Electronic mail

Aka e-mail (or email according to Knuth)

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Outline

History of email (1)

- 1971 Tomlinson's first email (e-mail?)
  - Introduces the use of the @-symbol
  - First based on CPYNET/SNDMSG,

    later piggybacked on FTP over ARPANET
- 1979 UUCP-based email
  - introduces the bang (!)
  - not based on TCP/IP (or NCP)

History of email (2)

- 1982 SMTP (Simple Mail Transfer Protocol) specified
- 1983 sendmail released (4.1c BSD)
- (late) 1983 DNS specified
- 1984 DNS toplevel domains specified
- sendmail knows about
  - @ (ARPANET)
  - ! (UUCP)
  - : (BerkNet)

Survey October 2001 (Dan Bernstein)

- 401 UNIX (Sendmail)
- 176 Windows (Exchange/IIS)
- 167 UNIX (qmail)
- 57 Windows (Ipswitch IMail)
- 23 UNIX (smap)
- 15 UNIX (IBM Postfix, formerly VMailer)
- 14 UNIX (Exim)

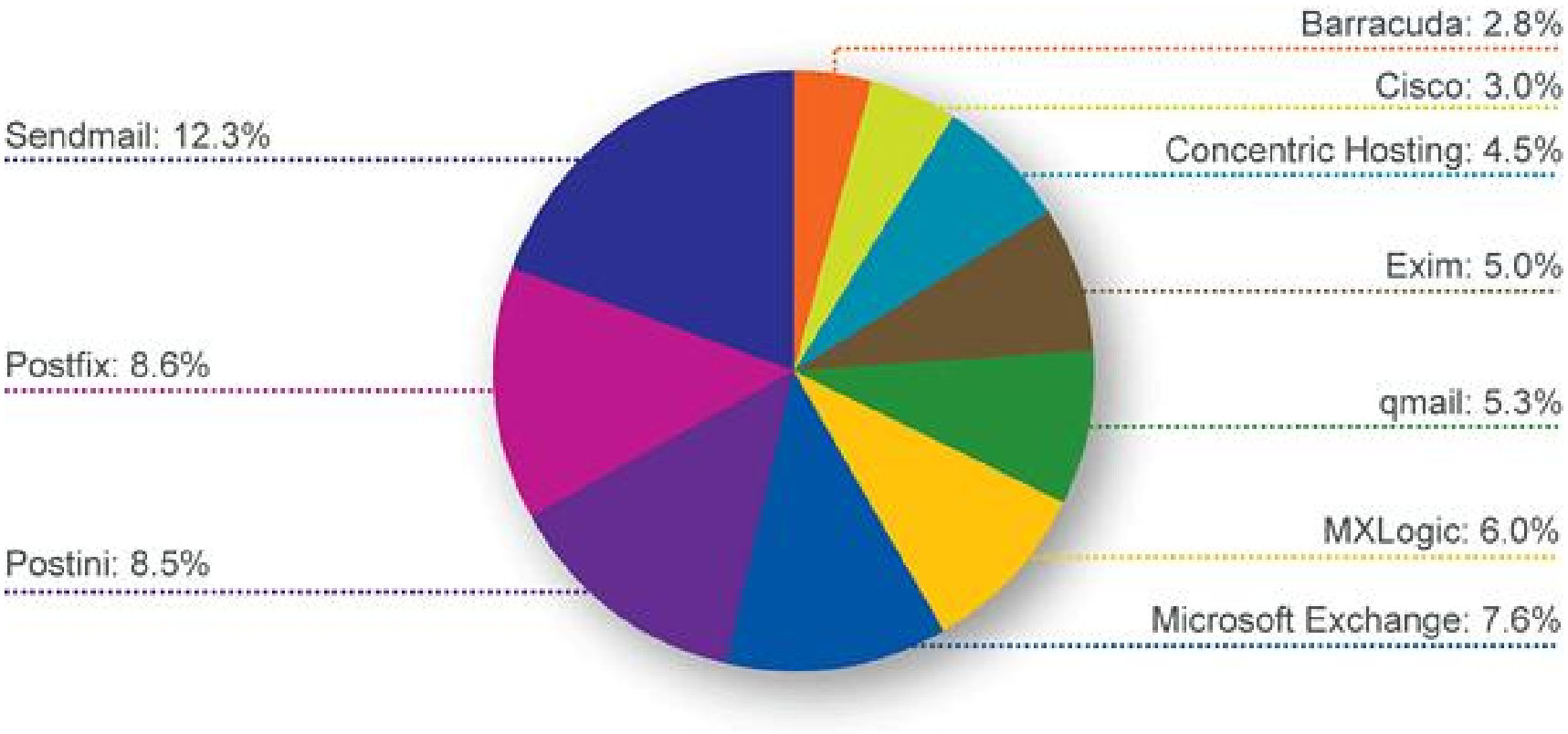
Survey May 2003 (Thomas Pircher)

- 19169 (35.59%) Sendmail
- 4537 (8.42%) qmail
- 4104 (7.62%) Postfix
- 2812 (5.22%) Microsoft (Exchange/IIS)
- 2464 (4.57%) Exim

Survey October 2004 (SNE)

- 20492 (35.3%) Sendmail
- 12172 (21.0%) Microsoft (Exchange/IIS)
- 6836 (11.8%) Exim
- 4008 (6.9%) iMail
- 3669 (6.3%) qmail
- 3172 (5.5%) Postfix

Survey 2006/2007 (MailChannels)



Source: O'Reilly SysAdmin

Outline

Email concepts

- Message transfer (RFC 5321)
- Message format (RFC 5322)
- Message agents (RFC 5598)
- Message stores (RFC 5598)

Message Agents

Agent acronym	Agent use
MUA	Message User Agent[1]
MTA	Message Transfer Agent
MDA	Message Delivery Agent
MSA	Message Submission Agent
MAA[2]	Message Access Agent
MRA[2]	Message Retrieval Agent

[1] According to RFC 5598, called Mail User Agent in RFC 5321

[2] Not standardised in RFC5598: "Internet Mail Architecture"

Outline

Mail User Agent

- Interface for the email user
  - Reads and composes messages
  - Thunderbird, Outlook, mutt, pine, mh ...
- Often uses SMTP to send mail ($\longrightarrow$ MSA)
- Often uses IMAP/POP3 to get mail ($\longleftarrow$ MAA)
- May have direct access to message store
  - Trend is to not have direct access

Message Transfer Agent

- Transfers email across the Internet
  - Uses SMTP as transfer protocol
  - sendmail, Postfix, qmail, Exim
- Often also operates as a Message Submission Agent
- Makes use of MX records to transfer email

Message Delivery Agent

- Delivers email into the message store (MS)
  - mail, mail.local, rmail, procmail
  - May do filtering, SPAM and virus checking, ...
  - Has knowledge about mailbox formats
  - Can use
    - Global file space (for example /var/mail/mbox)
    - User specific file space (for example $HOME/mbox)
    - Database (often not directly accessible)

Message Submission Agent (1)

- See RFC 4409
- Injects message into the mail system
- Sanitizes message content
  - Envelope domains must be FQDN's
- Often combined with MTA
  - Should bind to its own port (587), if possible

Message Submission Agent (2)

- Can operate locally
  - sendmail (no daemon mode)
  - postdrop
  - without SMTP or with piped SMTP
- May be an MTA-frontend
  - smapd

Message Access Agent

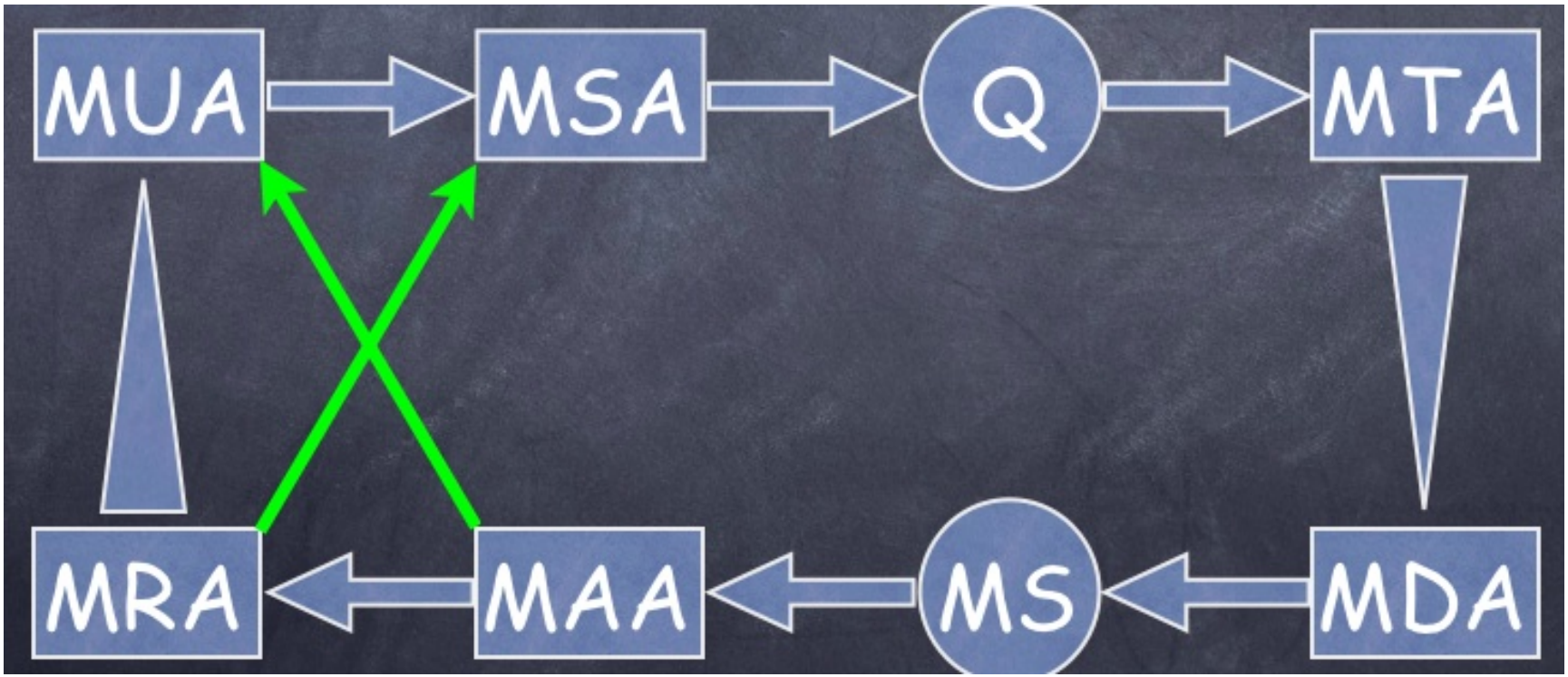
- Can get message out of Message Store (MS)
- Offers services to access mail to MUA (or MRA)
  - POP3 (Post Office Protocol)
  - IMAP (Internet Message Access Protocol, version 4)

Message Retrieval Agent

- Program that uses a MAA to collect mail
- Possibly reinjects mail into the mail system
  - fetchmail
  - SMTP TURN (Insecure!)
  - SMTP ETRN (More secure variant, RFC 1985)
  - SMTP ATRN[3] (Authenticated variant, RFC 2645)

[3] ODMR (On-Demand Mail Relay) for clients with dynamic IP addresses

Message Agent Relationships



Outline

Securing Email (1)

- Use secure protocols
  - imap (port 143) $\longrightarrow$ imaps (port 993)
  - pop3 (port 110) $\longrightarrow$ pop3s (port 995)
  - smtp (port 25) $\longrightarrow$ smtps, ssmtp (port 465)?[4]

[4] Not registered as such with IANA

Securing Email (2)

- SMTP improvements
  - Authenticated SMTP
    - AUTH extension (RFC 4954)
    - Based on SASL (RFC 4422)
  - STARTTLS extension (RFC 3207)
    - Replaces (s)smtp(s)
- These mechanisms are often used on mail submission via port 587

Securing Email (3)

Use MUA-based encryption and authentication

- PGP (Pretty Good Privacy)
  - Inline or PGP/MIME
  - GPG (GNU Privacy Guard)
  - Uses a web of trust
- S/MIME
  - Uses a hierarchy of trust (PKI)
- MIME
  - Multipurpose Internet Mail Extensions
  - Different character sets, binary attachments, multiple parts, internationalised headers

Outline

Message format

- RFC 5322
- Headers, empty line, body
- Only 7-bit US-ASCII (1-127) allowed
  - MIME extends this to possibly 8-bit
- Lines are delimited by <CR><LF>
- Lines should be no longer than 78 characters

Message (specified in the ABNF formalism)

- message = (fields / obs-fields) [CRLF body]
- body = *(*998text CRLF) *998text
- CRLF = %d13.10
- Mathematical isomorphism
  - $\text{text}^{*+} \cong (\text{text} \cup \{\text{CRLF}\})^*$
- CRLF is delimiter or separator, not terminator

Header format

- <Field name>:<Field body>
- <Field name>
  - printable US-ASCII (33-126)
  - except ":" (58)
- <Field body>
  - US-ASCII (1-127) except CR(13) and LF(10)...
    - ...but also (un)folding is allowed

Some important headers

- From:<originator mailbox>
- Sender:<sender mailbox>
- To:<recipient mailbox>
- Message-Id:<unique message identification>
- Received:<registration of message transfer>

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Message transfer

- SMTP (RFC 5321)
  - Uses Network Virtual Terminal (NVT)

    presentation layer from the TELNET RFC 854
  - Net-ASCII might be replaced in the future

    by Net-Unicode, see RFC 5198
- Mail objects
  - content (in "message format")
  - envelope (SMTP parameters)

Normal (E)SMTP session

- “EHLO” (greeting, option negotiation)
- “MAIL FROM:” (envelope sender)
- “RCPT TO:” (envelope recipient)
- “DATA” (content, ended by <CRLF>.<CRLF>)
- “QUIT” (goodbye)

Outline

Message store

- In database
  - Only accessible via IMAP, POP3
- In flat files
  - Also accessible via direct access
  - Enables “grepping” the message store

Mbox format

- Ordinary file with
  - multiple messages
  - separated by "From␣" at start of line
  - has extra blank line at end of message
  - quotes "From␣" to ">From␣"
    - and ">From␣" to ">>From␣"...
  - a first characteristic line
    - "From␣<envelopesender>␣<date>␣<optionalinfo>"

MMDF format

- Variant of mbox format
  - Uses ^A ^A ^A ^A as separator
  - Optionally has the mbox "From␣" information

MH format

- Mailbox is a directory
- Every message is a file with a numeric name
- Used by mh, nmh, xnmh MUA's

Maildir format

- Mailbox is again a directory
- Subdirectories tmp, new, cur
- Arriving mail: tmp/<time>.<pid>.<host>
- No mailbox locking needed
- Works reliably over NFS

Mailbox locking

- Uses flock, lockf, fcntl system calls
- Does not always work reliably over NFS
- Needed if delivery agents and/or access agents operate on the same file (mailbox)

Cyrus MDA/MAA at OS3

- IMAP server with support for local delivery through LMTP
- LMTP: Local Mail Transfer Protocol
  - Similar to ESMTP
  - Uses LHLO in stead of EHLO
  - Reports separate status results for every “RCPT TO:”
- Uses (improved) Maildir format as message store
- Does not support direct access to mail files

OS3 Mail Infrastructure (1)

- Separate incoming and outgoing mail services
- Incoming: smtp.os3.nl
  - Listens on port 25 to the world for mail destined for os3.nl
  - Includes SPAM checking
  - Delivers local mail via LMTP to imap.os3.nl (Cyrus)
  - Forwards outbound aliases to mail.serv.os3.nl
- Outgoing: mail.serv.os3.nl
  - Listens on port 25 to the internal network

    for mail destined for the world (including os3.nl)
  - Forwards local mail to smtp.os3.nl

OS3 Mail Infrastructure (2)

- Enable relaying for authenticated users
  - Listen on port 587 as a mail submission agent
  - First enforce STARTTLS
  - Use username/password authentication

    inside the protected connection