Introduction to Internet Mail

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Mail agents

- MUA = Mail User Agent
- Interacts directly with the end user

  Pine, MH, Elm, mutt, mail, Eudora, Marcel, Mailstrom, Mulberry, Pegasus, Simeon, Netscape, Outlook, ...
- Multiple MUAs on one system - end user choice

- MTA = Mail Transfer Agent
- Receives and delivers messages

  Sendmail, Smail, PP, MMDF, Charon, Exim, qmail, Postfix, ...
- One MTA per system - sysadmin choice

Message format (1)

```
From: Philip Hazel <ph10@cus.cam.ac.uk>
To: Julius Caesar <julius@ancient-rome.net>
Cc: Mark Anthony <MarkA@cleo.co.uk>
Subject: How Internet mail works

Julius,
  I'm going to be running a course on ...
```

- Format was originally defined by RFC 822 in 1982
- Now superseded by RFC 2822
- Message consists of

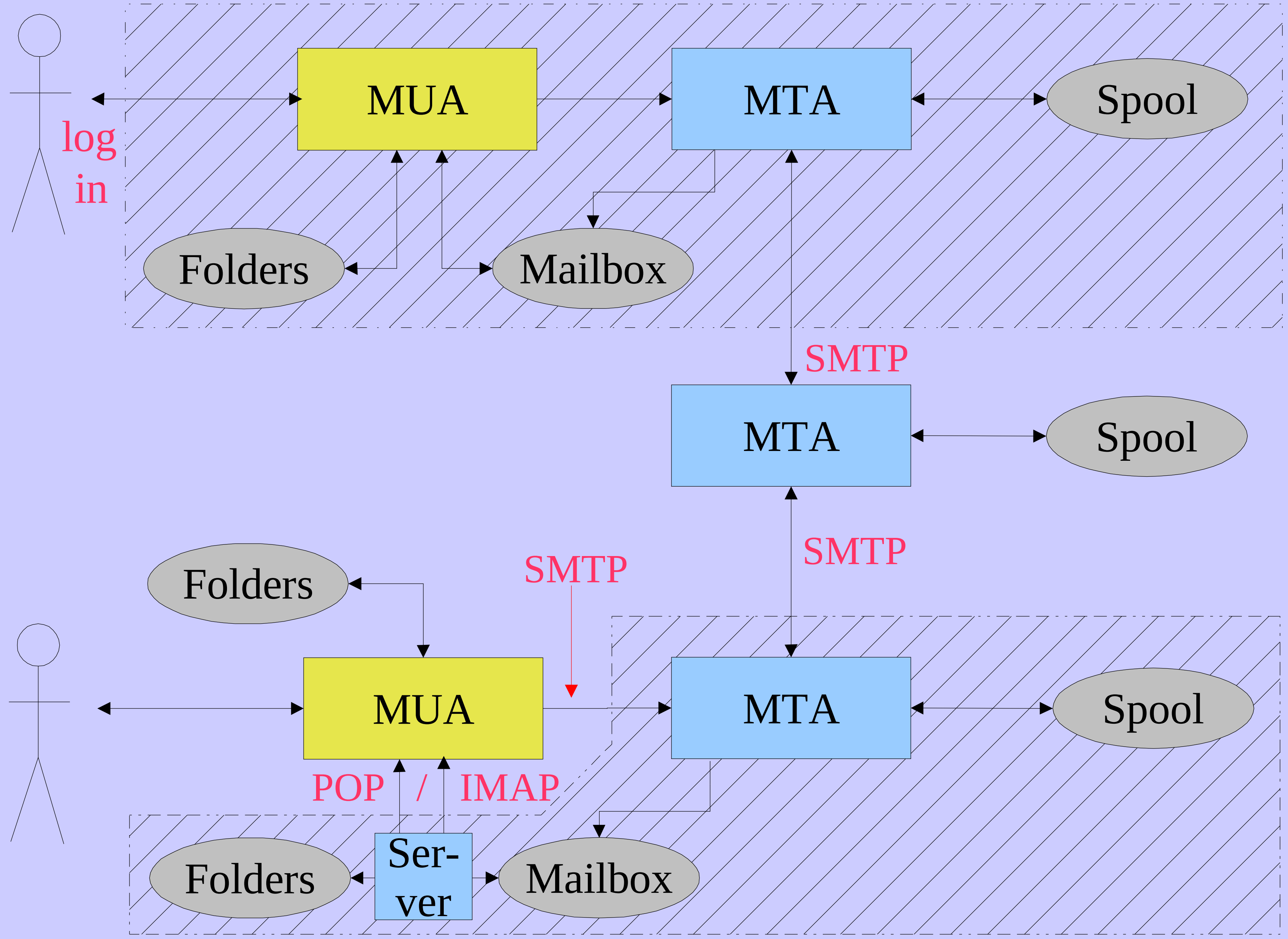
  Header lines

  A blank line

  Body lines

Message format (2)

- An address consists of a *local part* and a *domain*
- A basic message body is unstructured
- Other RFCs (MIME, 2045) add additional headers which define structure for the body
- MIME supports attachments of various kinds and in various encodings
- Creating/decoding attachments is the MUA's job


log
in
MUA
MTA
Spool
Folders
Mailbox
SMTP
MTA
Spool
SMTP
SMTP
Folders
MUA
MTA
Spool
POP / IMAP
Folders
Ser-
ver
Mailbox

Authenticating senders

- Embedded MUA uses inter-process call to sent to MTA
  - May use pipe, file, or internal SMTP over a pipe
  - MTA knows the identity of the sender
  - Normally inserts *Sender:* header if differs from *From:*
- Freestanding MUA uses SMTP to send mail
  - MTA cannot easily distinguish local/remote clients
  - No authentication in basic protocol
  - AUTH command in extended SMTP
  - Use of security additions (TLS/SSL)
  - MUA can point at any MTA whatsoever
  - Need for relay control
  - Host and network blocks

A message in transit (1)

- Headers added by the MUA

```
From: Philip Hazel <ph10@cus.cam.ac.uk>
To: Julius Caesar <julius@ancient-rome.net>
cc: Mark Anthony <MarkA@cleo.co.uk>
Subject: How Internet mail works
Date: Fri, 10 May 2002 11:29:24 +0100 (BST)
Message-ID: <Pine.SOL.3.96.990117111343.
  19032A-100000@taurus.cus.cam.ac.uk>
MIME-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII

Julius,
  I'm going to be running a course on ...
```

A message in transit (2)

- Headers added by MTAs

```
Received: from taurus.cus.cam.ac.uk
  ([192.168.34.54] ident=exim)
  by mauve.csi.cam.ac.uk with esmtp
  (Exim 4.00) id 101qxX-00011X-00;
  Fri, 10 May 2002 11:50:39 +0100
Received: from ph10 (helo=localhost)
  by taurus.cus.cam.ac.uk with local-smtp
  (Exim 4.10) id 101qin-0005PB-00;
  Fri, 10 May 2002 11:50:25 +0100
From: Philip Hazel <ph10@cus.cam.ac.uk>
To: Julius Caesar <julius@ancient-rome.net>
cc: Mark Anthony <MarkA@cleo.co.uk>
...
```

A message in transit (3)

- The message *envelope*:

```
MAIL FROM:<ph10@cus.cam.ac.uk>
RCPT TO:<julius@ancient-rome.net>
```

- The envelope is separate from the RFC 2822 message
- Envelope (RFC 2821) fields need not be the same as the header (RFC 2822) fields
- MTAs are (mainly) concerned with envelopes

  Just like the Post Office...
- Error (“bounce”) messages have null senders

An SMTP session (1)

```
telnet relay.ancient-rome.net 25
220 relay.ancient-rome.net ESMTP Exim ...
EHLO taurus.cus.cam.ac.uk
250-relay.ancient-rome.net ...
250-SIZE 10485760
250-PIPELINING
250 HELP
MAIL FROM:<ph10@cus.cam.ac.uk>
250 OK
RCPT TO:<julius@ancient-rome.net>
250 Accepted
DATA
354 Enter message, ending with “.”
Received: from ...
```

(continued on next slide)

An SMTP session (2)

```
From: ...
To: ...
etc...
.
250 OK id=10sPdr-00034H-00
quit
221 relay.ancient-rome.net closing conn...
```

SMTP return codes

2*xx*	OK
3*xx*	send more data
4*xx*	temporary failure
5*xx*	permanent failure

Email forgery

- It is trivial to forge unencrypted, unsigned mail
- This is an inevitable consequence when the sender and recipient hosts are independent
- It is less trivial to forge really well!
- Most SPAM usually contains some forged header lines
- Be alert for forgery when investigating

The Domain Name Service

- The DNS is a worldwide, distributed database
- DNS servers are called *name servers*
- There are multiple servers for each DNS *zone*
- Secondary servers are preferably off-site
- Records are keyed by type and domain name
- Root servers are at the base of the hierarchy
- Caching is used to improve performance
- Each record has a time-to-live field

Use of the DNS for email (1)

- Two DNS record types are used for routing mail

- *Mail Exchange* (MX) records map mail domains to host names, and provide a list of hosts with preferences:

```
hermes.cam.ac.uk  MX 5 green.csi.cam.ac.uk
                  MX 7 ppsw3.csi.cam.ac.uk
                  MX 7 ppsw4.csi.cam.ac.uk
```

- *Address* (A) records map host names to IP addresses:

```
green.csi.cam.ac.uk  A  131.111.8.57
ppsw3.csi.cam.ac.uk  A  131.111.8.38
ppsw4.csi.cam.ac.uk  A  131.111.8.44
```

Use of the DNS for email (2)

- MX records were added to the DNS after its initial deployment

- Backwards compatibility rule:

  If no MX records found, look for an A record, and if found, treat as an MX with 0 preference

- MX records were invented for gateways to other mail systems, but are now heavily used for handling generic mail domains

Other DNS records

- The PTR record type maps IP addresses to names

```
57.8.111.131.in-addr.arpa
  PTR  green.csi.cam.ac.uk
```

- PTR and A records do not have to be one-to-one

```
ppsw4.cam.ac.uk   A   131.111.8.33
33.8.111.131.in-addr.arpa
  PTR  lilac.csi.cam.ac.uk
```

- CNAME records provide an aliasing facility

```
pelican.cam.ac.uk
  CNAME redshank.csx.cam.ac.uk
```

DNS lookup tools

- *host* is easy to use for simple queries

```
host demon.net
host 192.168.34.135
host -t mx demon.net
```

- *nslookup* is more widely available, but is more verbose

```
nslookup bt.net
nslookup 192.168.34.135
nslookup -querytype=mx bt.net
```

- *dig* is the ultimate nitty-gritty tool

```
dig bt.net
dig -x 192.158.34.135
dig bt.net mx
```

DNS mysteries

- Sometimes primary and secondary name servers get out of step

- When mystified, check for server disagreement

```
host -t ns ioe.ac.uk
ioe.ac.uk  NS  mentor.ioe.ac.uk
ioe.ac.uk  NS  ns0.ja.net

host mentor.ioe.ac.uk mentor.ioe.ac.uk
mentor.ioe.ac.uk  A  144.82.31.3

host mentor.ioe.ac.uk ns0.ja.net
mentor.ioe.ac.uk has no A record at
  ns0.ja.net (Authoritative answer)
```

Common DNS errors

- MX records point to aliases instead of canonical names

  This should work, but is inefficient and deprecated

- MX records point to non-existent hosts

- MX records contain an IP address instead of a host name on the right-hand side

  Unfortunately some MTAs accept this

- MX records do not contain a preference value

- Some broken name servers give a server error when asked for a non-existent MX record

Routing a message

- Process local addresses
  - Alias lists
  - Forwarding files
- Recognize special remote addresses
  - e.g. local client hosts
- Look up MX records for remote addresses
- If self in list, ignore all MX records with preferences greater than or equal to own preference
- For each MX record, get IP address(es)

Delivering a message

- Perform local delivery
- For each remote delivery
  - Try to connect to each remote host until one succeeds
  - If it accepts or permanently reject the message, that's it
- After temporary failures, try again at a later time
- Time out after deferring too many times
- Addresses are often sorted to avoid sending multiple copies

Checking incoming senders

- A lot of messages are sent with bad envelope senders
  - Mis-configured mail software
  - Unregistered domains
  - Mis-configured name servers
  - Forgers
- Forgery seems to be the largest category nowadays
- Many MTAs check the sender's domain
- It is harder to check the local part
  - Uses more resources, and can be quite slow
- Bounce messages have no envelope sender

Checking incoming recipients

- Some MTAs check each local recipient during the SMTP transaction
  - Errors are handled by the *sending* MTA
  - The receiving MTA avoids problems with bad senders
- Other MTAs accept messages without checking, and look at the recipients later
  - Errors are handled by the *receiving* MTA
  - More detailed error messages can be generated
- The current proliferation of forged senders has made the first approach much more popular

Relay control

- From any host to specified domains

  e.g. incoming gateway or backup MTA

- From specified hosts to anywhere

  e.g. outgoing gateway on local network

- From authenticated hosts to anywhere

  e.g. travelling employee or ISP customer connected to remote network

- Encryption can be used for password protection

Policy controls on incoming mail

- Block known miscreant hosts and networks

  Realtime Blackhole List (RBL), Dial-up list (DUL), etc.

  http://mail-abuse.org and others

- Block known miscreant senders

  Not as effective as it once was for SPAM

- Refuse malformed messages

- Recognize junk mail

  Discard

  Annotate