B211 Internet Computing

How Does Email Work?

Lecture Outline

- The Components of an E-mail Exchange
- E-mail Message Formats
- E-mail Transport Protocols
- Mailing Lists

Introduction

- Electronic Mail (E-mail) is one of the most popular communication tools on the Internet.
- E-mail and the World-Wide-Web (WWW) have turned out to be the two killer-applications for the Internet
  - these two software are principally responsible for the wide-spread adoption of the Internet around the world.
- Just like the WWW, there needs to be standards on how to exchange messages in order for different people and machines to communicate using e-mail.

Introduction (cont'd)

- E-mail standards define two principal things:
  - what format the messages can be in, and
  - how to transfer messages.

Basic Components in Email Messaging

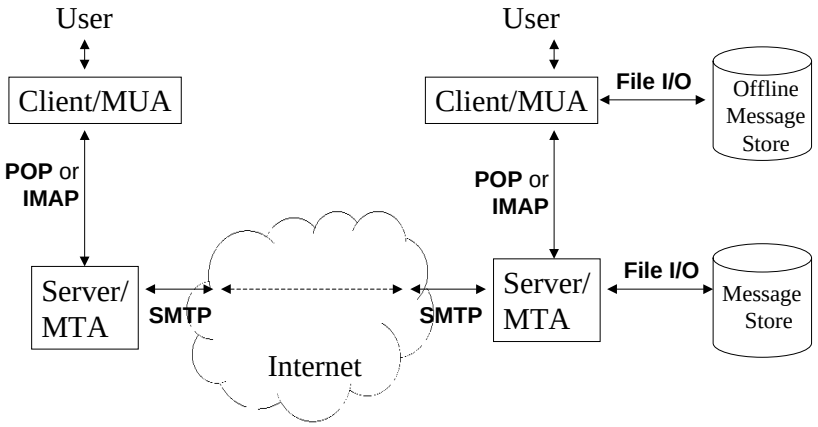
- ***User***
  - the person sending or receiving a message.

- ***Mail User Agent*** (MUA)
  - Also called ***mailer***, ***mail client***, ***mail application***, or ***mail program.***
  - the interface for the users to manipulate their messages.
  - Some examples:
    - Qualcomm's Eudora
    - Netscape's Communicator
    - Microsoft's Outlook

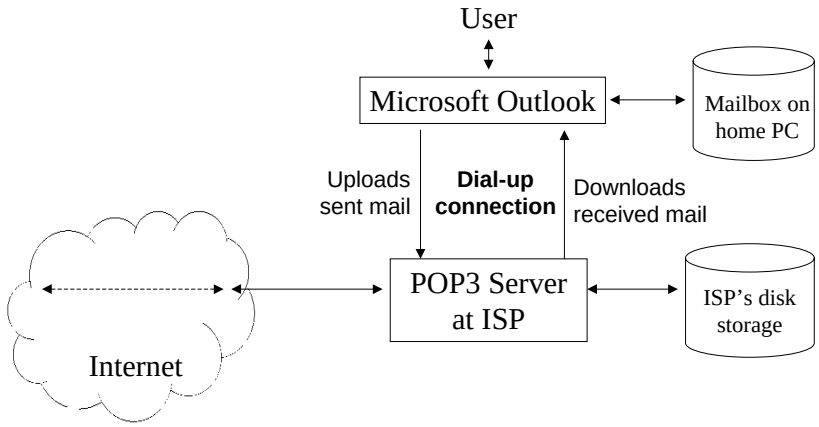
Basic Components in Email Messaging (cont'd)

- ***Mail Transport Agents (MTA)***
  - Also called ***mail servers***.
  - the software which receives stores and delivers e-mail messages.
  - Some examples:
    - sendmail
    - qmail
    - Sun's Internet Mail Server
    - Microsoft's Exchange Server

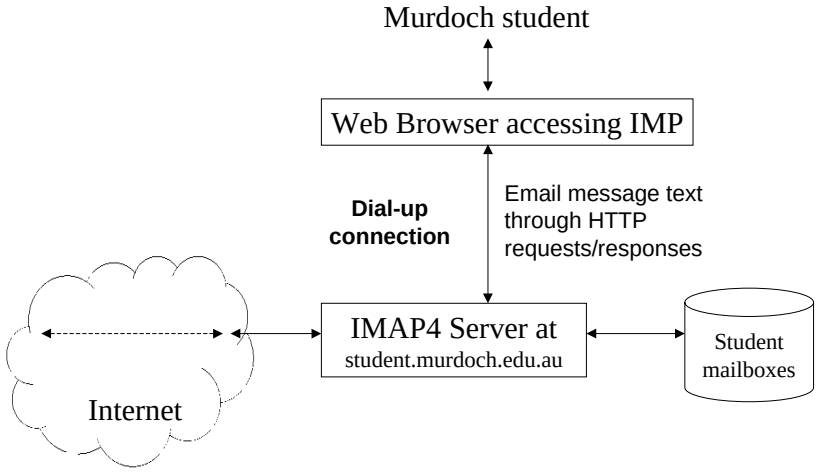
A Typical E-mail Exchange



Example Offline Mode



Example Online Mode: Murdoch's Webmail



Client-Server Models for E-Mail

- One way of describing an e-mail system is expressing it as an *offline*, *online* or *disconnected* model
- Offline
  - Client connects to e-mail server from time to time and download/uploads messages.
  - The client can delete messages on the server once downloaded, and all further processing happens on the client.

Client-Server Models for E-Mail

- Online
  - Client establishes a session with the e-mail server and processes the messages on the server.
  - No local copies of the messages.
- Disconnected
  - A mixture of Online and Offline.

E-mail Message Formats

- Different types of e-mail message formats:
  - RFC 822 - basic text messages
  - MIME
  - Secure messages

Text E-mail Message Format

- Originally defined in RFC 822
  - Basic e-mail messages is sometimes referred to as RFC822 messages.
- Used by POP3, SMTP and other e-mail transport protocols.

Text E-mail Message Format (cont'd)

- Components of an e-mail message:

1. Message Header
   - Generated by the user agent of the sender, and updated by every MTA that handled the message. Contains MTA info and time stamp.

2. Message Body
   - Text as composed by the sender
   - The specification requires that the messages be lines of ASCII text.

An Example Full E-mail Header

```
Received: from central.murdoch.edu.au (central.murdoch.edu.au [134.115.4.126])
      by dijkstra.it. murdoch.edu.au (8.9.3+Sun/8.9.3) with SMTP id MAA11148 for <hiew@it.murdoch.edu.au>;
      Tue, 17 Aug 1999 12:38:18 +0800 (WST)
Received: from Aus.Sun.COM by central. murdoch.edu.au (SMI-8.6/SMI-SVR4) id MAA02850;
      Tue, 17 Aug 1999 12:38:24 +0800
Received: from sunwa.Aus.Sun.COM by Aus.Sun.COM id OAA20503 (SMI-8.6/SMI-4.1 for <>);
      Tue, 17 Aug 1999 14:36:39 +1000
Received: from money by sunwa.Aus.Sun.COM (SMI-8.6/SMI-SVR4) id MAA19121;
      Tue, 17 Aug 1999 12:36:12 +0800
Message-Id: <199908170436.MAA19121@sunwa.Aus.Sun.COM>
Date: Tue, 17 Aug 1999 12:36:12 +0800 (WST)
From: Les Auty <Les.Auty@Aus.Sun.COM>
Reply-To: Les Auty <Les.Auty@Aus.Sun.COM>
Subject: SUN Solaris 7 System
Content-Length: 2786
Status: RO
MIME-Version: 1.0
Content-Type: TEXT/plain; charset=us-ascii
X-Mailer: dtmail 1.2.1 CDE Version 1.2.1 SunOS 5.6 sun4u sparc
...

Hello Hiew. In regards to your last message regarding the new release for Solaris,
...
```


An Example E-mail Message Header (cont'd)

- In the example message, note how we can tell that the message have passed through four different MTAs
  - Each line beginnning with "Received: ..." is added by a new MTA.
  - Eg. in the 1st line, the MTA on `dijkstra.it.murdoch.edu.au` received the message from `central.murdoch.edu.au`
  - Interesting things to note:
    - each MTA has their own slightly different format for the entry.
    - The local time stamp for each MTA may not be consistent with each other. Eg, central received the message first at 12:38:24 but dijkstra received it later at 12:38:18 !

Multipurpose Internet Mail Extensions (MIME)

- MIME enhances RFC 822 by defining formats for e-mail message that are not text.
- Backward compatible
  - all message formats conforming to RFC 822 can be handled by MIME-compatible software as well

MIME Content Types

- Different formats are defined in a message by using the **Content-Type** and **Content-Transfer-Encoding** header fields.
- There are currently 7 top-level MIME message types
  - Text (eg. **Content-Type: text/plain**)
  - Image (eg. **Content-Type: image/gif**)
  - Audio (eg. **Content-Type: audio/basic**)
  - Video (eg. **Content-Type: video/mpeg**)
  - Application (eg. **Content-Type: application/msword**)
  - Structured (mixture of types, eg. **Content-Type: multipart/mixed**)
  - Message (contains another complete message)

MIME Content Types

- Also refer to week 6 lecture 3 for details of character encodings used by MIME.

Secure E-mail Messages

- *Secure MIME* (S/MIME)
  - Currently developed by an IETF working group
  - a protocol for e-mail message formats which are secure.
  - Defines requirements for encryption, and for authentication using digital signatures.
- Other example secure and private e-mail message protocols:
  - Privacy Enhanced Mail (PEM)
  - Pretty Good Privacy (PGP)

How to Transport E-mail

- There exists protocols defining how e-mail messages are supposed to be transferred from one machine to another.
- For transferring between server and client:
  - POP
  - IMAP
- For transferring between servers:
  - SMTP

Post Office Protocol (POP)

- POP3 - current version 3 (RFC 1939)
- Uses the offline model.
- Client and server communicate by exchanging lines of text acting as commands.

Post Office Protocol (cont'd)

- In the original POP, all e-mail messages are downloaded when a POP client first queries the server for messages.
- POP3 has a richer set of commands for selectively downloading and deleting certain messages only.
- POP3 is very popular and widely implemented
  - used by a majority of ISPs to provide e-mail access to end-users.

Phases of a POP3 connection

- A POP3 connection is initiated when a user agent opens a TCP connection to port 110 on the server machine.
- Then POP3 goes through 3 phases:
  - Authorization:
    - User agent sends username and password for verification
  - Transaction:
    - User agent retrieves the messages to the client machine.
    - Marks certain messages for deletion
  - Update:
    - occurs after the user agent has quit.
    - server deletes the messages marked for deletion.

Internet Message Access Protocol (IMAP)

- Current version 4.
- Uses the online model.
- IMAP4 is more complicated and robust than POP3
  - more suitable on a laptop, or accessing messages over a slow telephone line, or access to messages from different locations.
- POP3 due to its simplicity is still more efficient, which is why is it currently the more deployed of the two options.

IMAP (cont'd)

- In contrast to POP3, IMAP for example
  - Downloads only selective messages, and parts of messages for reading.
  - Allows sending of multiple requests from the client to server without having to wait for a response for each request.
    - each request is uniquely tagged so that the client knows which request a certain response corresponds to, when it receives the responses.
  - Maintains messages on servers
    - so that if accessed from multiple locations, you won't have multiple mailboxes which are out-of-synch.
  - Encryption of passwords.

Simple Mail Transfer Protocol (SMTP)

- POP3 and IMAP are designed for mail access (server-to-client or client-to-server), and not for between server message transfers.
- SMTP is the heart of e-mail transfer over the Internet.
- Designed to efficiently transfer multiple messages to multiple recipients in a single session.

Simple Mail Transfer Protocol (SMTP)

- Works by request-response exchanges
  - like POP3, the requests and responses are in the form of ASCII text commands.
- SMTP uses the DNS for routing messages
  - looks up DNS resource record type "MX" (mail exchanger) to determine where to send the message to next.

An SMTP Connection

- An SMTP connection happens through port 25.
- The steps are
  1. Receiving server accepts connection.
  2. Sending server says hello and gives its name.
  3. Sending server gives the name of the user sending the message. Receiving server accepts.
  4. Sending server gives the name of the user who should receive the message. Receiving server accepts.
  5. Sending server transmits the message.
  6. Repeat from 1, or sending server quits.

SMTP Extensions

- Attractiveness of SMTP
  - simplicity of the protocol - makes it easy to understand and write clients/servers.
- Problems with SMTP
  - Too simple!
  - SMTP lacks
    - authentication mechanisms
    - accounting mechanisms (eg. determining costs for each user)
    - efficiency
- A number of extensions to SMTP (sometimes collectively referred to as ESMTP) have been defined in various RFCs to address SMTP's weaknesses.

Mailing Lists

- One of the popular ways of extending the use of e-mail beyond person-to-person communication is by using *mailing lists*.
- Mailing lists involves having a single e-mail address to refer to a group of subscribers, each with their own individual e-mail address.
  - It can be as simple as creating an alias on a server machine.
  - When a message is received for that alias, the message is forwarded to every address on that alias.

Why Use Mailing Lists?

- The concept of mailing lists can be done without involving servers, by
  - by senders typing in the appropriate addresses when sending messages, or
  - having mail clients keep the alias of a group of users.
- The problem is that it is very hard to ensure that everyone in a group is using and maintaining the same set of addresses.

Mailing Lists Managers (MLMs)

- There are MLM software available which makes mailing list more useful by
  - allowing control over who and when subscribers on the list gets forwarded messages.
  - easing the administration of the list of subscribers.
- Some example popular MLMs:
  - majordomo
  - listserv
  - mailman

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