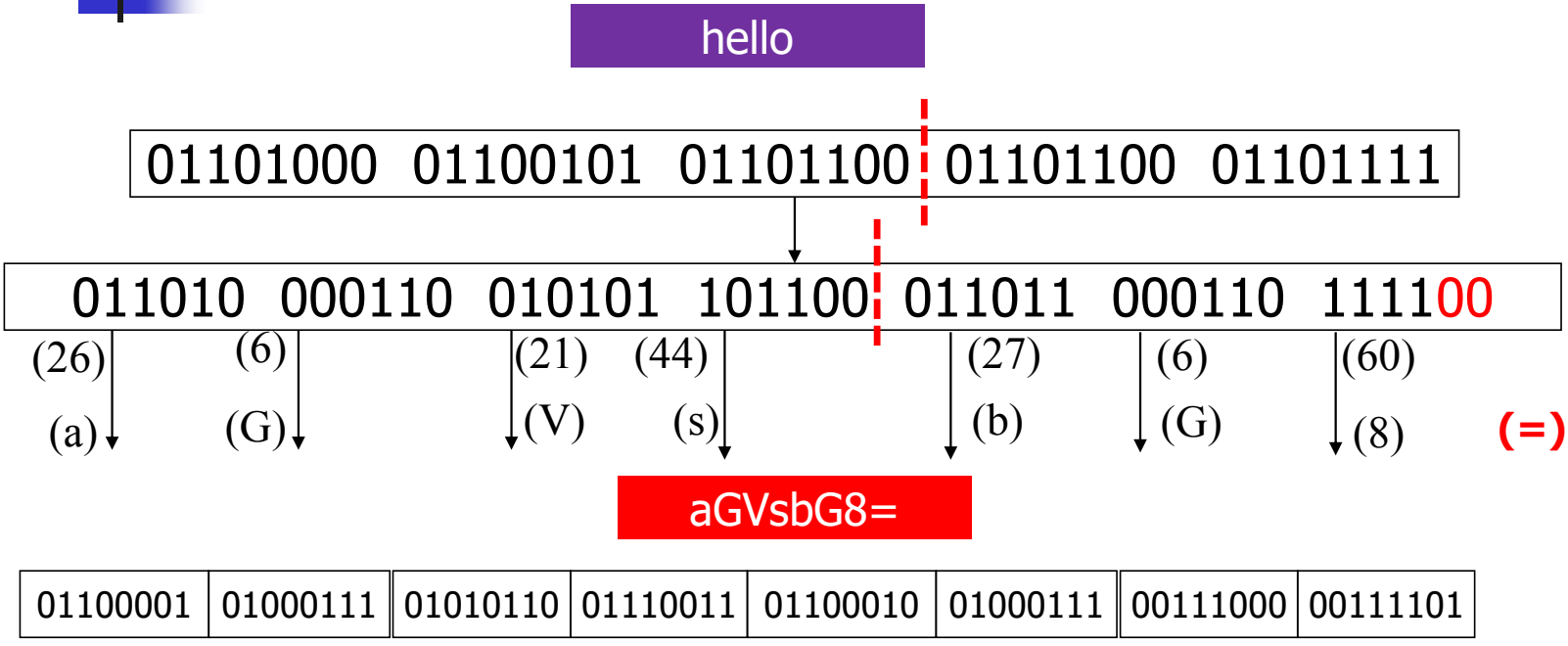
IMAP	Internet Message Access Protocol
IMF	Internet Message Format
MIME	Multipurpose Internet Mail Extension
MTA	Mail Transfer Agent
POP	Post Office Protocol
SMTP	Simple Mail Transfer Protocol
UA	User Agent

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 (8 bits), 25% overhead



Base64 Example



Online encoding and decoding:

http://tools.jb51.net/tools/base64_decode-gb2312.php

Base64 Encoding Table

6-bit value	character encoding	6-bit value	character encoding	6-bit value	character encoding	6-bit value	character encoding
0	A	16	Q	32	g	48	w
1	B	17	R	33	h	49	x
2	C	18	S	34	i	50	y
3	D	19	T	35	j	51	z
4	E	20	U	36	k	52	0
5	F	21	V	37	l	53	1
6	G	22	W	38	m	54	2
7	H	23	X	39	n	55	3
8	I	24	Y	40	o	56	4
9	J	25	Z	41	p	57	5
10	K	26	a	42	q	58	6
11	L	27	b	43	r	59	7
12	M	28	c	44	s	60	8
13	N	29	d	45	t	61	9
14	O	30	e	46	u	62	+
15	P	31	f	47	v	63	/
						(pad)	=