Database based Email System

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Outline

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1. Background
    - Motivation
    - System Architecture
    - IMAP server
2. LDAP Authentication
    - Directory structure
    - Directory entries
    - Authentication
3. Data Design
    - Database schema
4. Detailed design
    - Additions to IMAP
    - Mail Searching
    - Misc.
    - Squirrelmail Interface

Motivation

- To provide a means of email access to end-users through a command line interface or an RFC-compliant client.
- Email systems store emails on a flat file. They use operating system support for file access to service requests for messages by clients.

Why Database?

Database offers superior techniques for search than normal file system.

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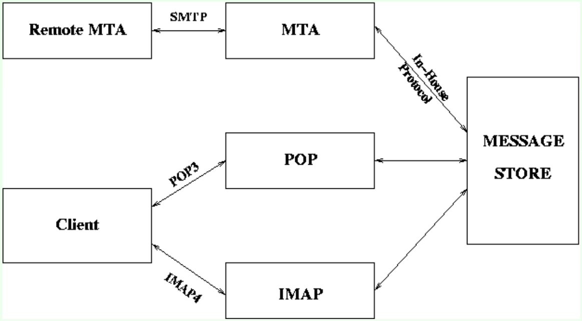
System Architecture



IMAP server

- Access to e-mail message stores as if they were local.
- User works on the message store itself, so requires persistent connection to the server.
- Each user can have multiple folders (INBOX, Trash, Sentmail, Drafts)
- Simultaneous access to the mailbox from two different locations (laptop, desktop etc.)
- Typically listens on port 143.

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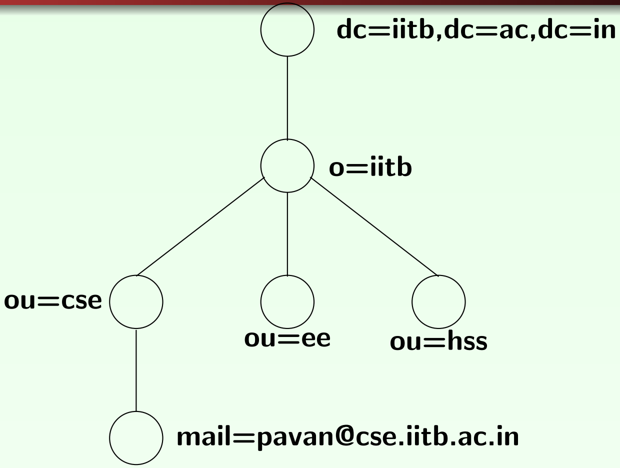
Directory structure



DIT for Email application

Directory entries

Sample ldif entry for a user:

dn: mail=pavan@cse.iitb.ac.in, ou=cse, o=iit, dc=iitb, dc=ac, dc=in
objectclass: account
objectclass: mailAccount
objectclass: top
userpassword: {md5}aknbKIfeaxs
uid: pavan
mail: pavan@cse.iitb.ac.in
mboxid: 20001

Authentication

- User requests a connection to his mailbox by sending login and password
- IMAP server initializes a handle to the ldap server - **ldap_init**
- IMAP server binds the connection with ldap user name and password - **ldap_bind**.
- Call the synchronous search, **ldap_search_s** with the email username to get the password and password type.
- Convert the entered password to the password type and authenticate if the user is legitimate (if it exists at all).
- Search also returns mailbox id for use by IMAP server to connect to the message store database.

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Database tables

- Mail-Message Table.
  Contains an entry for each message received by the SMTP server.
- Mail-Flag Table.
  Flags of each message in user's mailbox.
- User-Table.
  Contains for each mailbox, the number of messages it contains.
- CC Table
- To Table
- From Table
  Contain for each message, the list of users whose address is in To, Cc or From Field.

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Database tables (Contd.)

- User-Label Table.
  For each mailbox, contains the set of defined labels.
- Message-Label Table.
  For each message, contains the set of applied labels.
- Attachment Table.
  For each message the list of attachments.
- Filter Table.
  For each mailbox, the set of defined per-user filters.

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Structure of the tables

Mail-Message	
FieldName	Type
Message-ID	String
Subject	String
Date	Date
Blob path	String
Count	Int
Size	Int

User-Label	
FieldName	Type
Mail-Box-ID	Int
Label-ID	Sequence
Label	String

Message-Label	
FieldName	Type
Mail-Box-ID	Int
Message-ID	String
Label-ID	Sequence

Structure of the tables

To	
FieldName	Type
Message-ID	String
To	String

From	
FieldName	Type
Message-ID	String
From	String

Cc	
FieldName	Type
Message-ID	String
CC	String

Attachments	
FieldName	Type
Attachment-ID	Int
Message-ID	Int
Size	Int
Attachment-Name	Int
Pointer	Int

Structure of the tables (Contd.)

User-Table	
FieldName	Type
Mail-Box-ID	String
User-ID	Int
Count	Int

Filter	
FieldName	Type
Mail-Box-ID	Int
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Seive-Rule	String

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Support for Labels

DEFINELABEL $< label >$
: Defines a label for the user. An entry is added to the User-Label table if this is not a duplicate.

UNDEFLABEL $< label >$
: Removes a label defined for the user. Deletes the entry from the User-Label table.

ADDLABEL $< msg - num > \quad < label >$
: Defines a label for the message in the particular user's mailbox. Gets the corresponding message-id and adds an entry to Message Label table.

REMLABEL $< msg - num > \quad < label >$
: Removes a label from the message. Deletes the corresponding entry from the Message Label table.

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: Removes a label from the message. Deletes the corresponding entry from the Message Label table.

Support for Labels (Contd.)

SEARCH LABEL "String"
: Returns all message numbers with the given label in the user's mailbox

SEARCH ATTACHNAME attch-name
: Returns message numbers of all messages in the user's mailbox having an attachment with the given name

SEARCH INATTACH attch-name(optional) string
: Returns message numbers of all messages in the mailbox with the given word(s) in the attachment.

SEARCH FROM “cs701@cse.iitb.ac.in”

```
SELECT COUNT(*)+1 FROM
(SELECT * FROM Mail_Message mm,Mail-Flag mft
    WHERE mm.Message-ID=mft.Message-ID
    AND mft.Mail-Box-ID=mailboxid)m,
(SELECT msg.date
    FROM From f,Mail_Message msg,Mail-Flag mf
    WHERE f.From="cs701@cse.iitb.ac.in"
    AND f.Message-ID=msg.Message-ID
    AND msg.Message-ID=mf.Message-ID
    AND mf.Mail-Box-ID=mail-box-id)t
WHERE m.Mail-Box-ID=mailboxid
    AND convert(m.date)<convert(t.date)
    group by t.date;
```

Search by Keywords

SEARCH INATTACH “AttachName” “string”

```
SELECT line_number(msg.DATE)
FROM Mail-Message msg,Attachments a,
      Mail-Flag mf where (natural join)
AND a.AttachName=AttchName
AND search(a.AttachName,"string")==1;
```

- SEARCH BODY “string” uses similar query on the body.

Searching Mail

SEARCH BEFORE date	msg.Date<date
SEARCH AFTER date	msg.Date>date
SEARCH SMALLER size	msg.Size<size
SEARCH LARGER size	msg.Size>size
SEARCH DELETED(or any other flag)	Flags&&128 == 1

Search by Labels

SEARCH LABEL “LabelName”

```
SELECT line_number(msg.date)
FROM Mail-Message msg,User-Label u,Message-Label m
WHERE (natural join)
      AND u.Mail-Box-ID=mailboxid
      AND u.Label="LabelName";
```

LIST * Lists all the Labels of a User.

GETLABELS “Msg-ID” Lists the labels attached to a Msg-ID

Other Commands

- STORE "Msg-ID" +FLAGS (\DELETED)
  Message will be set for deletion.
- EXPUNGE
  - Look for all the messages in the mailbox with the deleted flag set.
  - For each message, decrement the count in the corresponding entry in the Mail-Message table by one.
  - To reduce the **expunge** time, entry in the database is not deleted immediately when count becomes zero.
  - Instead a **Garbage Collector** cleans up the orphaned blobs at some specified intervals or when the system load is low.
- LOGOUT
  - Expunge messages.
  - Logs out.

Displaying MailBox

- SELECT INBOX
- FETCH 1:* (FLAGS BODY[HEADER.FIELDS (FROM SUBJECT DATE SIZE)])

Labels

Client Side Action	Server Side Command
Create Label	DEFINE LABEL
Remove Label	UNDEF LABEL
Rename Label	REM LABEL
Add Label To a msg	ADDLABEL "String"
Remove Label from a msg	REMLABEL <Msg-ID> "String"

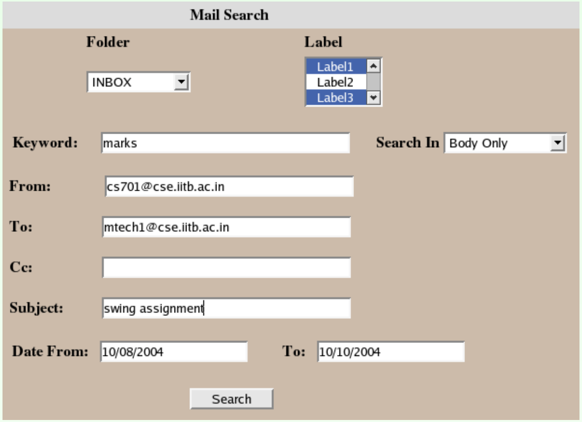
What are the available Labels?

LIST *

What are the labels associated with a message?

GETLABEL <Msg-ID>

Searching



Mail Search

Folder: INBOX

Label: Label1 [✓], Label2, Label3 [✓]

Keyword: marks

Search In: Body Only

From: cs701@cse.iitb.ac.in

To: mtech1@cse.iitb.ac.in

Cc:

Subject: swing assignment

Date From: 10/08/2004 To: 10/10/2004

Searching

- Complex Query

Get msgs from cs701@cse.iitb.ac.in having label "Swing"

From "cs701@cse.iitb.ac.in"

Client: SEARCH FROM "cs701@cse.iitb.ac.in"
Server: OK 12 16 17 19 24

Label "Swing"

Client: SEARCH LABEL "Swing"
Server: OK 11 16 19 25

- Messages that match - 16, 19

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Per-user Sieve filters

- Client converts filter definition to the seive rule in RFC 3028 format.
- Sends it to the server.
- Server checks the syntax
- Server stores rule in the database
- SMTP server applies the filter on incoming messages

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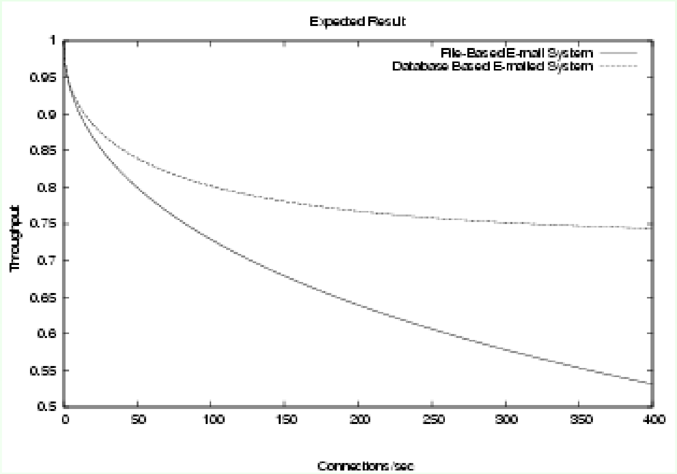
Performance graph



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