

What the heck  
is Electronic Mail?

Electronic Mail is a term that's been bandied about data processing circles for years.

Simply put, it means high-speed information transportation.

One of the most advanced methods is terminals talking to one another.

Your mailbox is the terminal on your desk. Punch a key and today's correspondence and messages are displayed instantly.

Need to notify people immediately of a fast-breaking development? Have your messages delivered to their terminal mailboxes electronically, across the hall or around the world.

Electronic Mail is document distribution that's more timely, accurate and flexible than traditional methods.

There's no mountain of paperwork.

Administrative personnel are more effective.

Managers have access to more up-to-date information. Decision-making is easier.

Tomorrow's automated office will clearly include Electronic Mail. But like the rest of the Office of the Future, it's available at Honeywell today.

For more information call Mr. Laurie Reeves at (800) 225-3222/3 (within the 617 area, call 552-2048). Or write him at Honeywell Office Automation Systems, Three Newton Executive Park Drive, Newton Lower Falls, Massachusetts 02162.

**Honeywell**

# Electronic Mail

# Overview

- Electronic mail
  - History
  - Format of email
    - RFC 822, MIME, email addresses
  - Sending email
    - SMTP, DNS
  - Retrieving email
    - POP, IMAP, Web-based

# Flashback to the 70s

- ARPANET just recently came alive

29 OCT 69	2100	LOADED OP. PROGRAM	CSK
		FOR BEN BARKER	
		BBV	
	22:30	Talked to SRS	CSK
		Host to Host	
		Left imp. program	CSK
		running after sending	
		a host dead message	
		to imp.	

*October 29, 1969:*

*First message sent on the ARPANET between UCLA and Stanford.*

*Attempted to type "login"  
Crashed after "lo".*

- July 1971, RFC-196: A Mail Box Protocol
  - Send documents to teletype printers
- Late 1971, Ray Tomlinson
  - Let the user decide whether to print or not

# First email

- Sent between two TENEX systems
  - Each machine had a MAILBOX file in a user's directory
  - Sender specified address of recipient
    - @ sign between user account name and the host name
  - If on remote system, opened a connection
  - Message appended to MAILBOX file
- Email client:
  - To read email: TYPE MAILBOX
  - To delete email: delete lines from MAILBOX



# Email format

- Email format

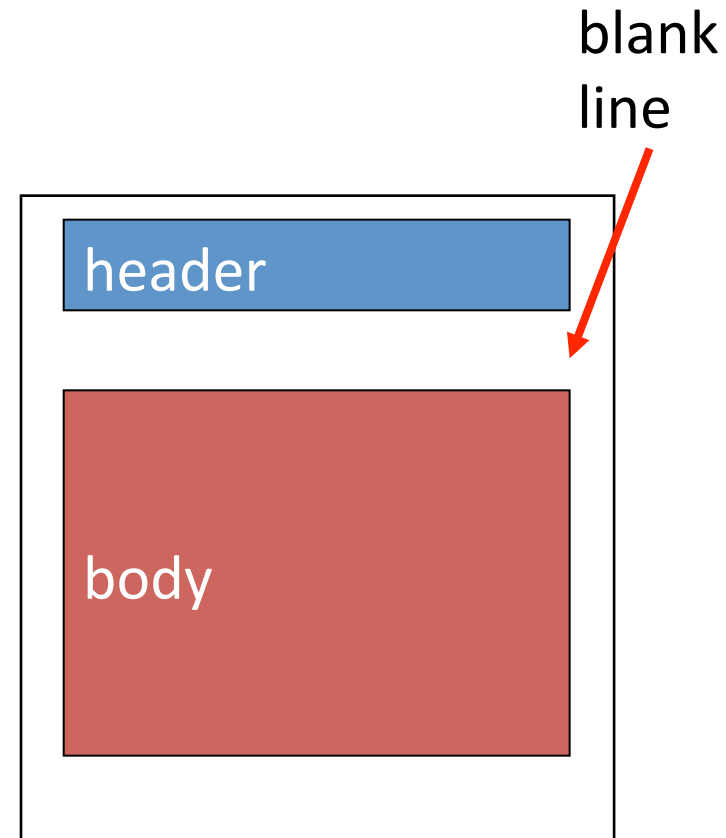
- Defined in RFC 822, Revised in RFC 5322, MIME
- Made up of two parts: header and body
- Everything in 7-bit ASCII text

- Header

- Lines with "type: value" pairs
- "To: user@mtech.edu"
- "Subject: meeting"

- Body

- The text of the message
- No particular structure



# Example email

Received: from mtmail8b.butte.campus ([10.34.34.212]) by mtmail8a.butte.campus ([10.34.34.211]) with mapi; Wed, 9 Nov 2011 15:53:59 -0700

From: "Evenson, Shaela" <SEvenson@mtech.edu>

To: All Faculty <all\_faculty\_users@mtech.edu>

Date: Wed, 9 Nov 2011 15:51:22 -0700

Subject: Volleyball Excuse List

Thread-Topic: Volleyball Excuse List

Thread-Index: AQHMnzJ3kOLNFJy+q0SZzTt4MMegZg==

Message-ID:

<AEC2139945463246967DF069BB2FA52153C220898F@mtmail8b.butte.campus>

Accept-Language: en-US

Content-Language: en-US

X-MS-Exchange-Organization-AuthAs: Internal

X-MS-Exchange-Organization-AuthMechanism: 04

X-MS-Exchange-Organization-AuthSource: mtmail8a.butte.campus

Content-Type: text/plain; charset="us-ascii"

Content-Transfer-Encoding: quoted-printable

MIME-Version: 1.0

Please excuse the following student athletes from class this Thursday, November 10th at 3:00pm and all day Friday, November 11th.

...



# Some RFC 5322 header fields

<b>Header</b>	<b>Meaning</b>
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

<b>Header</b>	<b>Meaning</b>
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

# Sending more complex things

- Users often want to send multiple things
  - A message plus multiple attachments
  - A message in different forms: plaintext and HTML version
  - A mailing list digest, messages from many people
- Users may want to send non-ASCII
  - ¿Qué pasa si usted quiere hablar español?
  - Binary files
- Message body can contain anything
  - Use some sort of known separator between parts
  - Need a standard to ensure interoperability



# MIME

- Multipurpose Internet Mail Extensions (MIME)
  - A series of RFCs, 2045-2047, 4288, 4289, 2049
- Addresses a number of issues:
  - Sending non-ASCII data
    - Other languages
    - Binary files, e.g. images, PDFs, videos
  - Sending multiple parts

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:	Type and format of the content

*Additional message headers defined by MIME.*

# Sending non-text data

- Problem: Email body, 7-bit US ASCII
- Solution: Convert non-ASCII to ASCII
- Base64 encoding (uuencode):
  - Group data in blocks of three bytes
  - Split each block into four 6-bit chunks
  - 0->A, 1->B, ..., 51->z, 52->0, 53->1, ..., 62->+, 63->/
  - If needed, pad last block with = signs to make four chunks

<b>Text content</b>	<b>M</b>	<b>a</b>	<b>n</b>	
<b>ASCII</b>	77	97	110	
<b>Bit pattern</b>	0 1 0 0 1 1 0 1	0 1 1 0 0 0 0 1	0 1 1 0 1 1 1 0	
<b>Index</b>	19	22	5	46
<b>Base64-encoded</b>	<b>T</b>	<b>W</b>	<b>F</b>	<b>u</b>



# MIME types

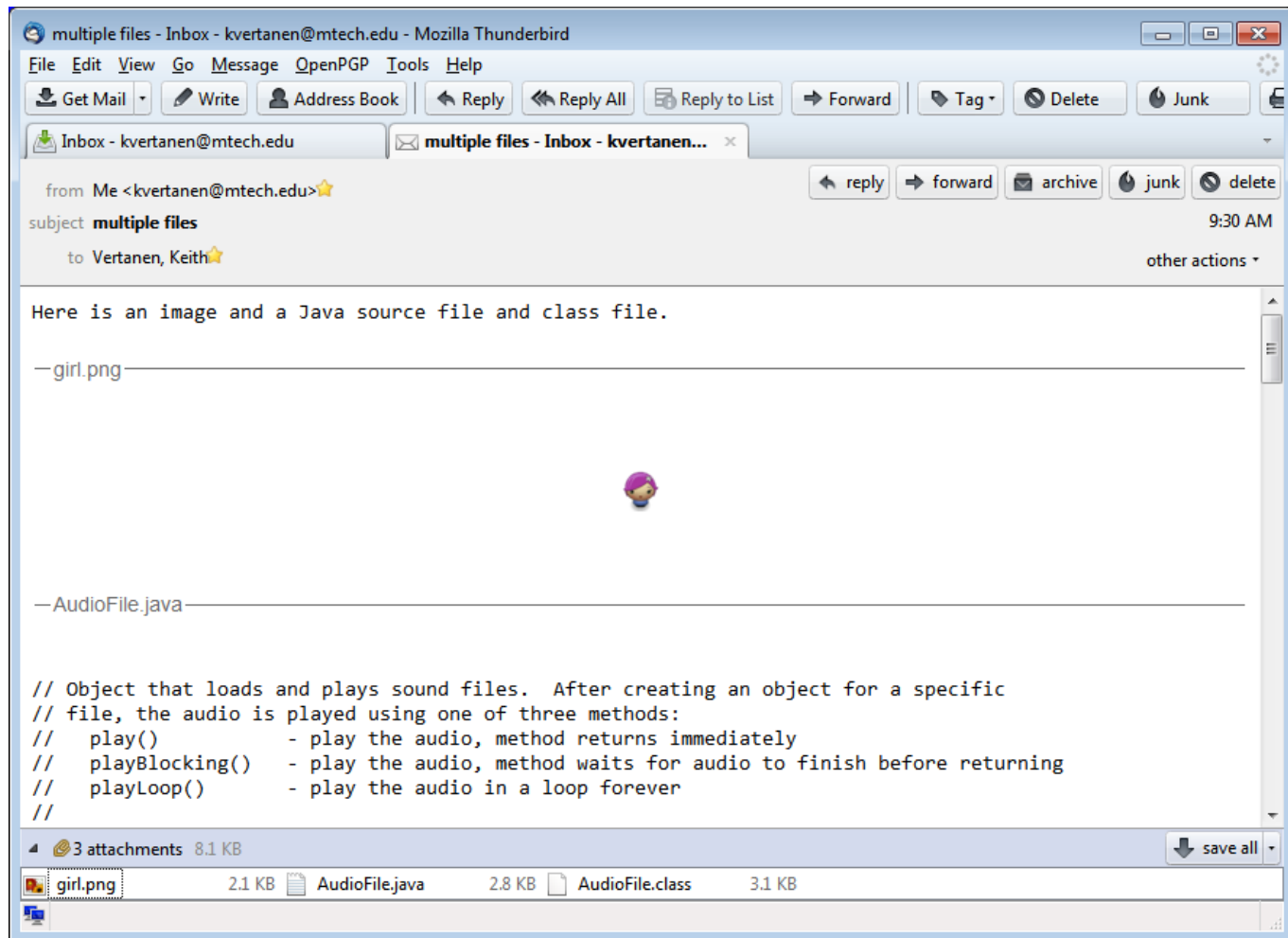
- Each part identified by type/subtype
  - Originally 7 types, now 9 with hundreds of subtypes
  - <http://www.iana.org/assignments/media-types/index.html>

Type	Example subtypes	Description
text	plain, html, xml, css	Text in various formats
image	gif, jpeg, tiff	Pictures
audio	basic, mpeg, mp4	Sounds
video	mpeg, mp4, quicktime	Movies
model	vrml	3D model
application	octet-stream, pdf, javascript, zip	Data produced by applications
message	http, rfc822	Encapsulated message
multipart	mixed, alternative, parallel, digest	Combination of multiple types

*MIME content types and some example subtypes.*

# multipart/mixed

- Each part a different type
  - e.g. multiple attachments



...

Content-Type: multipart/mixed; boundary="\_004\_4ED508B68000103mtechedu\_"  
MIME-Version: 1.0

--\_004\_4ED508B68000103mtechedu\_  
Content-Type: text/plain; charset="iso-8859-1"  
Content-Transfer-Encoding: quoted-printable

Here is an image and a Java source file and class file.

--\_004\_4ED508B68000103mtechedu\_  
Content-Type: image/png; name="girl.png"  
Content-Description: girl.png  
Content-Disposition: attachment; filename="girl.png"; size=2234;  
Content-Transfer-Encoding: base64

iVBORw0KGgoAAAANSUgAAACrkJggg==

--\_004\_4ED508B68000103mtechedu\_  
Content-Type: text/plain; name="AudioFile.java"  
Content-Description: AudioFile.java  
Content-Disposition: attachment; filename="AudioFile.java"; size=2968;  
Content-Transfer-Encoding: base64

Ly8gT2JqZWN0IHRoYXQgbG9hZHMgYW5kIHBsYXZlIHVvdW5kIGZpbGVzLiAgQWZ0ZXIyY3JlYXRp

...



# multipart/alternative

- Parts are different forms of the same content

CYBER MONDAY BLOWOUT | Buy.com at eBay - Inbox - kdv123 - Mozilla Thunderbird

File Edit View Go Message OpenPGP Tools Help

Get Mail Write Address Book Reply Reply All Reply to List Forward Tag Delete Junk

Inbox - kdv123 CYBER MONDAY BLOWOUT | Buy.com at eBay

from Buy.com Alert <buy.com\_offers@enews.buy.com> 11/28/2011 3:07 PM

subject CYBER MONDAY BLOWOUT | Buy.com at eBay

reply-to Buy.com Alert <buy.com\_offers-ctg0aeb62aadi2naxgiv3nhnibqhalpa@enews.buy.com>


to kdv123@googlemail.com


view in browser

**BIG SAVINGS. NO WAITING. EXCLUSIVE OFFERS.**

**CYBER MONDAY**  
*Specials*

**THANK YOU FOR YOUR PAST PURCHASE ON EBAY**

 **Nero 11 Platinum**  
**FREE BUDGET SHIPPING**  
Buy.com Price: **\$53.99**

 **TP-LINK TL-PA211KIT AV200 Mini Powerline Starter Kit & TP-LINK TL-PA211 AV200 Mini Powerline Adapter**  
**FREE BUDGET SHIPPING**  
Buy.com Price: **\$59.99**  
(expires 11/29/2011)

<http://enews.buy.com/cgi-bin5/DM/t/n8mCOPAYg80SY50VJdH0GI>

...

Subject: CYBER MONDAY BLOWOUT | Buy.com at eBay

MIME-Version: 1.0

Content-Type: multipart/alternative; boundary="-----00000000000000000000000000000000"

----- 00000000000000000000000000000000

Content-Type: text/plain; charset="utf-8"

Content-Transfer-Encoding: 8bit

Join us on:

View In Browser

<http://enews.buy.com/cgi-bin5/DM/t/m8mCOPAyG80SY50VJdG0HI>

----- 00000000000000000000000000000000

Content-Type: text/html; charset="utf-8"

Content-Transfer-Encoding: 8bit

<HTML><HEAD><TITLE></TITLE><STYLE type=text/css>

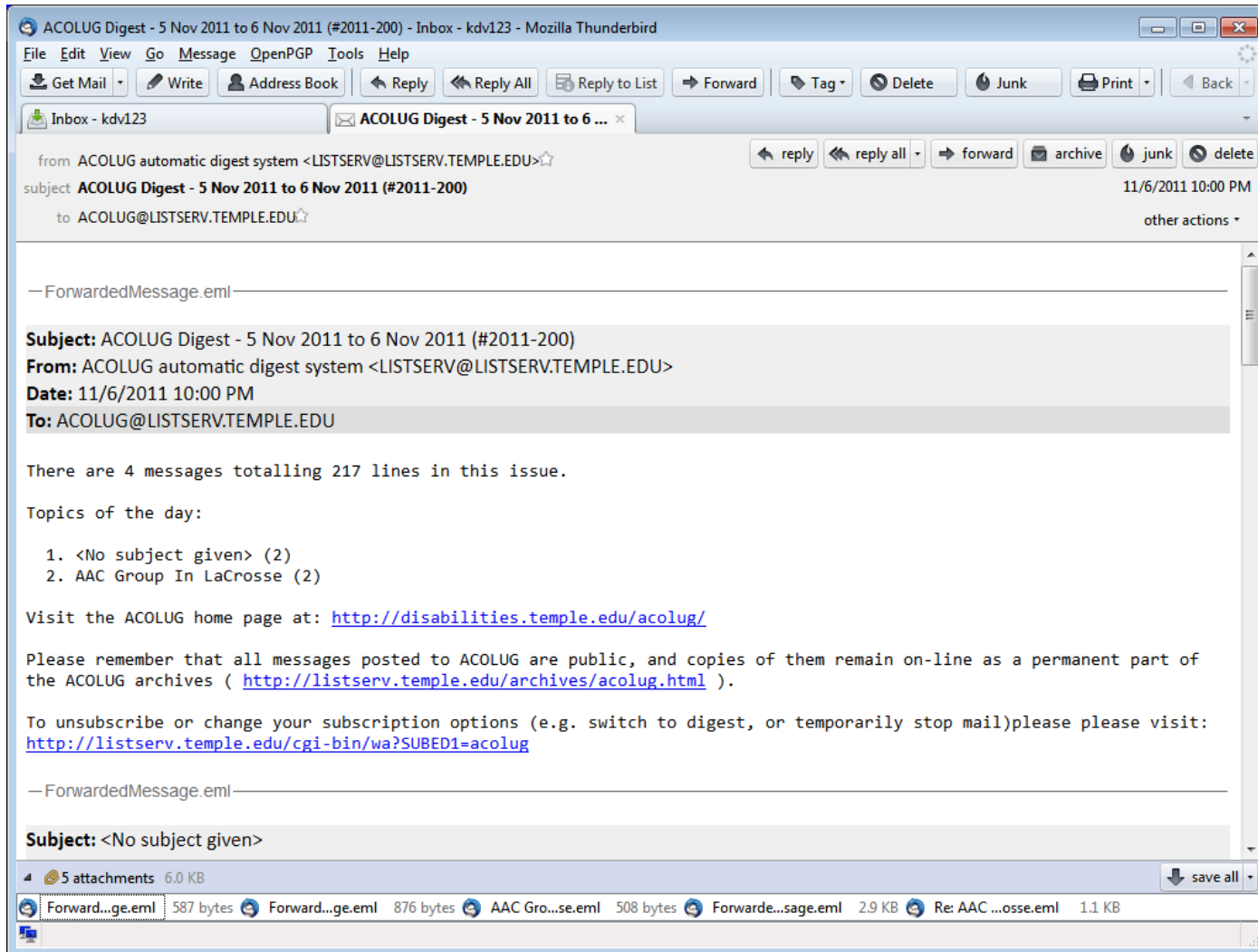
<!--

a:link {text-decoration: none}

...

# multipart/digest

- Combine messages in a mailing list



...

MIME-Version: 1.0

Content-Type: multipart/digest; boundary="LZQGCUJHLICPcMVULTPFREXCMLdADY"

--LZQGCUJHLICPcMVULTPFREXCMLdADY

Date: Mon, 7 Nov 2011 00:00:28 -0500

From: ACOLUG automatic digest system <LISTSERV@LISTSERV.TEMPLE.EDU>

Subject: ACOLUG Digest - 5 Nov 2011 to 6 Nov 2011 (#2011-200)

To: ACOLUG@LISTSERV.TEMPLE.EDU

Message-ID: <ACOLUG%201111070000287422.2EEF@LISTSERV.TEMPLE.EDU>

List-Unsubscribe: <mailto:ACOLUG-unsubscribe-request@LISTSERV.TEMPLE.EDU>

List-Subscribe: <mailto:ACOLUG-subscribe-request@LISTSERV.TEMPLE.EDU>

There are 4 messages totalling 217 lines in this issue.

1. <No subject given> (2)
2. AAC Group In LaCrosse (2)

--LZQGCUJHLICPcMVULTPFREXCMLdADY

Date: Sun, 6 Nov 2011 14:41:10 -0500

...

# Email addresses

- **username@company.tld**
  - Local mailbox on the left of @
  - Domain name on the right of @
- **Domain name may not be same as mail server**
  - Mail may live on different server than web server
  - Multiple mail servers for failover

| valid email  | invalid email                              |
|--|--|
| niceandsimple@example.com  | Abc.example.com                            |
| a.little.unusual@example.com   | A@b@c@example.com                          |
| much."more\ unusual"@example.com   | "(),;:<>[\]@example.com                    |
| very.unusual."@"unusual.com@example.com                                  | just"not"right@example.com                 |
| very."(),;:<>[]."VERY."very\\\ \@<br>\"very".unusual@strange.example.com | this\ is\"really\"not\\allowed@example.com |

E - MAIL ADDRESSES IT WOULD BE  
REALLY ANNOYING TO GIVE OUT  
OVER THE PHONE.

BY MICHAEL WARD

----

MikeUnderscore2004@yahoo.com

MikeAtYahooDotCom@hotmail.com

Mike\_WardAllOneWord@yahoo.com

AAAAAThatsSixAs@yahoo.com

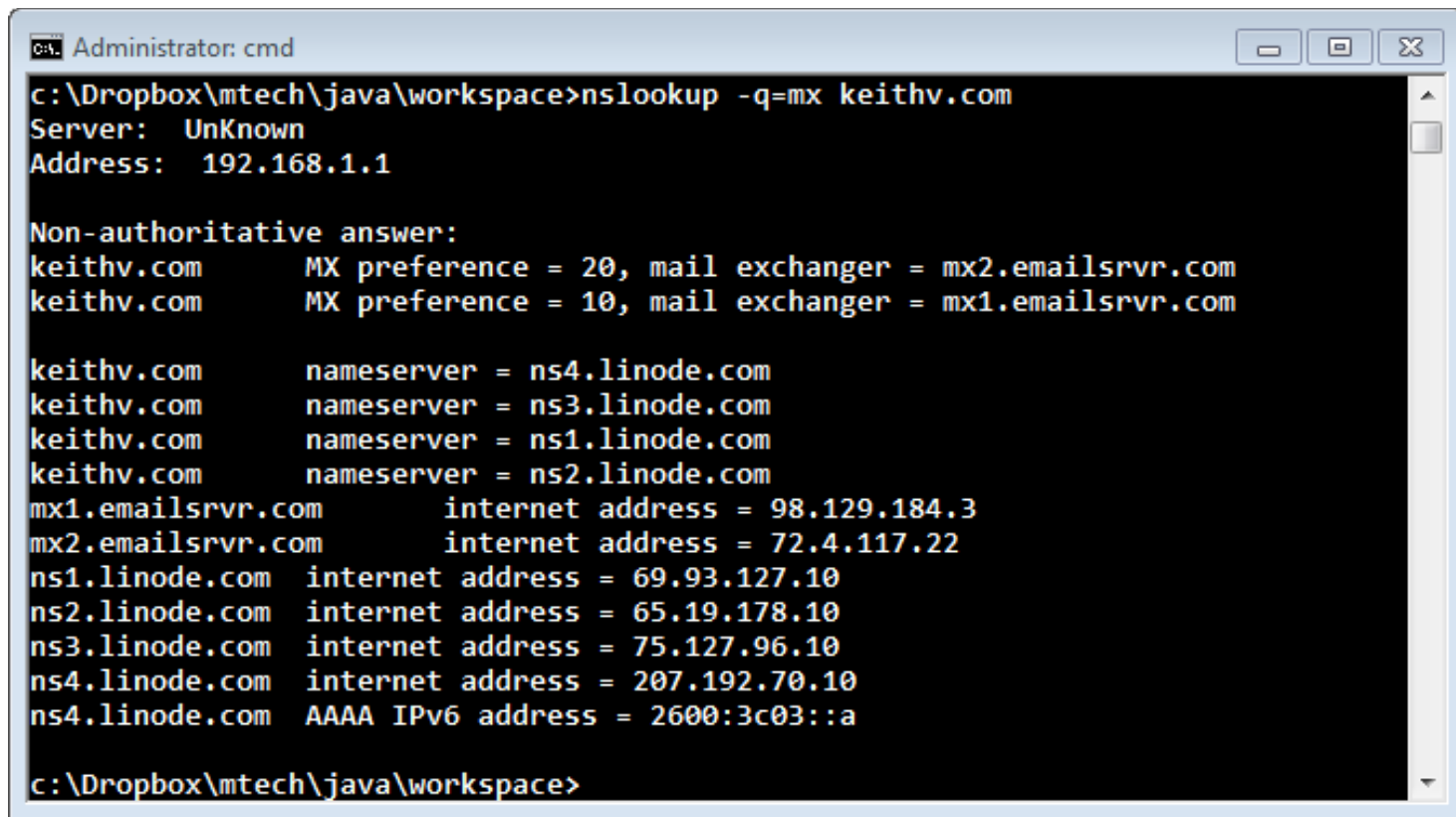
One1TheFirstJustTheNumberTheSecondSpelledOut@hotmail.com

<http://www.mcsweeneys.net/articles/e-mail-addresses-it-would-be-really-annoying-to-give-out-over-the-phone>



# Email addresses

- Mapping domain to mail server
  - Make DNS query for MX record (Mail eXchange)
    - e.g. nslookup -q=mx keithv.com



```
Administrator: cmd
c:\Dropbox\mtech\java\workspace>nslookup -q=mx keithv.com
Server: UnKnown
Address: 192.168.1.1

Non-authoritative answer:
keithv.com      MX preference = 20, mail exchanger = mx2.emailsrvr.com
keithv.com      MX preference = 10, mail exchanger = mx1.emailsrvr.com

keithv.com      nameserver = ns4.linode.com
keithv.com      nameserver = ns3.linode.com
keithv.com      nameserver = ns1.linode.com
keithv.com      nameserver = ns2.linode.com
mx1.emailsrvr.com  internet address = 98.129.184.3
mx2.emailsrvr.com  internet address = 72.4.117.22
ns1.linode.com    internet address = 69.93.127.10
ns2.linode.com    internet address = 65.19.178.10
ns3.linode.com    internet address = 75.127.96.10
ns4.linode.com    internet address = 207.192.70.10
ns4.linode.com    AAAA IPv6 address = 2600:3c03::a

c:\Dropbox\mtech\java\workspace>
```

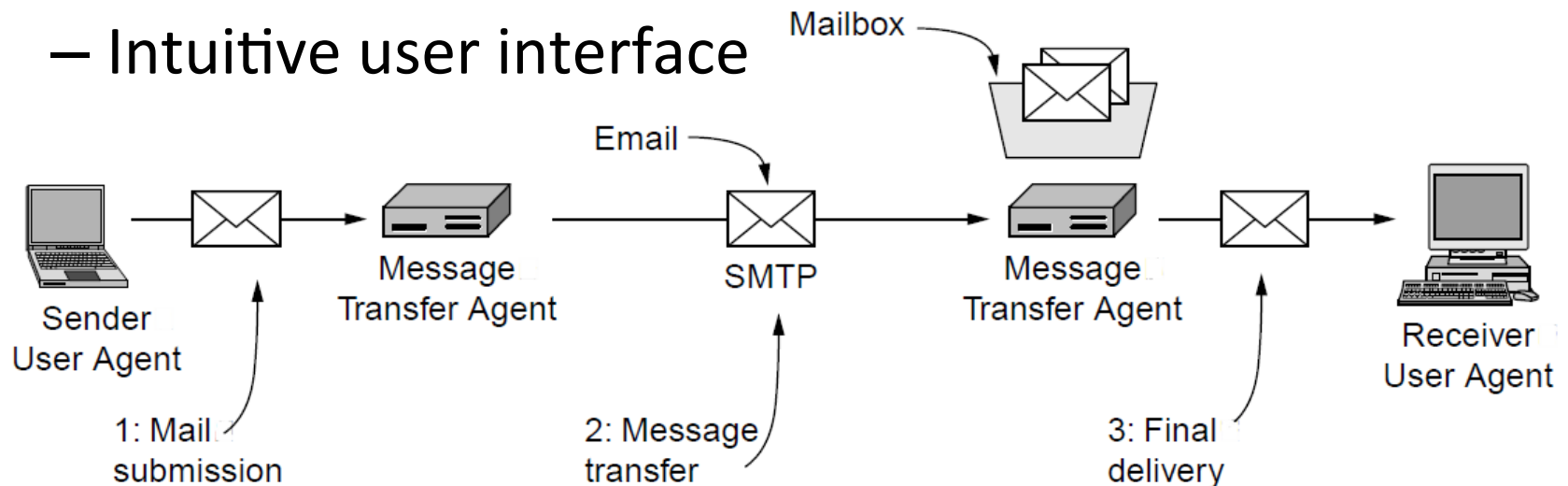
# Mail servers and user agents

- Mail servers

- Mail Transfer Agent (MTA), mail daemon
- Always on
- Transfer email to and from other servers

- User agents

- Sometimes on
- Intuitive user interface



# SMTP

- Simple Mail Transfer Protocol (SMTP)
  - Used to exchange email messages
    - "Push" protocol
  - Plaintext protocol over TCP (typically port 25)
  - Store-and-forward protocol
    - Messages sent through a series of servers
    - Servers queue messages and will retry on failure
    - Each hop adds its identity to "Received:" header



# Email with received header

Received: from hermes.umat.edu (10.10.7.32) by mtmail8e.butte.campus (10.34.34.215) with Microsoft SMTP Server id 8.3.137.0; Mon, 28 Nov 2011 14:43:39 -0700

Received: from umont01.umat.edu (umont01.umat.edu [10.249.8.16]) by hermes.umat.edu (8.13.8/8.13.8) with ESMTP id pASLhdt9003244 for <kvertanen@mtech.edu>; Mon, 28 Nov 2011 14:43:39 -0700

Received: from precisionconference.com ([204.232.241.168]) by umont01.umat.edu with ESMTP; 28 Nov 2011 14:43:39 -0700

Received: by precisionconference.com (Postfix, from userid 48) id 58ED92DF80AC; Mon, 28 Nov 2011 16:43:38 -0500 (EST)

From: "do\_not\_reply@precisionconference.com" <do\_not\_reply@precisionconference.com>

To: "Vertanen, Keith" <KVertanen@mtech.edu>

Date: Mon, 28 Nov 2011 14:43:38 -0700

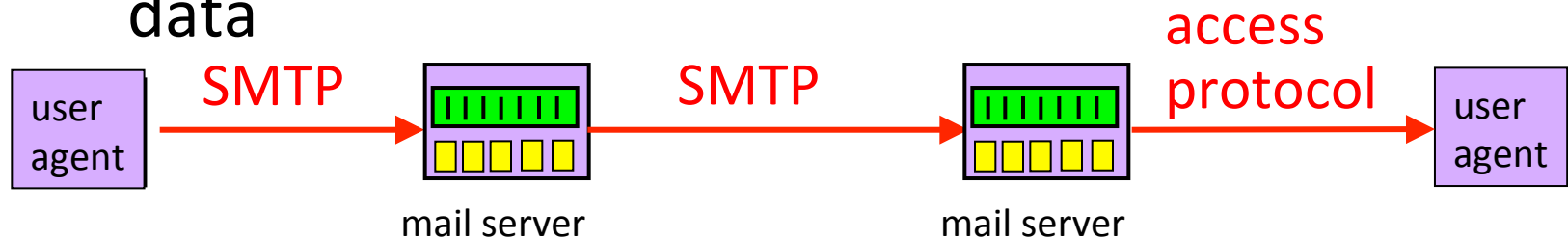
Subject: [IUI 2012 Short and Long Papers #319] Additional references

# Multiple server hops

- Usually at least two server hops
  - Sending and receiving mail servers
- But sometimes more. Why?
  - Separate mail servers for different functions
    - e.g. Spam filtering, virus scanning
  - Servers may redirect message
    - e.g. Forwarding old email address to a new one
  - Electronic mailing lists
    - Mail delivered to a mailing list's server
    - Sent off to all the subscribers of the list

# SMTP protocol

- Client-server protocol
  - Client is the sending machine
  - Server is the receiving machine
- Reliable data transfer
  - ASCII protocol running over TCP (port 25)
- Push protocol
  - Sending machine pushes the data to the receiver
  - Instead of having receiver periodically poll for data





# SMTP

- **Command/response protocol**
  - Commands are 4-letter ASCII commands and usually some argument
  - Response numeric code plus freeform human text
- **Synchronous**
  - Sender fire command and then waits for response
  - Pipelining added later (RFC 2920)
- **Process:**
  - Handshake
  - Transfer message(s)
  - Close connection

S: 220 smtp.example.com ESMTP Postfix  
C: HELO relay.example.org  
S: 250 Hello relay.example.org, I am glad to meet you  
C: MAIL FROM:<bob@example.org>  
S: 250 Ok  
C: RCPT TO:<alice@example.com>  
S: 250 Ok  
C: RCPT TO:<theboss@example.com>  
S: 250 Ok  
C: DATA  
S: 354 End data with <CR><LF>.<CR><LF>  
C: From: "Bob Example" <bob@example.org>  
C: To: "Alice Example" <alice@example.com>  
C: Cc: theboss@example.com  
C: Date: Tue, 15 Jan 2008 16:02:43 -0500  
C: Subject: Test message  
C:  
C: This is a test message.  
C: .  
S: 250 Ok: queued as 12345  
C: QUIT  
S: 221 Bye

# Trying SMTP for yourself

- Running SMTP

- "telnet popmail.mtech.edu 25" at UNIX prompt
- You'll get 220 reply from server
- Enter HELO, MAIL FROM, RECPT TO, DATA commands

- Spoofing?

- Yes, put whatever you like in "MAIL FROM"
- Original SMTP didn't include sender authentication
- Caused big spam issues in the 90s
  - Now AUTH extension to SMTP
- 9 out of 10 email messages are spam (McAfee 2010)

# Manually sending an email

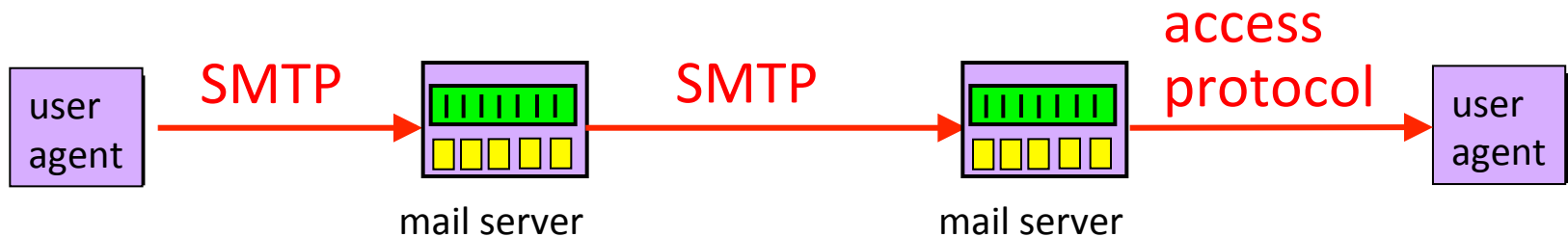
The image shows a terminal window and a Mozilla Thunderbird email client window. The terminal window displays the following text:

```
vertanen@katie:~$ telnet popmail.mtech.edu 25
Trying 10.34.34.211...
Connected to mtmail8a.mtech.edu.
Esc
220
11
HELO
250
MAIL
250
RCP
250
DATA
354
Subj
Lau
-
250
il
QUI
221
Con
ver
```

The Mozilla Thunderbird window shows an email from `president@whitehouse.gov` with the subject `URGENT`. The email body contains the text `Launch the missiles!`. The window title is `URGENT - Inbox - kvertanen@mtech.edu - Mozilla Thunderbird`. The interface includes a menu bar (File, Edit, View, Go, Message, OpenPGP, Tools, Help) and a toolbar with buttons for Get Mail, Write, Address Book, Reply, Reply All, Reply to List, Forward, Tag, and Delete. The email header shows the sender as `president@whitehouse.gov` and the subject as `URGENT`. The time of the email is `11:33 AM`. The email body text is `Launch the missiles!`.

# Retrieving your email

- Mail server stores email by mailbox
  - Based on the "From:" field in the message
- User agent needs to retrieve
  - At some later point, not when message was sent
  - View the message, reply, organize and store
- In the olden days:
  - Telnet to main machine at work
  - Mail client read the mailbox directly

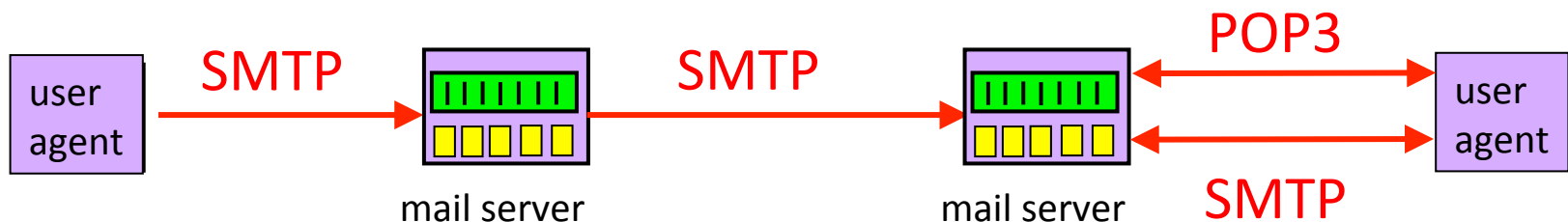


# Modern email retrieval

- People access same email account from:
  - Desktop at work
  - Laptop at home
  - Smart phone
- Problems:
  - No single device
  - Devices are not always-on
- Led to the Post Office Protocol (POP)
  - Retrieve email when connected to network
  - Allow users to view/manipulate messages offline
  - TCP on port 110

# Post Office Protocol (POP)

- Typical POP interaction:
  - Connect to server
  - Retrieve all email messages
  - Store messages on user's machine as new messages
  - Delete all the messages from the server
  - Disconnect from server
- User agent still uses SMTP to send messages



# POP3 example

## Authorization phase

- Client commands:
  - **user:** declare username
  - **pass:** password
- Server responses
  - **+OK**
  - **-ERR**

```
S: +OK POP3 server ready
C: user bob
S: +OK
C: pass hungry
S: +OK user successfully logged on
```

## Transaction phase

- **list:** list message numbers
- **retr:** retrieve message by number
- **dele:** delete
- **quit**

```
C: list
S: 1 498
S: 2 912
S: .
C: retr 1
S: <message 1 contents>
S: .
C: dele 1
C: retr 2
S: <message 1 contents>
S: .
C: dele 2
C: quit
S: +OK POP3 server signing off
```



# POP3 problems

- Not designed to keep messages on server
  - No way to track "read" state of messages across multiple client mail programs
- Does not handle multiple folders
  - Everything in one folder
- High bandwidth required
  - You can list message IDs and size
  - No search ability
  - Download entire message
  - TOP to view certain number of lines at top of message

# IMAP

- Internet Message Access Protocol (IMAP)
  - Plaintext protocol, TCP port 143
- Multiple client programs can connect at once
  - Server tracks message state
    - read, replied to, deleted
  - Server can synch changes between clients
- Access to MIME parts and partial fetch
  - Retrieve only parts of a message
  - e.g. Get the message but not any attachments
- Support creating/renaming/deleting folders
- Search messages on server-side

# IMAP commands

| Command      | Description                               |
|--------------|---|
| CAPABILITY   | List server capabilities                  |
| STARTTLS     | Start secure transport (TLS; see Chap. 8) |
| LOGIN        | Log on to server                          |
| AUTHENTICATE | Log on with other method                  |
| SELECT       | Select a folder                           |
| EXAMINE      | Select a read-only folder                 |
| CREATE       | Create a folder                           |
| DELETE       | Delete a folder                           |
| RENAME       | Rename a folder                           |
| SUBSCRIBE    | Add folder to active set                  |
| UNSUBSCRIBE  | Remove folder from active set             |

|         |  |
|---------|--|
| LIST    | List the available folders               |
| LSUB    | List the active folders                  |
| STATUS  | Get the status of a folder               |
| APPEND  | Add a message to a folder                |
| CHECK   | Get a checkpoint of a folder             |
| FETCH   | Get messages from a folder               |
| SEARCH  | Find messages in a folder                |
| STORE   | Alter message flags                      |
| COPY    | Make a copy of a message in a folder     |
| EXPUNGE | Remove messages flagged for deletion     |
| UID     | Issue commands using unique identifiers  |
| NOOP    | Do nothing                               |
| CLOSE   | Remove flagged messages and close folder |
| LOGOUT  | Log out and close connection             |

# telnet popmail.mtech.edu 143

```
S: * OK The Microsoft Exchange IMAP4 service is ready.  
C: ? CAPABILITY  
S: * CAPABILITY IMAP4 IMAP4rev1 AUTH=NTLM AUTH=GSSAPI AUTH=PLAIN STARTTLS  
IDLE NAMESPACE LITERAL+  
C: ? list "" "*"   
S: * LIST (\HasNoChildren) "/" "Deleted Items"  
S: * LIST (\HasNoChildren) "/" Drafts  
S: * LIST (\Marked \HasNoChildren) "/" INBOX  
S: * LIST (\HasNoChildren) "/" Sent  
C: ? SELECT INBOX  
S: * 1251 EXISTS  
S: * 0 RECENT  
S: * FLAGS (\Seen \Answered \Flagged \Deleted \Draft $MDNSent)  
S: * OK [PERMANENTFLAGS (\Seen \Answered \Flagged \Deleted \Draft $MDNSent)]  
Permanent flags  
S: * OK [UIDVALIDITY 535045] UIDVALIDITY value  
S: * OK [UIDNEXT 1422] The next unique identifier value
```

```
openssl s_client -connect imap.example.com:993 -crlf
```

# telnet popmail.mtech.edu 143

```
C: ? FETCH 1250:1251 flags
S: * 1250 FETCH (FLAGS (\Seen \Deleted))
S: * 1251 FETCH (FLAGS (\Seen))
C: ? FETCH 1251 rfc822.header
S: * 1251 FETCH (RFC822.HEADER {736}
S: MIME-Version: 1.0
S: Received: from evilgenius.com (10.33.73.166) by mtmail8a.butte.campus
(10.34.34.211) with Microsoft SMTP Server id 8.3.137.0; Tue, 29 Nov 2011
11:33:32 -0700
S: From: "president@whitehouse.gov" <president@whitehouse.gov>
S: Date: Tue, 29 Nov 2011 11:33:32 -0700
S: Subject: URGENT
S: Content-Type: text/plain; charset="iso-8859-1"
S: Content-Transfer-Encoding: quoted-printable
C: ? FETCH 1251 rfc822.header
S: * 1251 FETCH (RFC822.TEXT {24}
S: Launch the missiles!
S: FLAGS (\Seen))
C: ? LOGOUT
S: * BYE Microsoft Exchange Server 2007 IMAP4 server signing off.
```

# Web-based email

- User agent is a web browser

- Network protocol is HTTP
- e.g. Gmail, Yahoo mail, Hotmail



- Reading email

- Web page displays folders and messages
- HTTP "GET" request to retrieve pages



- Sending email

- Web form that does a "POST" to submit message
- Webmail provider sends message via SMTP



# Summary

- Application protocols we've seen so far:
  - Web: **HTTP**
  - Email: **SMTP, POP3, IMAP4**
- Electronic email
  - Message format specified originally by RFC 822
  - MIME allows multiple parts, binary data
  - SMTP for sending email
  - POP3, IMAP4, or HTTP for retrieving to mail