Introduction to Internet Mail

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(slides of Philip Hazel)

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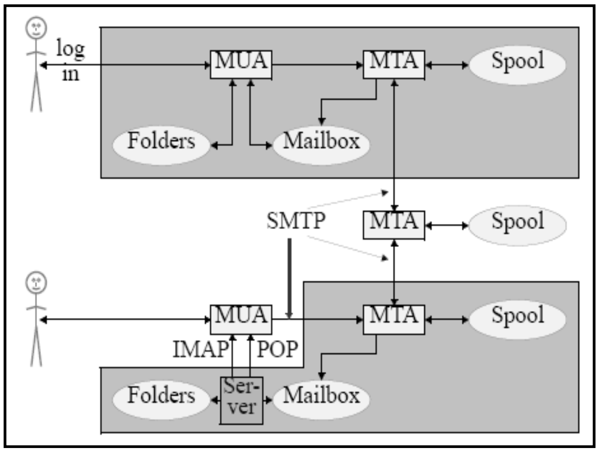
Mail agents

- MUA = Mail User Agent
- Interacts directly with the end user
  Pine, MH, Elm, mutt, mail, Eudora, Mulberry, Pegasus, Simeon, Netscape, Outlook, Thunderbird…
- Multiple MUAs on one system - end user choice
- MTA = Mail Transfer Agent
- Receives and delivers messages
  Sendmail, Smail, MMDF, Charon, Exim, qmail, Postfix, ...
- One MTA per system - sysadmin choice
- Most MTAs also act as Mail Submission Agents (MSAs)



Authenticating senders

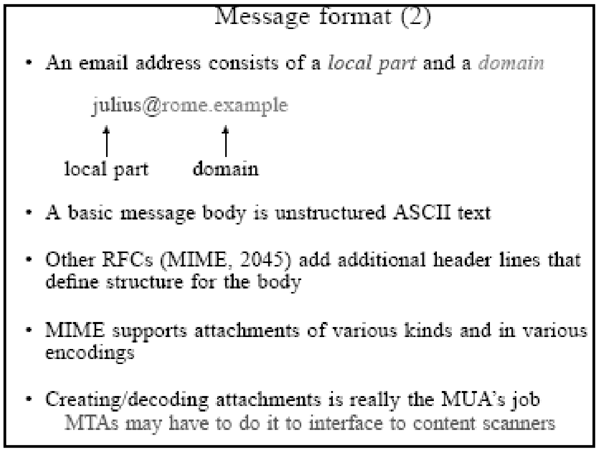
- Embedded MUA uses inter-process call to send to MTA
  May use pipe, file, or internal SMTP over a pipe
  MTA knows the identity of the sender
- *Freestanding MUA uses SMTP to send mail*
  MUA can point at any MTA whatsoever
  MTA must distinguish local/remote clients
  Need for relay control
  Host and network blocks
  Only “submission” clients are allowed to relay
  IP identification is no good for roaming clients
  No authentication in basic SMTP protocol
  AUTH command in extended SMTP
  Use of security additions (TLS/SSL)

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- Now superseded by RFC 2822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 – some have a well-defined syntax
  A blank line – terminates the end of the header
  Body lines
- Notice that a message is defined in terms of lines

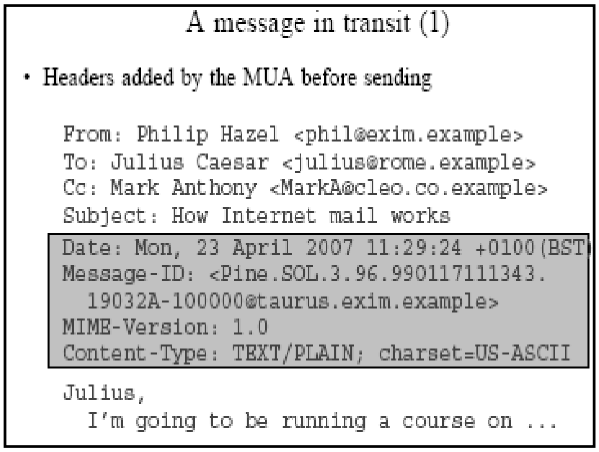


Message format (2)

- An email address consists of a *local part* and a *domain*

  julius@rome.example
  local part domain

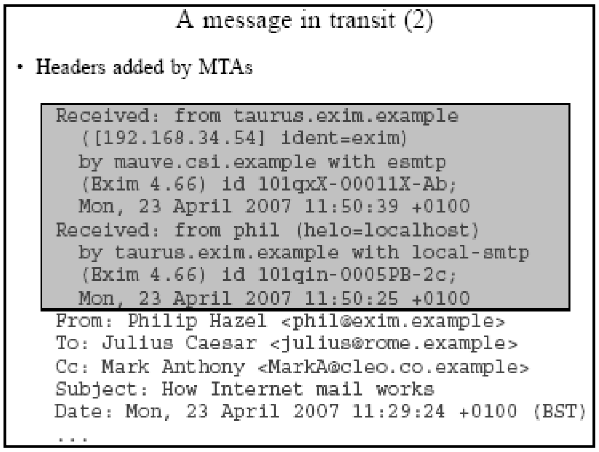
- A basic message body is unstructured ASCII text
- Other RFCs (MIME, 2045) add additional header lines that define structure for the body
- MIME supports attachments of various kinds and in various encodings
- Creating/decoding attachments is really the MUA’s job
  MTAs may have to do it to interface to content scanners



A message in transit (1)

- Headers added by the MUA before sending

```
From: Philip Hazel <phil@exim.example>
To: Julius Caesar <julius@rome.example>
Cc: Mark Anthony <MarkA@cleo.co.example>
Subject: How Internet mail works
Date: Mon, 23 April 2007 11:29:24 +0100(BST
Message-ID: <Pine.SOL.3.96.990117111343.
  19032A-100000@taurus.exim.example>
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.exim.example
  ([192.168.34.54] ident=exim)
  by mauve.csi.example with esmtp
  (Exim 4.66) id 101qxX-00011X-Ab;
  Mon, 23 April 2007 11:50:39 +0100
Received: from phil (helo=localhost)
  by taurus.exim.example with local-smtp
  (Exim 4.66) id 101qin-0005PB-2c;
  Mon, 23 April 2007 11:50:25 +0100
From: Philip Hazel <phil@exim.example>
To: Julius Caesar <julius@rome.example>
Cc: Mark Anthony <MarkA@cleo.co.example>
Subject: How Internet mail works
Date: Mon, 23 April 2007 11:29:24 +0100 (BST)
...
```

A message in transit (3)

- The message is transmitted with an *envelope:*

  MAIL FROM:<phil@exim.example>
  RCPT TO:<julius@rome.example>

- The envelope is separate from the RFC 2822 message
- Envelope (RFC 2821) fields need not be the same as the header (RFC 2822) fields (**From:** and **To:)**
- MTAs are (mainly) concerned with envelopes
  Just like the Post Office...
- Error ("bounce") messages have null senders
  MAIL FROM:< >
- This is to prevent looping

An SMTP session (1)

```
telnet relay.rome.example 25
220 relay.rome.example ESMTP Exim ...
EHLO taurus.exim.example
250-relay.ancient-rome.net ...
250-SIZE 10485760
250-PIPELINING
250 HELP
MAIL FROM:<phil@exim.example>
250 OK
RCPT TO:<julius@rome.example>
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.rome.example closing connec...
```

SMTP return codes

2xx OK
3xx send more data
4xx temporary failure
5xx 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
- Most SPAM usually contains some forged header lines
- Be alert for forgery when investigating
- and …

  Never send automatic spam or virus warnings!

- If you do, you are just adding to the problem
  This is known as "collateral spam" or "Joe jobs"

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 in the 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)

- Three 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
```

- IPv6 Addresses use AAAA(“quad A”) records

```
ahost.csi.cam.ac.uk.  AAAA  2001:630:200:…
```

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 (e.g. corporate) mail domains
- SRV (service) records can also be used for email routing
  This feature is not widely deployed

Other DNS records

- The PTR record type maps IP addresses to names
- The IP address is inverted, then looked up in **in-addr.arpa**

```
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

```
cam.ac.uk.      MX  7   mx.cam.ac.uk.
mx.cam.ac.uk.   A       131.111.8.33

33.8.111.131.in-addr.arpa.
  PTR  ppsw.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 in both input and output

```
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
  A second argument for **host** specifies a nameserver

host -t ns xxx.ac.uk

```
xxx.ac.uk  NS  mentor.ioe.ac.uk
xxx.ac.uk  NS  ns0.ja.net
```

host -t ns xxx.ac.uk mentor.ioe.ac.uk

```
harvey.xxx.ac.uk  A  144.82.31.3
```

host harvey.xxx.ac.uk ns0.ja.net

```
harvey.xxx.ac.uk has no A record at
  ns0.ja.net (Authoritative answer)
```

Common DNS errors

- Final dots missing on RHS host names in MX records
- 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
  - Also, some name server software conspires to support this
- MX records do not contain a preference value
- Some broken name servers give a server error when asked for a non-existent MX, AAAA, or SRV record

Routing a message

- Process local addresses
  - Alias lists
  - Forwarding files
  - Local mailboxes
- Recognize special remote addresses
  - For example, those for 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
  - This logic is for secondary MX servers
- For each remaining MX record, get the host's 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 of the same message
  - The RFCs recommend single copies with mutltiple recipients
  - Sometimes single copies are necessary

Checking incoming senders

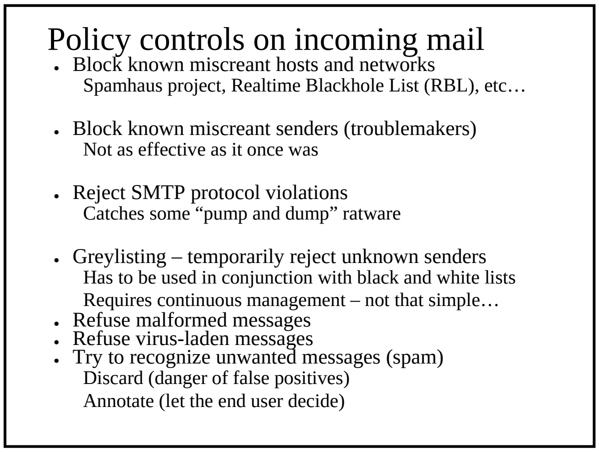
- A lot of messages are sent with bad envelope senders
  - Misconfigured mail software
  - Unregistered domains
  - Misconfigured name servers
  - Forgeries – probably the biggest cause nowadays
- Many MTAs check the domain of the sender address
- It is harder to check the local part
  - A reverse SMTP "callout" is needed
  - Uses more resources, and can be quite slow
- Bounce messages have no envelope sender; no check is possible

Checking incoming recipients

- Some MTAs check each local recipient during the SMTP transaction
  - RejErrors 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…
  - … but not necessarily delivered
  - … or delivered to an innocent 3rd party (collateral spam)
- The current proliferation of forged senders has made the first approach much more popular nowadays
  - Reduces collateral spam

Relay control

- Incoming: From any host to specified domains
  - Example: incoming gateway or backup MTA
- Outgoing: From specified hosts to anywhere
  - Example: outgoing gateway on local network
- From SMTP-authenticated hosts to anywhere
  - Example: travelling employee or ISP customer connected to remote network
- Encryption can be used for password protection during authentication
- Authentication can also be done using certificates
- Any other relaying is "open", and is a Bad Thing



Policy controls on incoming mail

- Block known miscreant hosts and networks
  - Spamhaus project, Realtime Blackhole List (RBL), etc…
- Block known miscreant senders (troublemakers)
  - Not as effective as it once was
- Reject SMTP protocol violations
  - Catches some “pump and dump” ratware
- Greylisting – temporarily reject unknown senders
  - Has to be used in conjunction with black and white lists
  - Requires continuous management – not that simple…
- Refuse malformed messages
- Refuse virus-laden messages
- Try to recognize unwanted messages (spam)
  - Discard (danger of false positives)
  - Annotate (let the end user decide)