Electronic Mail

- E-mail belongs to the **Application Layer**
- Has been around since the early 80's
- Enables new forms of interaction
  - Fast
  - Automatic processing (sorting, reply)
  - Can carry other content
- Electronic mail uses **client-server** architecture
  - Electronic mail client accepts mail from user and delivers to server on destination computer
  - Many variations and styles of delivery

Electronic Mailboxes

- E-mail users have an **electronic mailbox** into which incoming mail is deposited
- User then accesses mail with a mail reader program
- Usually associated with a computer account
  - One user may have different electronic mailboxes
E-mail Addresses

- Electronic mailbox is identified by an e-mail address
  - Typically user’s ID account, but not always
    - Administrators may create different mailbox identifiers, e.g. Firstname.Lastname (or even numbers, e.g. 578.4309)
  - To deliver email among networked computers, needs computer name together with mailbox
    - Typically: user@host
    - Sender uses the host part to select a destination; receiving server uses user part to select a mailbox

Mail Client-Server

- Source mail client:
  - Resolves destination name using DNS
  - Contacts mail delivery server at destination
  - Copies mail to server
- Destination mail server:
  - Interprets user name according to local mailbox addresses
  - Place mail in appropriate mailbox
E-mail Message Format

- Simple two-part format:
  - **Header** includes delivery information
  - **Body** carries text of message
- Header and body separated by blank line
- **Header:** lines of text in format
  - `keyword:information`
- Some keyword are required; some optional

Header Fields

- **To:** Addr. of primary recipient
- **Cc:** Addr. of secondary recipients
- **Bcc:** Addr. for blind carbon copies
- **From:** Person who "created" the message
- **Sender:** Person who actually "sent" the message
- **Receiver:** Line added by each transfer agent along the route
- **Date:** Date and time message was sent
- **Reply-To:** Email address to which replies should be sent
- **Message-Id:** Unique number for referencing this message
- **In-Reply-To:** Message-Id of message to which this is a reply
- **Subject:** Short summary of message for 1-line display
**Header - Example**

Received: from usc.edu by scrooge.systems.caltech.edu (4.1/1.34.1) id AA21880; Wed, 29 Mar 95 21:46:27 PST  
Received: from iris.usc.edu (nevati@iris.usc.edu [128.125.84.2]) by usc.edu (8.6.10/8.6.4)  
  with ESMTP id VAA26969 for <manduchi@systems.caltech.edu>; Wed, 29 Mar 1995  
  21:46:26 -0800  
Received: (nevati@localhost) by iris.usc.edu (8.6.10/8.6.7+ucs) id VAA05198 for  
  manduchi@systems.caltech.edu (Roberto Manduchi); Wed, 29 Mar 1995 21:46:26 -  
  0800  
Date: Wed, 29 Mar 95 21:46:26 PST  
From: Ram Nevatia <nevati@iris.usc.edu>  
To: manduchi@systems.caltech.edu  
Subject: talk  
Message-Id: <CMM.0.90.2.796542386.nevatia@iris.usc.edu>

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**Data in E-mail**

- **Original Internet system: RFC 822**
- **Perfectly suited for transmitting ASCII text**
- **Does not work with:**
  - Messages in languages with accents (e.g. French)
  - Messages in non-Latin alphabets (e.g. Russian)  
    or languages without alphabets (e.g. Chinese)  
  - Messages not containing text at all (e.g., audio and video)  
- **Solution: Multipurpose Internet Mail Extension (MIME)**
MIME

• MIME extends and automates encoding mechanisms
• Allows inclusion of separate components (programs, pictures, audio/video clips) in a single mail message
• Sending program identifies the components so receiving program can automatically extract and inform mail recipient

MIME (cont’d)

• MIME uses RFC 822 but adds structure to message body and defines encoding rules for non-ASCII messages
  – So one can use the same delivery mechanism
• MIME adds a **Content-Type** field, where a sender can specify the nature of the message body.
• *E.g.*, **Content-Type** = *video/mpeg*
  – Then the receiver knows that the message body contains a video encoded with the MPEG standard
E-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
SMTP

• Simple Mail Transfer Protocol (SMTP) is the standard application protocol for delivery of email from source to destination
• Provides reliable delivery of messages
• Uses TCP and message exchange between client and server
• Other functions:
  – Email address lookup
  – Email address verification
• Allows for multiple recipients (makes multiple copies for delivery)

Optimizing for Multiple Recipients

• If a user needs to send the same message to \( n \) different recipients at the same host address:
  – Either establish \( n \) different connections and send \( n \) identical;
  – Or, establish just one connection, send just one copy of the message, and have the server deliver a copy to each one of the \( n \) recipients
• Advantages: less data to transmit, messages arrive at the same time
Mailing Lists and Forwarders

- E-mail addresses can be attached to programs as well as electronic mailboxes
- **Mail exploder** or **mail forwarder** resends copies of message to e-mail addresses in **mailing list**
  - Just need to send one email to the mailing list recipient; mail gets forwarded to all recipients in the list

Mail Gateways

- Mailing list processing may take significant resources in large organizations
- **Mail gateway**
  - Provides single mail destination point for all incoming mail (e.g.: ucsc.edu)
  - Gateway computer has a database for all people in the destination, with the name of the computer where their mailbox is
  - Gateway relays mail to the destination
  - E.g.: mail to manduchi@ucsc.edu is relayed to manduchi@cse.ucsc.edu
Mail Gateways

Mailbox Access

- Where should mailbox be located?
- Users want to access mail from most commonly used computer
  - But not all computers can run an email server!
    - Note that email server must run continuously (never be disconnected)
- A possibility: telnet to remote computer with mail server
- Better than telnet: Post Office Protocol (POP)
**POP**

- It is not practical to have mailboxes on any computer
- Computer with mailboxes runs POP server
- User runs POP client on local computer
- POP client can access and retrieve messages from mailbox
- Requires authentication (password)
- Local computer uses SMTP for outgoing mail
**POP and Dialup Access**

- **POP useful for dialup connection**
  - User’s computer not always connected
  - Can download all mail at once and read off-line
  - Can compose mail off-line and mail in one connection

- **An alternative to POP: IMAP (Interactive Mail Access Protocol):**
  - Does not copy email to user’s PC - email always resides in the mail server
  - Useful when user has several computers