

# Electronic Mail Paradigm

- E-mail uses the client-server model.
- E-mail was designed as an electronic extension of the old paper office memo.
  - A quick and easy means of low-overhead written communication.
  - Dates back to time-sharing systems in the 1960s.
- Since e-mail is electronic, new forms of interaction became possible.
  - Automatic processing such as sorting and replies.
  - A means of carrying other types of content.

# Electronic Mailboxes

- Each e-mail user has an electronic mailbox into which incoming e-mail is deposited.
- An electronic mailbox is a passive storage area (file). On our UNIX system, mailboxes are files in the directory **`/var/mail`**.
- A user accesses e-mail with a mail reader program.
- A mailbox is associated with a computer account.
- One user may have different electronic mailboxes corresponding to several accounts.

# Electronic Mail Addresses

- An electronic mailbox is identified by an e-mail address.
- An e-mail address is typically a user's account ID, but not necessarily.
- On a non-networked multi-user computer, an e-mail address is just an account ID. There's no need to identify the computer.
- Mail delivery is more complicated among network users.
  - An e-mail address must identify the computer as well as the mailbox.

# Electronic Mail Addresses

- An e-mail address consists of a computer name and a mailbox name.
- The most widely used form is **mailbox@computer**—that is, **user@host**.

# Internet Mail Addressing

- The user part is site-specific. The host part is the domain name.
  - **jfink@gettysburg.edu** is used to send me e-mail at the College.
  - **jfink@cs.gettysburg.edu** is used to send me e-mail in the department.
- What the source mail client does:
  - Resolves the destination name using DNS.
  - Contacts the mail delivery server at the destination.
  - Sends the mail message to the server.

# Internet Mail Addressing

- What the destination mail server does:
  - Interprets the user name according to local mailbox addresses.
  - Places the mail message in the appropriate mailbox.

# E-Mail Message Format

- E-mail has a simple two-part format:
  - A header which includes delivery information.
  - A body which carries the text of the message.
- The header and the body are separated by a blank line.

# E-Mail Headers

- Each line in a header has the form  
**keyword: information**
- The **keyword** identifies the kind of information.
- Required information:
  - **To:** recipients' addresses (entered by sender).
  - **From:** sender's address (entered by sender's e-mail software).
- Optional information:
  - **Date:** date e-mail is sent.
  - **Subject:** topic of the message.



# E-Mail Headers

- **Cc:** address for carbon copies.
- **Reply-to:** address to which reply should be sent.
- **X-Charset:** character set (usually ASCII).
- **X-Mailer:** mail software used.
- **X-Sender:** duplicate of sender's address.
- E-mail software passes unknown header lines unchanged.
  - Application programs that use e-mail to communicate can add lines to the header to control processing.
  - An e-mail software vendor can add functionality by using extra header lines.

# E-Mail Data

- Original Internet e-mail carried only 7-bit ASCII data. Adequate for basic text.
- Original e-mail couldn't contain arbitrary data such as an executable program or a graphics image.
- Techniques were developed to encode binary data in text form.
- One encoding technique is **uuencode**.
  - Three 8-bit binary values are encoded as four ASCII characters (6 bits each).
  - Carries file name and protection.
  - Incurs a 33% overhead.
  - Requires manual intervention.

# MIME (RFC 2045)

- Multipurpose Internet Mail Extensions (MIME) - a mechanism for allowing nontext data to be sent in a standard Internet e-mail message.
- MIME was designed by the IETF to facilitate multimedia e-mail and to provide an encoding that could get binary data past the most brain-damaged mail transfer programs.
- MIME is an open standard for sending multipart multimedia data (programs, pictures, audio clips) through Internet e-mail.

## MIME (RFC 2045)

- Although designed for e-mail, MIME is also used by non-e-mail programs such as Web browsers.
- The sending program identifies the content type and subtype in a header line so that the receiving program can extract the file type and inform the recipient. Is it a picture? Text? A movie?

Example:

```
MIME-Version: 1.0  
Content-Type: image/gif  
(type/subtype)
```

## MIME (RFC 2045)

- MIME is an open standard; that is, it does not dictate a single standard. It is extendable in that a sender and a receiver can agree on a nonstandard encoding scheme by using the prefix **x-**.

Example:

**Content-Type: application/x-tex**

This identifies the MIME type **application** and the nonstandard subtype **x-tex** for a TeX document.

## MIME (RFC 2045)

- MIME is compatible with existing e-mail systems.
  - Everything is coded in ASCII.
  - Headers and separators are ignored by non-MIME mail systems.
- MIME encapsulates binary data in an ASCII mail envelope.

# E-Mail & Programs

- An electronic mailbox can be associated with a program instead of a user's mail reader.
- Incoming mail is automatically passed as input to a program.
- Operates on a client-server model.
  - A client request arrives in a mail message.
  - A server response is returned in a mail reply.
- Examples:
  - Subscribing to a mailing list.
  - Obtaining information from a database.

# Mail Transfer

- E-mail transfer is a several part process.
- A user composes a mail message with an e-mail interface program.
- A mail transfer program delivers the mail to the destination.
  - Waits for mail to be placed in an outgoing message queue.
  - Picks up a message and determines the recipient(s).
  - Becomes a client and contacts a server on the recipient's computer.
  - Passes the message to the server.



# Mail Transfer

- The server on the recipient's computer copies the message to the recipient's mailbox.

## SMTP (RFC 821)

- Simple Mail Transfer Protocol (SMTP) - a protocol used to deliver (send) e-mail from one computer to another across the Internet. Part of the TCP/IP protocol suite.
- Provides reliable delivery of messages.

# Mail Gateways

- E-mail processing may take significant resources in a large organization.
- mail gateway - a computer dedicated to processing e-mail.

Example: The College uses **gbmail**.

- A mail gateway provides a single uniform mail destination point for all incoming mail.

Example: **gettysburg.edu**

- The MX (Mail Exchange) records in DNS can be used to cause all e-mail to be delivered to a gateway.

# Forwarding E-Mail

- Users within an organization may want to read mail on a local or a department computer.
- Users can arrange to have mail forwarded from a mail gateway to another computer.  
Example: Most of us in CS have our e-mail forwarded to Triton.
- A mail message will then make multiple hops for delivery.
- Hops may be recorded in the header.

# Mailbox Access

- Where should a mailbox be located?
- A user wants e-mail access from a frequently used computer.
- However, a mailbox cannot always be located on a desktop computer.
  - A computer must have a mail server program that accepts mail messages and stores them in mailboxes.
  - Running servers requires a multi-tasking OS.
  - Servers are expected to run continuously, and desktop computers aren't always on.

## Mailbox Access

- Since mailboxes are usually not on desktop computers, users can either move to an e-mail computer (awkward) or Telnet to an e-mail computer.
- Alternately, one can use POP.

## POP (RFC 1939)

- Post Office Protocol (POP) - a protocol used to access e-mail on a remote computer. Part of the TCP/IP protocol suite.
- A computer with mailboxes runs a POP server.
- A user runs a POP client on a local computer.
- A POP client can access and retrieve messages from a mailbox.
- POP requires password authentication.

## POP (RFC 1939)

- POP can be used with a dial-up connection.
  - A user's local computer need not always be connected.
  - A user can download e-mail all at once and read it off-line.
  - A user can compose e-mail off-line and send it all at once.



# Sending & Receiving E-Mail

- A computer that has mailboxes must run two servers:
  - A mail server using SMTP to accept incoming mail and deliver it to the appropriate mailbox.
  - A POP server to allow users on remote machines to access their mailboxes.
- SMTP is a push protocol. POP is a pull protocol.

## IMAP (RFC 2060)

- POP is a very simple mail access protocol.
  - It does not carry state information across POP sessions.
  - It does not allow a user to maintain a folder hierarchy on the server machine.
- Internet Mail Access Protocol (IMAP) - a mail access protocol with many more features than POP.
- Designed to allow users to maintain remote mailboxes as if they were local.
- Allows users to obtain components of messages such as headers and parts of a multipart MIME message.

# HTTP

- More and more e-mail is being sent using browser-based e-mail services such as Hotmail.
- The user agent is an ordinary Web browser.
- The user communicates with a mailbox via HTTP.
- When a recipient wants to access e-mail messages, the messages are sent from the mail server to the browser using HTTP instead of POP.
- When a sender sends a message, the message is sent to the mail server using HTTP instead of SMTP.

# HTTP

- The mail server still sends messages to and receives messages from other mail servers using SMTP.
- Enormously convenient for users on the go.
- Some predict it may even replace SMTP, POP, and IMAP.
- A downside is that it can be slow.
  - The mail server is far away from the user.
  - Interaction is done through CGI scripts.