CS43: Computer Networks

Email

Kevin Webb
Swarthmore College
September 24, 2015
Electronic mail

Three major components:
• mail user agent (MUA)
• mail transfer agent (MTA)
• simple mail transfer protocol: SMTP

User Agent
• a.k.a. “mail reader”
• composing, editing, reading mail messages
• e.g., Outlook, Thunderbird, iPhone mail client
• outgoing, incoming messages stored on server
MTAs: Mail Servers

mail servers:

- **mailbox** contains incoming messages for user
- **message queue** of outgoing (to be sent) mail messages
- **SMTP protocol** between mail servers to send email messages (one-way)
  - client: sending mail server
  - “server”: receiving mail server
When Alice Sends An Email To Bob

A. Her mail client sends a message to his mail server

B. Her mail server sends a message to his mail server

C. Her mail server sends a message to his mail client

D. Her mail client sends a message to his mail client
Scenario: Alice sends message to Bob

1) Alice uses a MUA to compose message “to” bob@swarthmore.edu
2) Alice’s MUA sends message to her mail server; message placed in message queue
3) client side of SMTP opens TCP connection with Bob’s mail server
4) SMTP client sends Alice’s message over the TCP connection
5) Bob’s mail server places the message in Bob’s mailbox
6) Bob invokes his MUA to read message
Mail Servers: Ever Vigilant

• Always on, because they always need to be ready to accept mail.

• Usually owned by ISP
  – You use the email server for either Swarthmore College, or the CS department.
Simple Mail Transfer: SMTP [RFC 2821]

• Uses TCP to reliably transfer email message from client to server, port 25
• Direct transfer: sending server to receiving server
• Three phases of transfer
  – handshaking (greeting)
  – transfer of messages
  – closure
• Command/response interaction (like HTTP, FTP)
  – commands: ASCII text
  – response: status code and phrase
• Messages must be in 7-bit ASCII
Mail message format

SMTP: protocol for exchanging email messages
RFC 822: standard for text message format:
  - header lines, e.g.,
    - To:
    - From:
    - Subject: different from SMTP MAIL FROM, RCPT TO: commands!
  - Body: the “message”
    - ASCII characters only
    - Signal EOM with “\r\n.\r\n”
Try SMTP interaction for yourself:

• `telnet allspice.cs.swarthmore.edu 25`
• You should see a 220 reply from the server.
• enter HELO, MAIL FROM, RCPT TO, DATA, QUIT commands

(lets you send email without using email client (MUA))
Demo
Sample SMTP interaction

$ telnet allspice.cs.swarthmore.edu 25
Trying 130.58.68.9...
Connected to allspice.cs.swarthmore.edu
220 allspice.cs.swarthmore.edu ESMTP Postfix
HELO cs.swarthmore.edu
250 allspice.cs.swarthmore.edu
MAIL FROM:<kwebb@cs.swarthmore.edu>
250 2.1.0 OK
RCPT TO:<kwebb@cs.swarthmore.edu>
250 2.1.5 OK
DATA
354 End data with <CR><LF>.<CR><LF>
To: Kevin Webb <kwebb@cs.swarthmore.edu>
From: Kevin Webb <kwebb@cs.swarthmore.edu>
Subject: Telnet test message
This is a test message, via telnet, to myself.
.

$ telnet allspice.cs.swarthmore.edu 25
Trying 130.58.68.9...
Connected to allspice.cs.swarthmore.edu
220 allspice.cs.swarthmore.edu ESMTP Postfix
HELO cs.swarthmore.edu
250 allspice.cs.swarthmore.edu
MAIL FROM:<kwebb@cs.swarthmore.edu>
250 2.1.0 OK
RCPT TO:<kwebb@cs.swarthmore.edu>
250 2.1.5 OK
DATA
354 End data with <CR><LF>.<CR><LF>
To: Kevin Webb <kwebb@cs.swarthmore.edu>
From: Kevin Webb <kwebb@cs.swarthmore.edu>
Subject: Telnet test message
This is a test message, via telnet, to myself.
.
End of message.
What keeps us from entering a fake information (e.g., FROM address)?

A. Nothing.

B. The MTA checks that the FROM is valid.

C. We enter a name/password logging into the MTA.
Fun Demo
Wait, this seems too horrible to be true. We can prevent header forging by requiring users to log in.

(How or why not?)

A. True

B. False
Message Signing

1. Sender creates cryptographic public/private key pair, publishes public key to the world

2. Sender uses private key to sign messages

3. Receiver can verify*, using published public key, that only the holder of the corresponding private key could have sent the message

* With very high probability.
Message Signing: Challenges

• Disseminating public keys
  – How do you trust that the published public key isn’t also a lie?

• It’s more work, can’t be bothered...
  – Adoption is very low
SMTP versus HTTP

- HTTP: pull
- SMTP: push

- Both have ASCII command/response interaction, status codes

- HTTP: each object encapsulated in its own response message

- SMTP: multiple objects sent in multipart message
SMTP: final words

- SMTP uses persistent connections
  - Can send multiple emails in one session

- SMTP requires message (header & body) to be in 7-bit ASCII

- SMTP server uses CRLF.CRLF to determine end of message
If SMTP only allows 7-bit ASCII, how do we send pictures/videos/files via email?

A. We encode these objects as 7-bit ASCII

B. We use a different protocol instead of SMTP

C. We’re really sending links to the objects, rather than the objects themselves
Base 64

- Designed to be an efficient way to send binary data as a string
- Uses A-Z, a-z,0-9, “+” and “/” as digits
- A number with digits $d_n d_{n-1} \ldots d_1 d_0 = 64^n d_n + 64^{n-1} d_{n-1} + \ldots + 64 d_1 + d_0$
- Recall from Computer Organization: Other non-base-10 number systems (binary, octal, hex).
Multipurpose Internet Mail Extensions (MIME)

• Special formatting instructions

• Indicated in the header portion of message (not SMTP)
  – SMTP does *not* care, just looks like message data

• Supports
  – Text in character sets other than ASCII
  – Non-text attachments
  – Message bodies with multiple parts
  – Header information in non-ASCII character sets
MIME

• Adds optional headers
  – Designed to be compatible with non-MIME email clients
  – Both clients must understand it to make sense of it

• Specifies content type, other necessary information

• Designates a boundary between email text and attachments
Mail access protocols

- **SMTP**: delivery/storage to receiver’s server
- mail access protocol: retrieval from server
  - **POP**: Post Office Protocol: authorization, download
  - **IMAP**: Internet Mail Access Protocol: more features, including manipulation of stored messages on server
  - **HTTP**: gmail, Hotmail, Yahoo! Mail, etc.
**POP3 protocol**

### Authorization phase
- **client commands:**
  - **user:** declare username
  - **pass:** password
- **server responses**
  - +OK
  - -ERR

### Transaction phase, client:
- **list:** list message numbers
- **retr:** retrieve message by number
- **dele:** delete
- **quit**

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

```
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
```
More about POP3

• Previous example uses “download and delete” mode
  – Bob cannot re-read e-mail if he changes client

• POP3 “download-and-keep”: copies of messages on different clients

• POP3 is stateless across sessions

• Limitations:
  – Can’t retrieve just the headers
  – Can’t impose structure on messages
IMAP

• Keeps all messages in one place: at server

• Allows user to organize messages in folders

• Keeps user state across sessions:
  – names of folders and mappings between message IDs and folder name

• Can request pieces of a message (e.g., text parts without large attachments)
Webmail

• Uses a web browser

• Sends emails using HTTP rather than POP3 or IMAP

• Mail is stored on the 3rd party webmail company’s servers
Reading

• Next topic: Peer to peer, DHTs
  – Reading: 2.6