

The background of the slide features a series of concentric circles in various shades of blue, creating a ripple effect. A horizontal band of a lighter blue color runs across the middle of the slide, serving as a backdrop for the title text.

# **Chapter 19**

## **Electronic Mail**

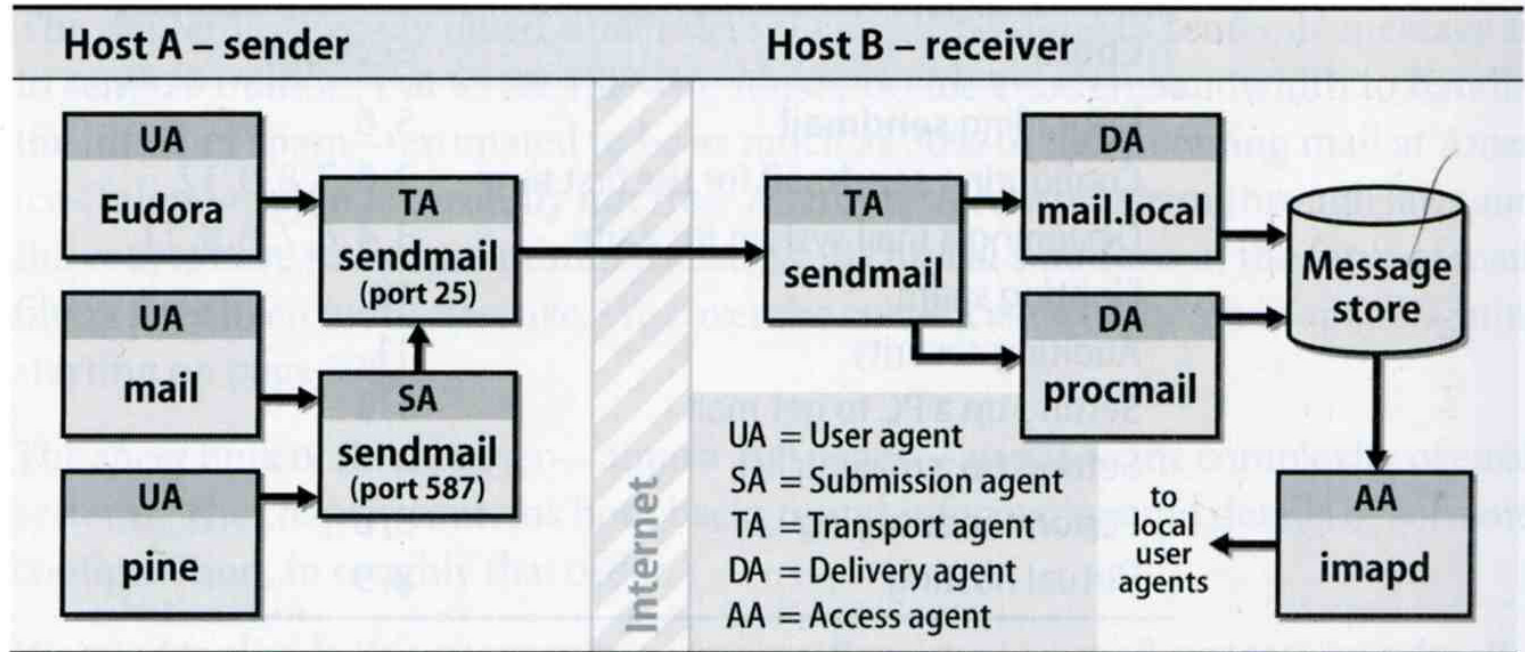
# Mail System (1)

## > Major components

- **Mail User Agent (MUA)**
  - Help user read and compose mails
- **Mail Transport Agent (MTA)**
  - Route mails among machines
- **Delivery Agent (DA)**
  - Place mails in users' mail boxes
- **Access Agent (AA)**
  - Connects the user agent to the mail box using POP or IMAP protocols
- **Submission Agent (SA)**
  - Route mails to local MTA

# Mail System (2)

Exhibit A Mail system components



# Mail System – The Message Stores

- > The place on the local machine where email is stored
  - **Usually the directory: /var/mail or /var/spool/mail**
    - Users' mails are stored in files named with each user's login name
      - > Such as /var/mail/tytsai
    - Permission "775" and root:mail as the owner and group owner
      - > drwxrwxr-x 2 root mail 512 Dec 16 15:51 mail/
  - **Using database**
    - When the organization is large or for ISP with millions of customers

# Mail System – The User Agent (1)

- > Help user read and compose mails
  - **UA must know mail format**
    - Originally: Text only
    - Now: MIME
  - **MIME (Multipurpose Internet Mail Extensions)**
    - Include several types of content that can be encoded in the mail, such as image, video, ...



# Mail System – The User Agent (2)

## — Popular Mail User Agents

User Agent	System Config.	User Config.	MIME	POP	IMAP	SMTP
bin/mail	mail.rc	.mailrc				
pine	pine.conf	.pinerc	✓	✓	✓	✓
elm	lib/elm.rc	.elm/elmrc	✓	✓	✓	
mutt	/etc/Muttrc	.muttrc	✓	✓	✓	
Netscape	-	-	✓	✓	✓	✓
Eudora	-	-	✓	✓	✓	✓
Outlook Ep.	-	-	✓	✓	✓	✓

# Mail System – The Transport Agent (1)

## > Route mails among machines

- **Accept mail from UA, examine the recipients' addresses, and delivery the mail to the correct host**
- **Protocols**
  - SMTP (Simple Mail Transport Protocol)
    - > RFC 821
  - ESMTP (Extended SMTP)
    - > RFC 1869, 1870, 1891, 1985
- **Popular transport agents**
  - sendmail
  - Portfix

# Mail System – The Transport Agent (2)

## > Conversation between TAs

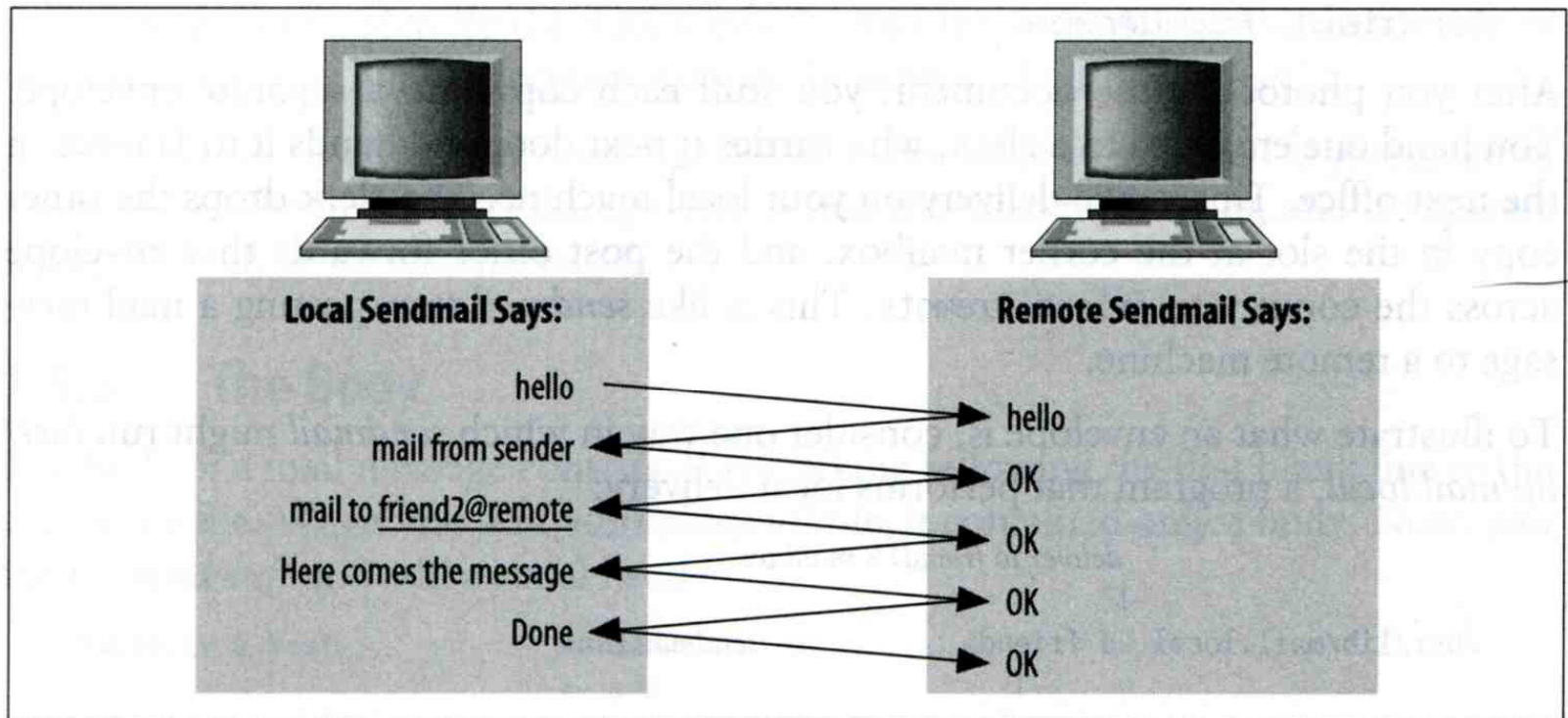


Figure 1-2. A simplified conversation



# Mail System – The Transport Agent (3)

## > Taking in SMTP

```
tytsai@tybsd:/etc> telnet localhost 25
Trying 127.0.0.1...
Connected to localhost.csie.nctu.edu.tw.
Escape character is '^]'.
220 tybsd.csie.nctu.edu.tw ESMTP Sendmail 8.13.1/8.13.1; Mon, 20 Dec 2004 15:49:00 GMT
HELP
214-2.0.0 This is sendmail version 8.13.1
214-2.0.0 Topics:
214-2.0.0      HELO    EHLO    MAIL    RCPT    DATA
214-2.0.0      RSET    NOOP    QUIT    HELP    VRFY
214-2.0.0      EXPN    VERB    ETRN    DSN     AUTH
214-2.0.0      STARTTLS
214-2.0.0 For more info use "HELP <topic>".
214-2.0.0 To report bugs in the implementation send email to
214-2.0.0      sendmail-bugs@sendmail.org.
214-2.0.0 For local information send email to Postmaster at your site.
214 2.0.0 End of HELP info
EHLO tybsd
250-tybsd.csie.nctu.edu.tw Hello localhost [127.0.0.1], pleased to meet you
...
quit
221 2.0.0 tybsd.csie.nctu.edu.tw closing connection
Connection closed by foreign host.
```

# Mail System – The Delivery Agent

## > Place mails in users' mail boxes

- **Accept mail from MTA and deliver the mail to the local recipients**
- **Type of recipients**
  - User
  - Program, such as
    - > mail.local
    - > procmail
- **mail.local**
  - Read the stdin up to an EOF and appends it to each user's mail file
- **procmail**
  - Do something between mail coming in and stored in mail box
  - CSIE: Help → 5 → 2 → 8

# Mail System – The Access Agent

> Help user download mail from server

— **Protocols**

- IMAP (Internet Message Access Protocol)
- POP (Post Office Protocol)

# Mail System – The Submission Agent

## > Route mails to local MTA

- **Typical works that a MTA must do:**
  - Ensuring that all hostname are fully qualified
  - Modifying headers
  - Logging errors
  - ...
- **RFC2476 introduces the idea of splitting MTA**
  - Let SA to share the load

# Components of a mail (1)

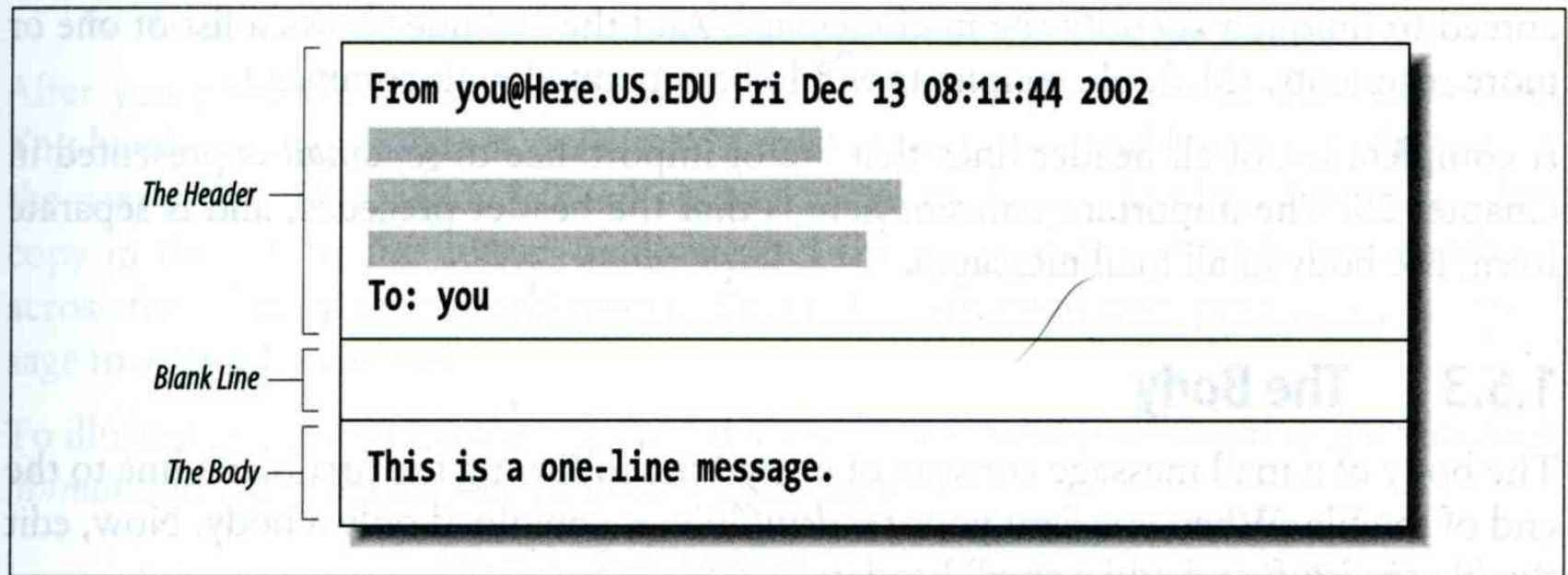


Figure 1-1. Every mail message is composed of a header and a body



# Components of a mail (2)

## > Three major components

### — The envelope

- Invisible to users
- Determine where the message should be delivered, or to whom it should be returned

### — The headers

- Information about the messages, defined in RFC822
  - > From, To, Date, Time, MTA, ...

### — The message body

- Plain text only
- Various MIME contents are encoded as printable characters using radix-64 algorithm

# Mail Addressing (1)

## > Two kinds of email addresses:

### — Route based address

- Message will travel through several intermediate hosts to the destination
- Format: host!path!user
  - > Ex: castle!sun!sierra!hplabs!ucbvax!winsor
  - > This mail is sent from “castle” host to the user “winsor” at “ucbvax” host

### — Location independent address

- Simply identify the final destination
- Format: user@host.domain
  - > Ex: tytsai@tybsd.csie.nctu.edu.tw

# Mail Addressing (2)

## > Alias

- **Map a username to something else, such as**
  - To a group of users
    - > *Ex: cp86 → tytsai, chiaming, wujc, ...*
  - To the same user at different machine
    - > *Ex: tytsai@csie.nctu.edu.tw → tytsai@ee.nctu.edu.tw*
  - To another user
    - > *Ex: admin@csie.nctu.edu.tw → tytsai@csie.nctu.edu.tw*

# Mail Addressing (3)

## > Where to send the mail?

— When you want to send the mail to `tytsai@csie.nctu.edu.tw`, the MTA will:

- First, lookup up the mail exchanger of “csie.nctu.edu.tw”

> % dig mx csie.nctu.edu.tw

> If there is any servers, choose the higher preference one

> If this preferred one can not be connected, choose another

> If all the mx servers can not be connected, mail it directly to the host

> Ex:

```
tytsai@ccduty:~/Mail/2004-12-18> dig mx csie.nctu.edu.tw
```

```
;; ANSWER SECTION:
```

csie.nctu.edu.tw.	8640	IN	MX	1 mx3.csie.nctu.edu.tw.
csie.nctu.edu.tw.	8640	IN	MX	5 mx1.csie.nctu.edu.tw.
csie.nctu.edu.tw.	8640	IN	MX	5 mx2.csie.nctu.edu.tw.

# Mail Addressing (4)

- > Why using “Mail eXchanger”?
  - We can centralize all the mail tasks to group of servers
  - Multiple mail exchangers make it more robust



# Mail Headers (1)

- > Defined by RFC822 which is obsoleted by RFC2822
  - **Mail reader will hide some uninteresting header information**

```
Date: Sat, 18 Dec 2004 11:50:13 +0000
From: Tsung-Yi Tsai <tytsai@tybsd.csie.nctu.edu.tw>
To: Tsung-Yi Tsai <tytsai@tybsd.csie.nctu.edu.tw>
Subject: 哈哈
User-Agent: Mutt/1.4.2.1i
```

# Mail Headers (2)

From tytsai@tybsd.csie.nctu.edu.tw Sat Dec 18 11:50:13 2004  
Return-Path: <tytsai@tybsd.csie.nctu.edu.tw>  
Received: from tybsd.csie.nctu.edu.tw (localhost [127.0.0.1])  
by tybsd.csie.nctu.edu.tw (8.13.1/8.13.1) with ESMTP id iBIBoDmY029830  
for <tytsai@tybsd.csie.nctu.edu.tw>; Sat, 18 Dec 2004 11:50:13 GMT  
(envelope-from tytsai@tybsd.csie.nctu.edu.tw)  
Received: (from tytsai@localhost)  
by tybsd.csie.nctu.edu.tw (8.13.1/8.13.1/Submit) id iBIBoDjv029829  
for tytsai@tybsd.csie.nctu.edu.tw; Sat, 18 Dec 2004 11:50:13 GMT  
(envelope-from tytsai)  
Date: Sat, 18 Dec 2004 11:50:13 +0000  
From: Tsung-Yi Tsai <tytsai@tybsd.csie.nctu.edu.tw>  
To: Tsung-Yi Tsai <tytsai@tybsd.csie.nctu.edu.tw>  
Subject: 哈哈  
Message-ID: <20041218115013.GA29818@tybsd.csie.nctu.edu.tw>  
Mime-Version: 1.0  
Content-Type: text/plain; charset=utf-8  
Content-Disposition: inline  
Content-Transfer-Encoding: 8bit  
User-Agent: Mutt/1.4.2.1i  
Status: RO  
Content-Length: 10  
Lines: 1

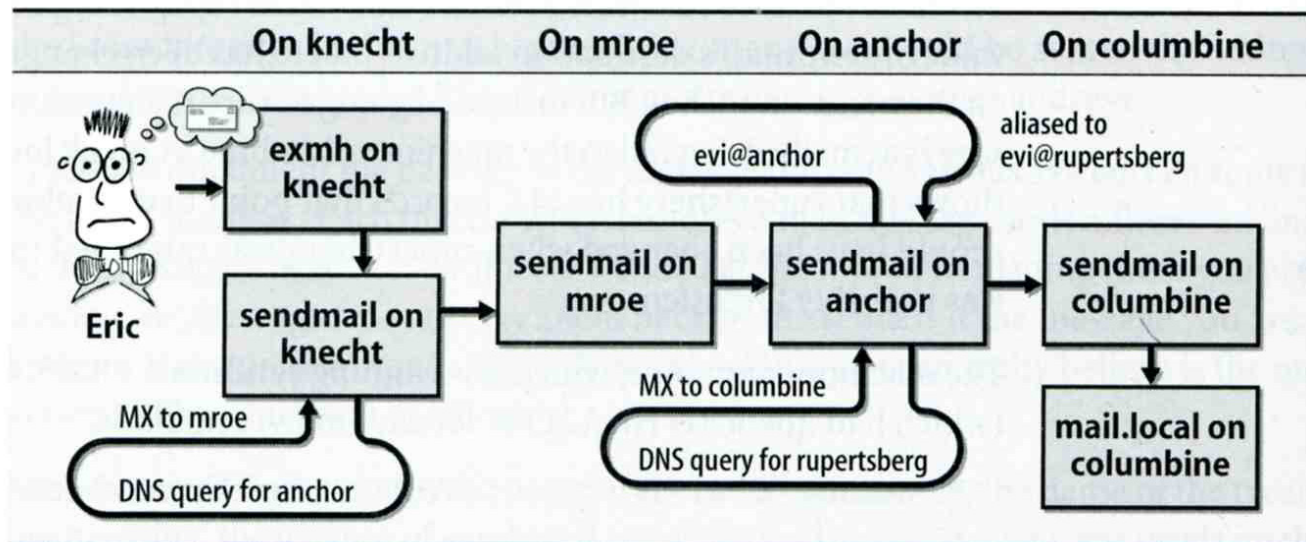
現在呢

# Mail Headers (3)

## > Example

- User “eric” on “knecht.sendmail.org” sends a email to user “evi” on “anchor.cs.colorado.edu”
  - % dig mx anchor.cs.colorado.edu  
> mroe.cs.colorado.edu

Exhibit B A message from Eric



# Mail Headers (4)

## > Headers in this example

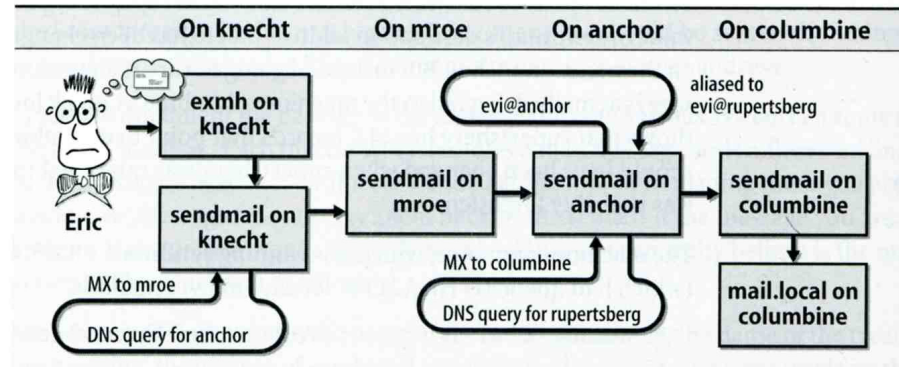
- **From eric@knecht.sendmail.org**
  - Added by mail.local when the mail is put in user's mailbox
  - Used to separate message boundary
- **Return-Path: eric@knecht.sendmail.org**
  - Used to send the error message to this address
  - May be different to the "From" address
- **Received: from knecht.sendmail.org (localhost [127.0.0.1]) by knecht.sendmail.org (8.9.3/8.9.2) with ESMTP id GAA18984; Fri 1 Oct 1999 06:04:02 -800 (PST)**
  - Every machine that is ever processed this mail will add a "Received" record in top of headers
    - > Sending machine
    - > Receiving machine
    - > Version of sendmail in receiving machine
    - > Message unique identifier in receiving machine
    - > Date and time



# Mail Headers (5)

- Received: from **anchor.cs.Colorado.EDU** (root@anchor.cs.colorado.edu [128.138.242.1]) by **columbine.cs.colorado.edu** (8.9.3/8.9.2) with ESMTP id HAA21741 for <evi@rupertsberg.cs.colorado.edu>; Fri, 1 Oct 1999 07:04:25 - 0700 (MST)
- Received: from **more.cs.colorado.edu** (more.cs.colorado.edu [128.138.243.1]) by **anchor.cs.colorado.edu** (8.9.3/8.9.2) with ESMTP id HAA26176 for <evi@anchor.cs.colorado.edu>; Fri, 1 Oct 1999 07:04:24 -0700 (MST)
- Received: from **knecht.sendmail.org** (knecht.sendmail.org [209.31.233.160]) by **more.cs.colorado.edu** (8.9.3/8.9.2) with ESMTP id HAA09899 fro <evi@anchor.cs.colorado.edu>; Fri, 1 Oct 1999 07:04:23 -700 (MST)
- Received: from **knecht.sendmail.org** (localhost [127.0.0.1]) by **knecht.sendmail.org** (8.9.3/8.9.2) with ESMTP id GAA18984; Fri 1 Oct 1999 06:04:02 -800 (PST)

Exhibit B A message from Eric





# Mail Headers (6)

- **Message-Id:** <199910011404.GAA18984@knecht.sendmail.org)
  - Add by sender's MTA
- **X-Mailer:** exmh version 2.0.2 2/24/98
  - MUA
  - Non-standard header information
- **To:** Evi Nemeth <evi@anchor.cs.colorado.edu>
- **Subject:** Re: hi
- **Date:** Fri, 1 Oct 1999 06:04:02 -800

# Mail System Architecture

## > Components in a mail system architecture

- Mail servers for incoming and outgoing mails
- Mail home
- IMAP or POP to integrate PC and remote clients

## > Simplest architecture

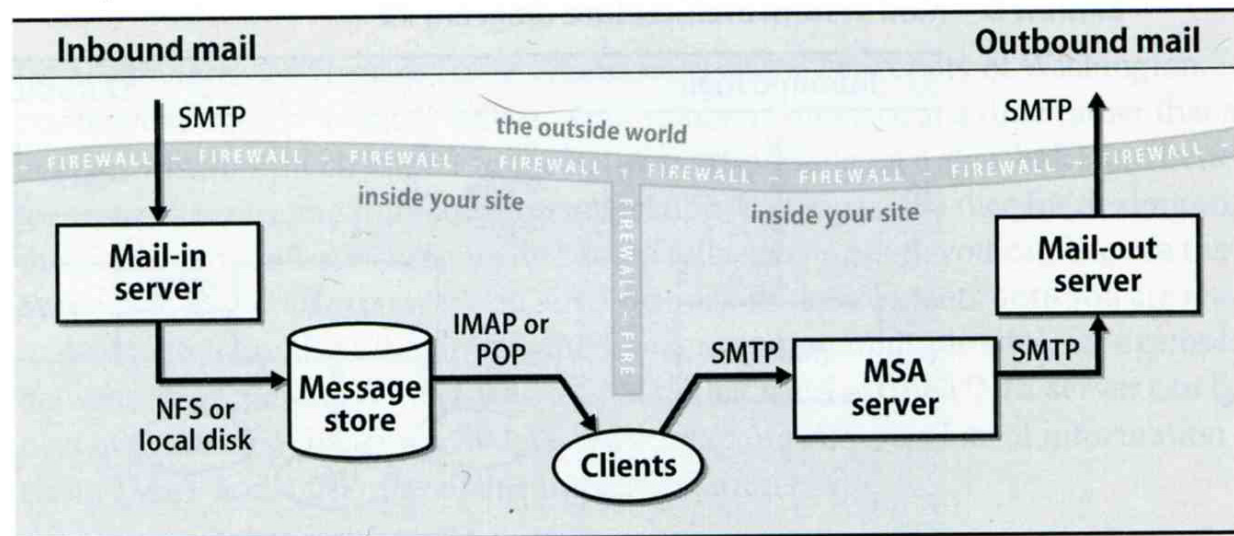
- Only one machine
  - This machine has sendmail to let you send and receive mail
  - This machine is also the mailbox home
  - This machine also provides IMAP or POP to let you download mail from PC

# Mail System Architecture – Scalable architecture for medium sites

## > Centralize

- At least one machine for incoming message and
  - Mail home can be the same host or another one
- At least one machine for outgoing message
  - Each host run MSA and forward mail to the same mail-out server or send the mail directly

Exhibit C Mail system architecture



# Mail Alias

- > Several mechanisms to define aliases:
  - **Traditional method: in files**
  - **Traditional method with NIS**
  - **LDAP (Light-weight Directory Access Protocol)**
  
- > When the sendmail wants to resolve name
  - **File-based method**
    - sendmail looks up files to resolve it by itself
  - **LDAP-based method**
    - sendmail call LDAP server to resolve the name and return the results

# Mail Alias –

## Traditional aliasing mechanism (1)

- > Aliases can be defined in three places
  - **In MUA's configuraiton file**
    - Read by MUA and expand the alias before injecting the message into the mail system
  - **In the system-wide /etc/mail/aliases file**
    - Read by MTA
    - The path to the system-wide alias file can be specified in sendmail's configuration file
  - **In user's forwarding file, ~/.forward**
    - Read by MTA after system-wide alias file



# Mail Alias – Traditional aliasing mechanism (2)

## > The format of an entry in aliases file

### 1. Local-name: recipient1,recipient2,...

#### – Ex:

- admin: tytsai,jwwang
- tytsai: tytsai@tybsd.csie.nctu.edu.tw

### 2. Local-name: :include:another-file

#### – Ex:

- bsdTA: :include:/usr/local/mail/bsdTA

Contents of bsdTA

```
tytsai  
kctao  
chiahung  
lwhsu  
chlo  
hwchu  
liling
```

# Mail Alias –

## Traditional aliasing mechanism (3)

### 3. Local-name: absolute-path-file

– Mails will be appended to this file

– Ex:

- complaints: /dev/null
- troubles: trouble\_admin, trouble\_log
- trouble\_admin: :include:/usr/local/mail/troadm
- trouble\_log: /usr/local/mail/logs/troublemail

### 4. Local-name: "|program-path"

– Route mail to stdin of program

– Ex:

- autoftp: "|/usr/local/bin/ftpserver"

# **Mail Alias –**

## **Traditional aliasing mechanism (4)**

### **> The hashed aliases DB**

- /etc/mail/aliases is the plaintext aliases information**
- /etc/mail/aliases.db is the hashed version for efficiency**
- Use “newaliases” command to rebuild the hashed version when you change the aliases file**

# Mail Alias –

## Traditional aliasing mechanism (5)

- > User maintainable forwarding file
  - In `~/.forward`
  - Format: comma-separated
  - Ex:
    - `tytsai@gmail.com`
    - `\tytsai, tytsai@gmail.com, tytsai@yahoo.com.tw`
  - Must be owned by user and with permission of 600
    - The path to `.forward` file should be writable only to user

# Mail Alias –

## Traditional aliasing mechanism (6)

### > Alias must

- **postmaster and MAILER-DAEMON**
  - Mail system maintainer
- **bin, sys, daemon, nobody, ...**
  - System accounts (root)
- **root**
  - forward root mail to the administrator (.forward)

```
MAILER-DAEMON: postmaster
postmaster: root
bin:    root
bind:   root
daemon: root
games:  root
kmem:   root
mailnull: postmaster
nobody: root
operator: root
...
```

The background is a solid blue color with a pattern of concentric circles in a lighter shade of blue. A horizontal white band runs across the middle of the image. The word "sendmail" is written in a bold, dark blue font within this white band.

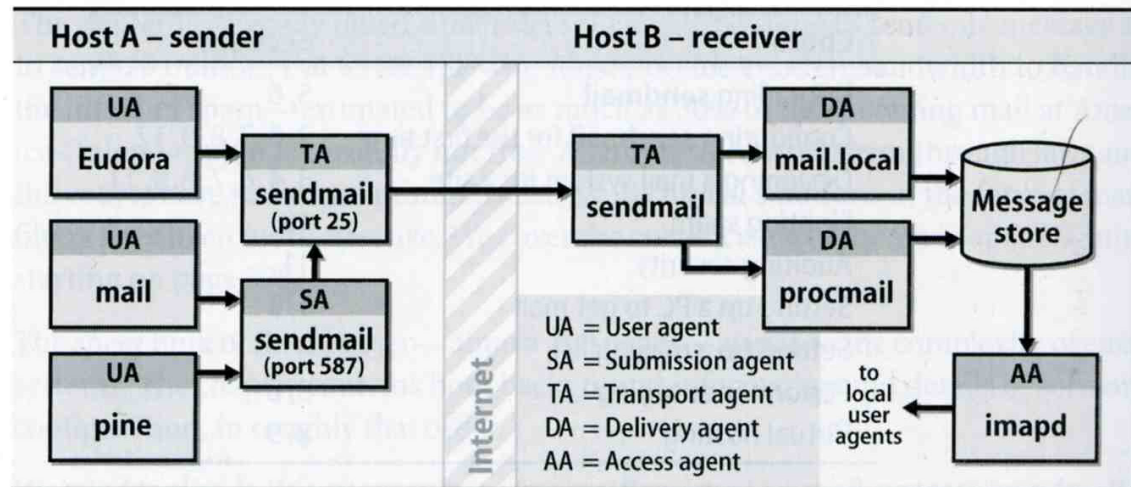
**sendmail**



# Introduction

- > sendmail is a MTA program
  - The most complete and complex mail transport program with about 70% popularity
  - Interface between MUA and MDA
  - Speak SMTP and deliver mail to remote via the Internet

Exhibit A Mail system components



# History of sendmail

- > sendmail version5
  - **Eric Allman, student of UC Berkeley, in 1983**
- > IDA sendmail enhanced from v5
  - **Lennart Lovstrand, student of University of Linköping in Sweden, 1987**
    - Institutionen for Datavetenskap (cs department)
- > KJS sendmail enhanced from IDA
  - **Paul Vixie at DECWRL during 1989-1993**
    - King James Sendmail
- > sendmail version8
  - **Eric included enhanced features in IDA and KJS in 1993**

# sendmail installation

## > Major components of sendmail

- **/usr/sbin/sendmail**
  - The sendmail binary with access mode 4755 setuid to root
- **/etc/mail/sendmail.cf**
  - Configuration file
- **/var/spool/mqueue**
  - Mail queue directory, with mode 700 owned by root
- **newaliases, mailq, hoststat, ...**
  - Various link to sendmail
- **mail.local and smrsh**
  - sendmail's safer local delivery agent

# Modes of operation

> sendmail can be run in several modes

Flag	Meaning	link
-bd	In daemon mode, on port 25	
-bD	In daemon mode, on port 25, foreground	
-bh	View recent connection information	hoststat
-bH	Purge disk copy of outdated connection info	purgestat
-bi	Initialize hashed aliases	newaliases
-bp	Print mail queue	mailq
-bt	Enter address test mode	
-bv	Verify mail address only; don't send mail	
-bs	Enter SMTP server mode (on stdin, not port 25)	

# Modes of operation – daemon mode

## > Daemon mode

- **sendmail listens on port 25 and waits for work**
- **Usually specify the `-q` flag to set the interval to process mails in queue**
  - `-q30m` to check the queue every 30 minutes
  - `-q1h` to check the queue every 1 hour
- **`/var/run/sendmail.pid`**
  - Contain the sendmail pid and command that starts it
- **Reset sendmail when you change the configuration**
  - `% kill -1 `head -1 /var/run/sendmail.pid``

```
tytsai@tybsd:/var/run> sudo less sendmail.pid
567
/usr/sbin/sendmail -L sm-mta -bd -q30m -ODaemonPortOptions=Addr=localhost
```



# Mail queue (1)

## > When to store message in queue

- Messages that host is too busy to deliver immediately or
- Messages that destination host is unavailable

## > Components of each queued message

- Each message is saved in pieces in several different files
  - Filename: Two-bit-prefix + random-ID

```
tytsai@tybsd [2:43pm] /var/spool/mqueue> ls -l
total 4
-rw----- 1 root daemon 16          Dec 20 14:32 dfiBKEWSmU037293
-rw----- 1 root daemon 1215        Dec 20 14:41 qfiBKEWSmU037293
tytsai@tybsd [2:44pm] /var/spool/mqueue> mailq
/var/spool/mqueue (1 request)
-----Q-ID----- --Size-- -----Q-Time----- -----Sender/Recipient-----
iBKEWSmU037293      16 Mon Dec 20 14:32 <tytsai@tybsd.csie.nctu.edu.tw>
(Deferred: Connection refused by r21607.csie.nctu.edu.tw.)
<shrang@r21607.csie.nctu.edu.tw>
Total requests: 1
```

# Mail queue (2)

## > Queued message prefix

### — Required pieces

- qf
  - > Message header (H)
  - > envelope address
    - Sender Address (S)
    - Recipient Address (R)
  - > The date to return as undeliverable
  - > Message priority in queue (P)
  - > The reason of why being queued (M)
  - > Time last processed (K)
  - > Time created (T)
- df
  - > Message body

# Mail queue (3)

## > Example of qf

```
V8
T1103553148
K1103553704
N2
P120520
I4/12/1343513
MDeferred: Connection refused by r21607.csie.nctu.edu.tw.
Fbs
$_localhost [127.0.0.1]
$rESMTP
$stybsd.csie.nctu.edu.tw
${daemon_flags}
${if_addr}127.0.0.1
S<tytsai@tybsd.csie.nctu.edu.tw>
MDeferred: Connection refused by r21607.csie.nctu.edu.tw.
rRFC822; shrang@r21607.csie.nctu.edu.tw
RPFD:<shrang@r21607.csie.nctu.edu.tw>
```

# Mail queue (4)

```
H?P?Return-Path: <<81>g>
H??Received: from tybsd.csie.nctu.edu.tw (localhost [127.0.0.1])
    by tybsd.csie.nctu.edu.tw (8.13.1/8.13.1) with ESMTP id iBKEWSmU037293
    for <shrang@r21607.csie.nctu.edu.tw>; Mon, 20 Dec 2004 14:32:28 GMT
    (envelope-from tytsai@tybsd.csie.nctu.edu.tw)
H?x?Full-Name: Tsung-Yi Tsai
H??Received: (from root@localhost)
    by tybsd.csie.nctu.edu.tw (8.13.1/8.13.1/Submit) id iBKEWSvL037292
    for shrang@r21607.csie.nctu.edu.tw; Mon, 20 Dec 2004 14:32:28 GMT
    (envelope-from tytsai)
H??Date: Mon, 20 Dec 2004 14:32:28 +0000
H??From: Charlie Root <root@tybsd.csie.nctu.edu.tw>
H??To: shrang@r21607.csie.nctu.edu.tw
H??Subject: test1
H??Message-ID: <20041220143228.GA37284@tybsd.csie.nctu.edu.tw>
H??Mime-Version: 1.0
H??Content-Type: text/plain; charset=us-ascii
H??Content-Disposition: inline
H??User-Agent: Mutt/1.4.2.1i
.
```

# Mail queue (5)

## > When /var/spool/mqueue is full

- we can move mqueue to another place and digest it later using this command
  - % /usr/sbin/sendmail -oQ/var/spool/cloggedqueue
- Example script to help to digest large amount of queued mails manually

```
#!/bin/sh
for suffix in 0 1 2 3 4 5 6 7 8 9
do
    mkdir clog${suffix}
    mv ?f*${suffix} clog${suffix}
    /usr/sbin/sendmail -oQclog${suffix}
done
```