Networking Applications

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Electronic Mail
Outline

• Introduction
• SMTP
• MIME
• Mail Access Protocols
Introduction

- Email from user to user (or a group of users)
- Email from user to a mailing list
- SMTP (Simple Mail Transfer Protocol) is the standard mechanism for email in the Internet
- Analogy to postal mail (envelope and message (header and body))
- Email addresses in the form \(<\text{local-part}@\text{domain-name}>\)
  - Local-part: address of user mailbox on local site
  - Domain-name: destination domain name

Recall MX resource record in DNS database
Architecture and Protocols

• A client-server architecture
  ➢ *Email client* accepts mail and delivers to *email server* in destination domain
  ➢ End-to-end delivery
  ➢ *Store and forward* mechanism

• Simple Mail Transfer Protocol (*SMTP*)
  ➢ TCP/IP
  ➢ Delivery of simple text messages (7-bit ASCII format)

• Multi-purpose Internet Mail Extension (*MIME*)
  ➢ An extension to SMTP ➞ Delivery of other types of data (e.g., languages not supported by 7-bit ASCII, Voice, images, or video clips)
Client-Server Architecture

User

SMTP client

Internet

SMTP server

User
User Agent and Mail Transfer Agent

Actual mail transfer through MTA

User A

UA

MTA client

Internet

User B

UA

MTA server
User Agent (UA)

• Software that does the following
  - *Composing messages*: provides a template to be filed
  - *Reading messages*: When UA is invoked, it checks for mail in the incoming mail box
  - *Replying to messages*
  - *Forwarding messages*
  - *Handles mailboxes*: Inbox, sent, and others

• Could be command-driven (pine or mail) or GUI-based (Eudora or Outlook)
Mail Transfer Phases

• Connection Establishment
  ➢ SMTP client makes a TCP connection to well-known port 25
  ➢ SMTP server starts the connection phase

• Message Transfer

• Connection Termination
Mail Delivery From Sender to Receiver 1/3

• Stage 1
  - Email goes from UA to local server (MTA client)
  - Mail stored in local server until it can be sent (spooled)
  - UA uses SMTP client software and local server uses SMTP server software
  - Why not deliver email directly to remote server?

• Stage 2
  - Local MTA performs a DNS lookup to obtain the mail exchange servers for the destination domain
Mail Delivery From Sender to Receiver 2/3

• Stage 3

  ➢ *Push Operation*: local MTA (SMTP client) relays email to remote server (SMTP server) Why not deliver to remote UA?
  
  ➢ Email received by mail server and stored in the user mailbox for later retrieval

• Stage 4

  ➢ Remote UA employs a *mail access protocol* to access the mailbox and obtain her/his email (pull protocols)

    ☐ Post Office Protocol: POP3
    
    ☐ Internet Mail Access Protocol: IMAPv4
Mail Delivery From Sender to Receiver

User A
Interface
UA
Spool
Mailboxes
Database
Client MTA Server

Internet

User B
Interface
UA
Spool
Mailboxes
Database
Server MTA Client

MTA
MTA
Alias exp.

MTA
Alias exp.
Relay MTA 1/2

User A

UA

MTA

Client

Internet

Relay MTA

MTA

Server

UA

User B
Relay MTA 2/2

The concept of an email hub
SMTP
SMTP Sequence of Events

- Source connects
- Target responds → 220 Ready for mail
- Source sends HELO
- Target responds with identification
- Source sends from and to fields
- Target accepts
- Source sends one or more messages
- Target closes connection when complete
Mail Message Contents

- Each queued message has:
  - Message text
    - header with message envelope and list of recipients
    - Message body, composed by user
  - A list of mail destinations
    - Derived by user agent from header
    - May be listed in header
    - May require expansion of mailing lists
    - May need replacement of mnemonic names with mailbox names
Mail Sending Optimization

• If message destined for multiple users on a given host, it is sent only once
  ➢ Delivery to users handled at destination host

• If multiple messages ready for given host, a single TCP connection can be used
  ➢ Saves overhead of setting up and dropping connection
Possible Errors

- Host unreachable
- Host out of operation
- TCP connection fail during transfer
- Sender can re-queue mail
  - Give up after a period
- Faulty destination address
  - User error
SMTP Receiver

• Accepts arriving message

• Places in user mailbox or copies to outgoing queue for forwarding

• Receiver must:
  ➢ Verify local mail destinations
  ➢ Deal with errors
    ✔ Transmission
    ✔ Lack of disk space

• Sender responsible for message until receiver confirm complete transfer
  ➢ Indicates mail has arrived at host, not user
E-mail Headers

- Lines of text in format *keyword: information*

- *keyword* identifies information; information can appear in any order

- Essential information:
  - To: list of recipients
  - From: sender
  - Cc: list of copy recipients

- Useful information
  - Reply-to: different address than From:
  - Received-by: for debugging
Data in Email

• Original Internet mail carried only 7-bit ASCII data
  ➢ Couldn’t contain arbitrary binary values; e.g., executable program
  ➢ Can not be used for languages that are not supported by 7-bit ASCII (e.g., French, German, Chinese, and Japanese)

MIME
(Multipurpose Internet Mail Extensions)
MIME Introduction

- Transforms non-ASCII data at sender site to ASCII data and delivers to client SMTP
- Server SMTP at receiving side receives ASCII data and delivers to MIME
- MIME at receiver transforms to original data
MIME: From Non-ASCII to ASCII

NVT is Network Virtual terminal

User

Non-ASCII code

MIME

7-bit NVT ASCII

SMTP

User

Non-ASCII code

MIME

7-bit NVT ASCII

SMTP
MIME Headers 1/3

- 5 headers can be added to original SMTP header to define transformation parameters
  
  - **MIME-version**: 1.0 or 1.1
  
  - **Content-Type**
    
    - Type of data used in body of message
    
    - **Content-Type**: `<type/subtype/parameters>`
    
    - **Text (plain)**, **Multipart**, **Message**, **Image**, **Video**, **Audio**, and **Application**
MIME Headers 2/3

• 5 headers can be added to original SMTP header to define transformation parameters
  ➢ Content-Transfer Encoding
    □ 7bit, 8bit, Binary, Base64 (6-bit blocks encoded into 8-bit ASCII characters), and Quoted-printable (Non-ASCII characters encoded as an equal sign followed by an ASCII code. ASCII is sent as is)
  ➢ Content-Id
    □ Identify whole message in a multiple message environment
  ➢ Content-Description
MIME Headers 3/3

Binary data into Radix-64 format
A Base 64 encoding table is used to interpret 6-bit into one char
Mail Access Protocols

- POP3
- IMAPv4
- Web-based email
POP3

- Client POP3 installed on recipient computer
- Server POP3 installed on main server
- User needs to download email from mailbox on the mail server
- UA opens a connection with server on TCP port 110
- Sends user name and password
- User can list and retrieve messages
- Delete and keep mode
IMAP4

- POP3 does not allow user to organize mail on server (user cannot have different folders on server)
- POP3 does not allow user to partially check the contents of the mail before downloading
- IMAP offers the following
  - User checks email header prior to downloading
  - User can search contents of email for a search string before downloading
  - User can create, delete, or rename mailboxes on mail server
  - User can create folders for email storage
Web-based Email

- Mail transfer from User browser to mail server performed through HTTP
- Transfer of message from sending mail server to receiving mail server through SMTP
- Message from receiving server to recipient’s browser performed through HTTP
- Need for Webmail software
Further Information

• RFC 821: Simple Mail Transfer Protocol, August 1982
• RFC 822, ARPA Internet Text Messages, August 1982
• RFC 1521: MIME – Part 1, September 1993
• RFC 1522: MIME-Part 2, September 1993
• RFC 1939: POP3, May 1996
• RFC 3501, IMAP4, March 2003