Scalable Open-source Email Infrastructure at SUNY Potsdam

Presented by Jeff Hardy
Team Lead, CTS Host & Network Services
SUNY Potsdam

http://fritz.potsdam.edu/projects/email

2012-11-13

Scalable Open-source Email Infrastructure at SUNY Potsdam

Application Design

- MTA, POP/IMAP, content-scanning, antivirus, anti-spam, quarantine, phish, storage...

Federating Management

- Postmaster, Helpdesk

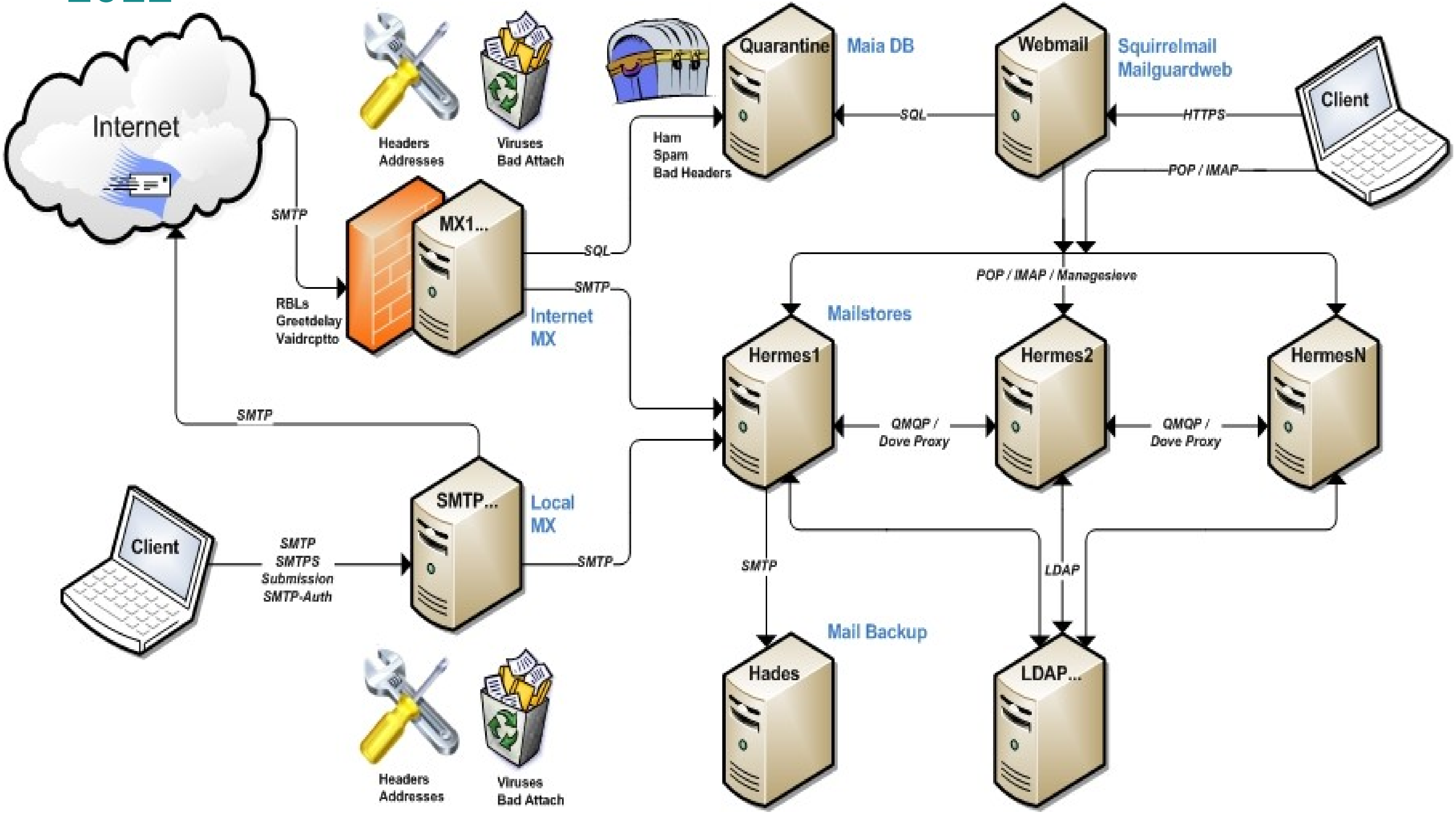
Banner/LDAP Account Synchronization

- Userclass standardization, CASL/WAM

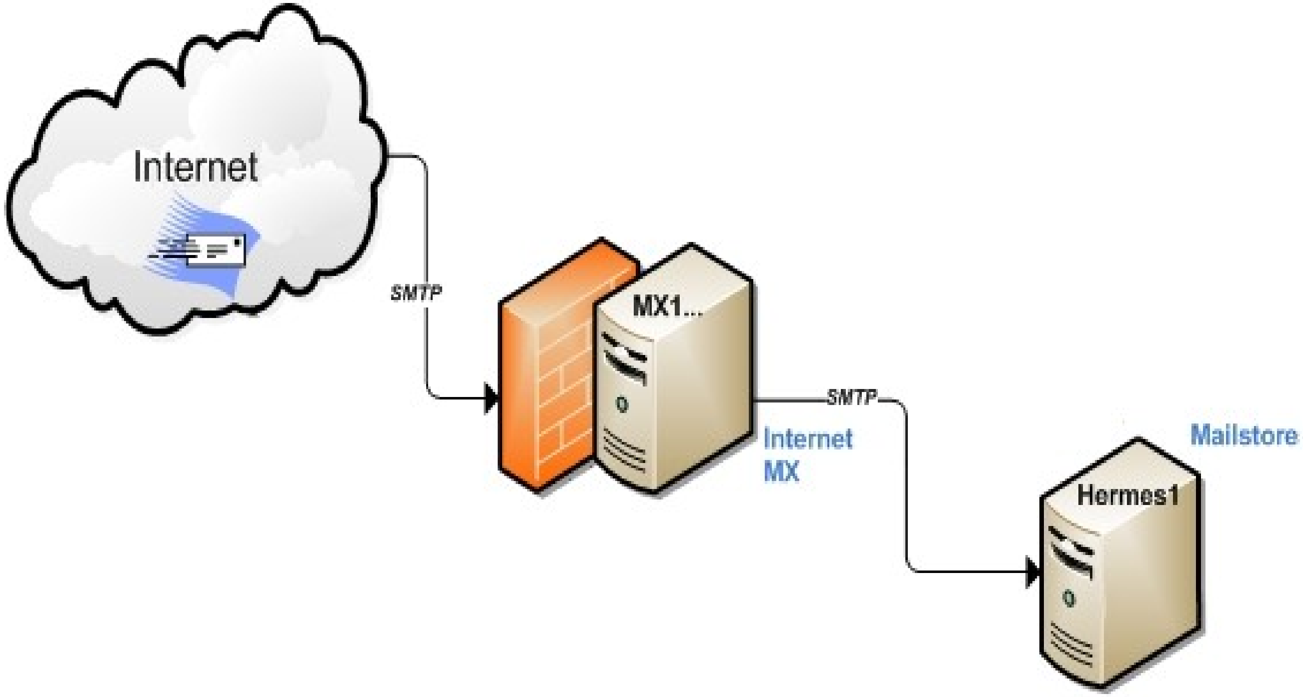
To Cloud or Not to Cloud

- Pros/Cons

2012


Internet
Headers
Addresses
Viruses
Bad Attach
Quarantine
Maia DB
Webmail
Squirrelmail
Mailguardweb
Client
SQL
HTTPS
Ham
Spam
Bad Headers
POP / IMAP
SMTP
MX1...
SQL
SMTP
Internet
MX
RBLs
Greetdelay
Vaidrcptto
POP / IMAP / Managesieve
Mailstores
Hermes1
Hermes2
HermesN
QMQP /
Dove Proxy
QMQP /
Dove Proxy
SMTP
SMTP...
Local
MX
Client
SMTP
SMTPS
Submission
SMTP-Auth
SMTP
SMTP
LDAP
Mail Backup
Hades
LDAP...
Headers
Addresses
Viruses
Bad Attach

2002



Application Design Goals

Open standards

- SMTP, POP/IMAP, ManageSieve

Open-source

- qmail, Dovecot, Amavisd-new/Maia Mailguard, ClamAV, SpamAssassin, MySQL, ...

Scalable

- Horizontal scalability: application cluster

Modular/Flexible

- Swap in/out other technologies, build own tools, federate management

DJB's qmail?

qmail vs Postfix vs Exim vs Sendmail

qmail ?

- no “development” for a decade: qmail-1.03
- hampered by no license until 2007 when entered public domain
- piles of extra patches for modern features (ldap, smtp-auth, tls)

qmail !

- no security issues for a decade
- novel design: mutually untrusting components
- atomic operations guarantee delivery
- invented Maildir
- well-understood, high performance

Qmail Patchsets

Netqmail

- A motley krewe of qmail contributors (see the README) has put together a netqmail-1.06 distribution of qmail. It is derived from Daniel Bernstein's qmail-1.03 plus bug fixes, a few feature enhancements, and some documentation.
- Our standard install, “the” de facto standard install

Qmail-ldap

- A patch to qmail 1.03 to retrieve all user data from a ldap-directory rather than from files on the disk. There is also clustering support builtin making qmail-ldap very well suited for big mail installations at ISPs.
- Mail stores and mail backup

JMS combined patch set

- John M Simpson's patch to qmail-1.03, combining several of the best practice patches, and modern SMTP features such as SMTP-Auth, valid recipient checking, and a few other novel things.
- Mail exchangers

Other DJB Software

daemontools

- collection of tools for managing UNIX services
- supervise: runs, monitors, starts a service -> used to start/init all qmail services
- multilog: logging, log rotation, TAI64 datestamps

ucspi-tcp

- collection of tools for building client-server applications
- tcpserver: network listener -> used as listener for all SMTP services
- rblsmtpd: blocks mail from listed RBL sites

Other DJB Software: tcpserver

tcpserver

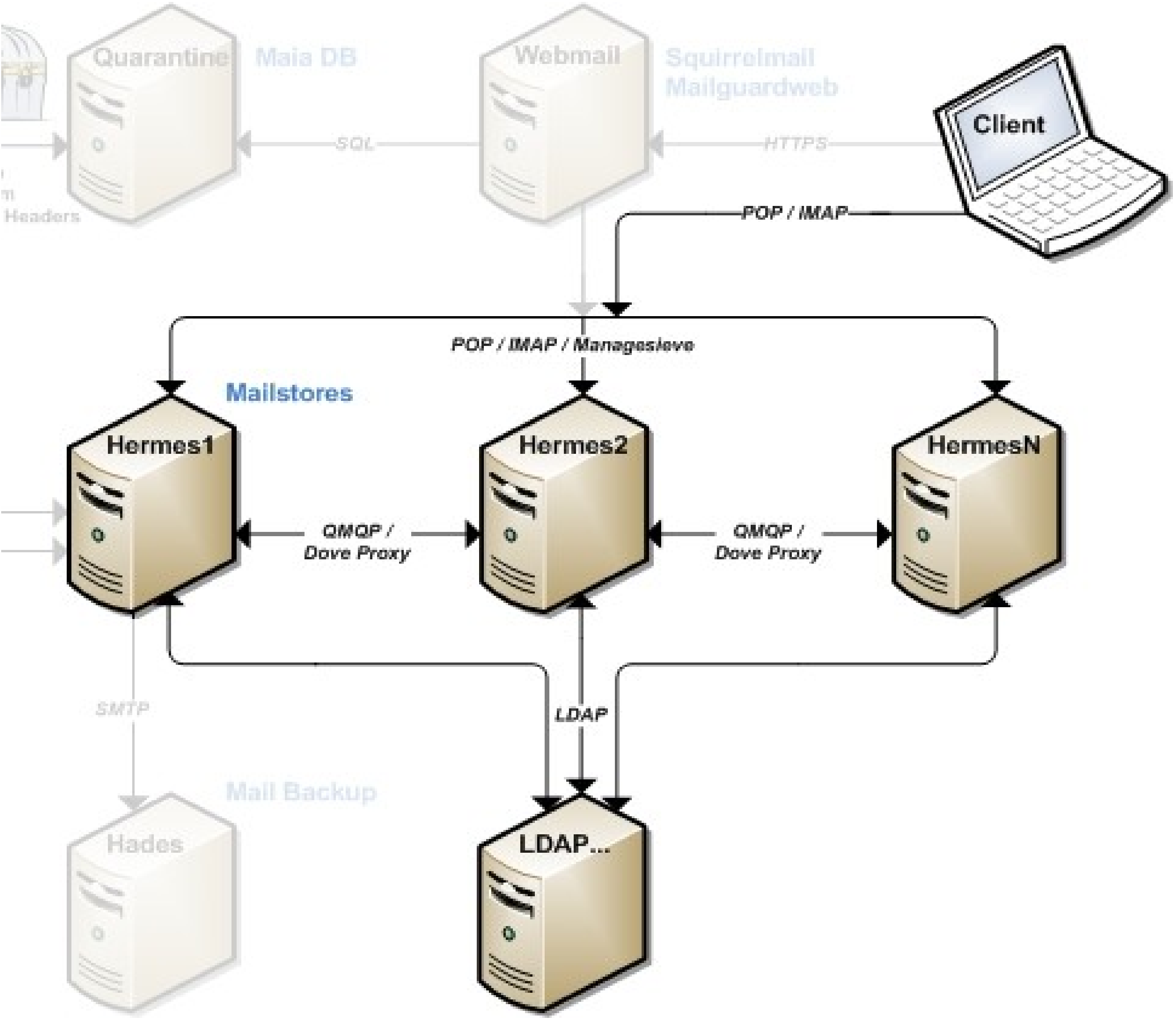
great flexibility to set different configurations for different source IP ranges via environment variables

```
127.:allow,RELAYCLIENT="",RBLSMTPD=""
137.143.:allow,RELAYCLIENT="",RBLSMTPD=""

# Baddies
137.143.67.71:deny
71.16.72.:deny

# Default
:allow,VALIDRCPTTO_CDB="/var/qmail/control/validrcptto.cdb",
VALIDRCPTTO_LIMIT="10",GREETDELAY="30",DROP_PRE_GREET="0",DENY_
TLS="1",LOGREGEX="1"
```

Mailstores


Quarantine
Maia DB
Webmail
Squirrelmail
Mailguardweb
SQL
HTTPS
Client
Headers
POP / IMAP
POP / IMAP / Managesieve
Mailstores
Hermes1
Hermes2
HermesN
QMQP /
Dove Proxy
QMQP /
Dove Proxy
SMTP
LDAP
Mail Backup
Hades
LDAP...

Account Home

We configure qmail-ldap to create home and Maildir at time of delivery.

```
/home/hardyjm/Maildir
                     /cur   /new   /tmp
```

- Every message is an individual file
- Message moved from delivery queue to tmp
- Message moved from tmp to new
- POP/IMAP client moves from new to cur

```
/home/hardyjm/.sieve/
```

- Storage location for sieve scripts: server-side filtering

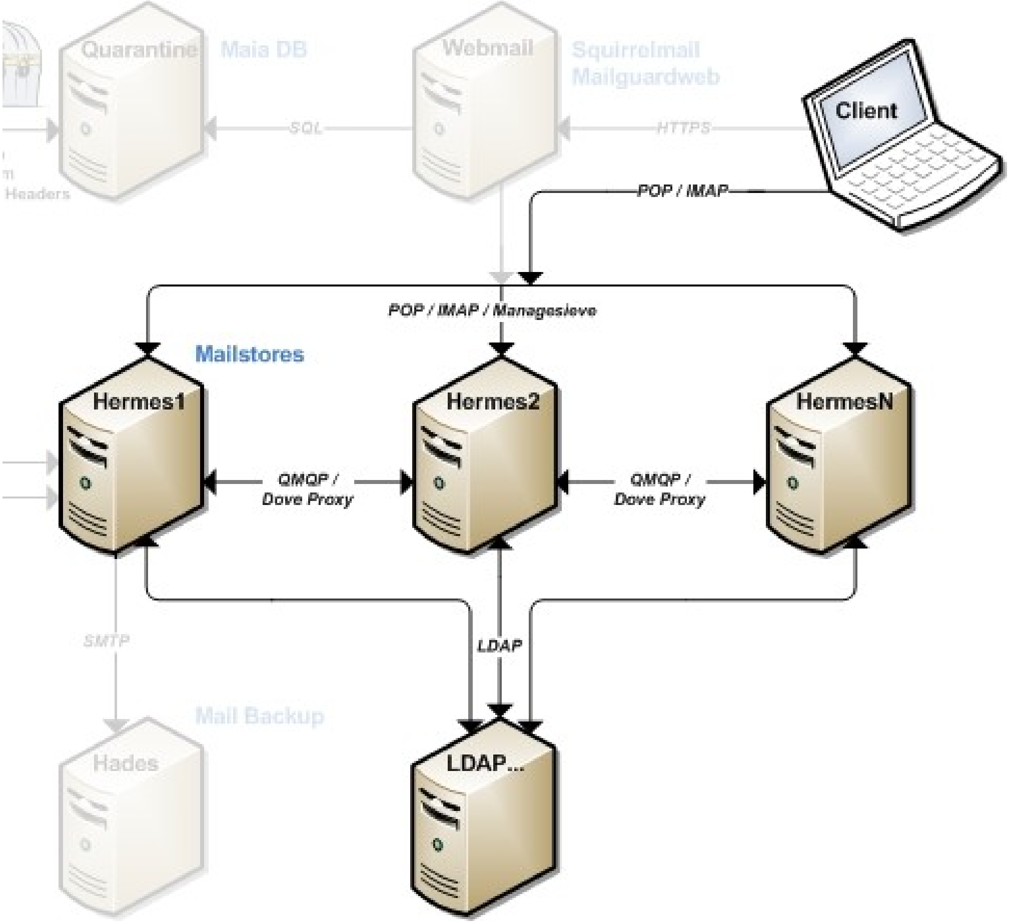
qmail-ldap

```
dn: uid=hardyjm,ou=People,o=madstop.edu
---------------------------------------------
objectClass: top
objectClass: account
objectClass: posixAccount
objectClass: sambaSamAccount
objectClass: person
objectClass: organizationalPerson
objectClass: inetorgPerson
objectClass: spotperson
objectClass: qmailuser
objectClass: sunyPerson
mail: hardyjm@madstop.edu
mailAlternateAddress: hardy@madstop.edu
mailAlternateAddress: hardyjm-null@madstop.edu
uid: hardyjm
accountStatus: active
mailHost: hermes.madstop.edu
homeDirectory: /mnt/home/hardyjm
aliasEmpty: using default
qmailDotMode: both
uidNumber: 16814
gidNumber: 100
mailQuotaSize: 0 (unlimited)
mailQuotaCount: 0 (unlimited)
mailSizeMax: 0 (unlimited)
mailReplyText: undefined
```

- objectClass: qmailUser
- mail
  - key for all mail delivery
- accountStatus
  - controls message receipt
  - active/disabled/deleted
- mailHost
  - specify cluster host
  - forwards via qmqp
- mailAlternateAddress
  - secondary recipient address aliases for user

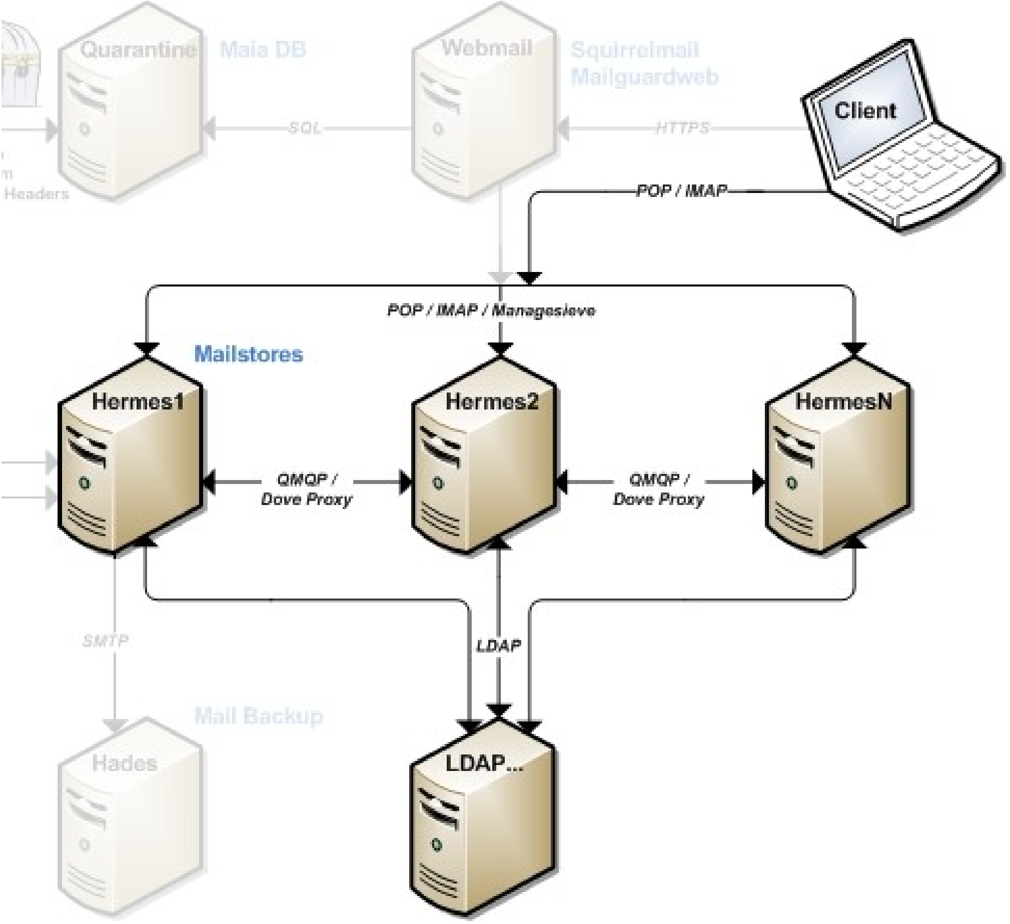
Mail Reception Clustering

- rcptto: hardyjm@potsdam.edu
- Any ldap aware qmail that receives this message conducts ldap search for hardyjm@potsdam.edu to find the user uid of the recipient
- If user mailhost attribute is equal to this host, delivered locally to user Maildir
- Otherwise, forwarded via qmqpd directly into the queue of the mailhost for that user
- More users, more mailhosts
- Balance flexibility: RR DNS, forwarding frontend(s), MX qmqp

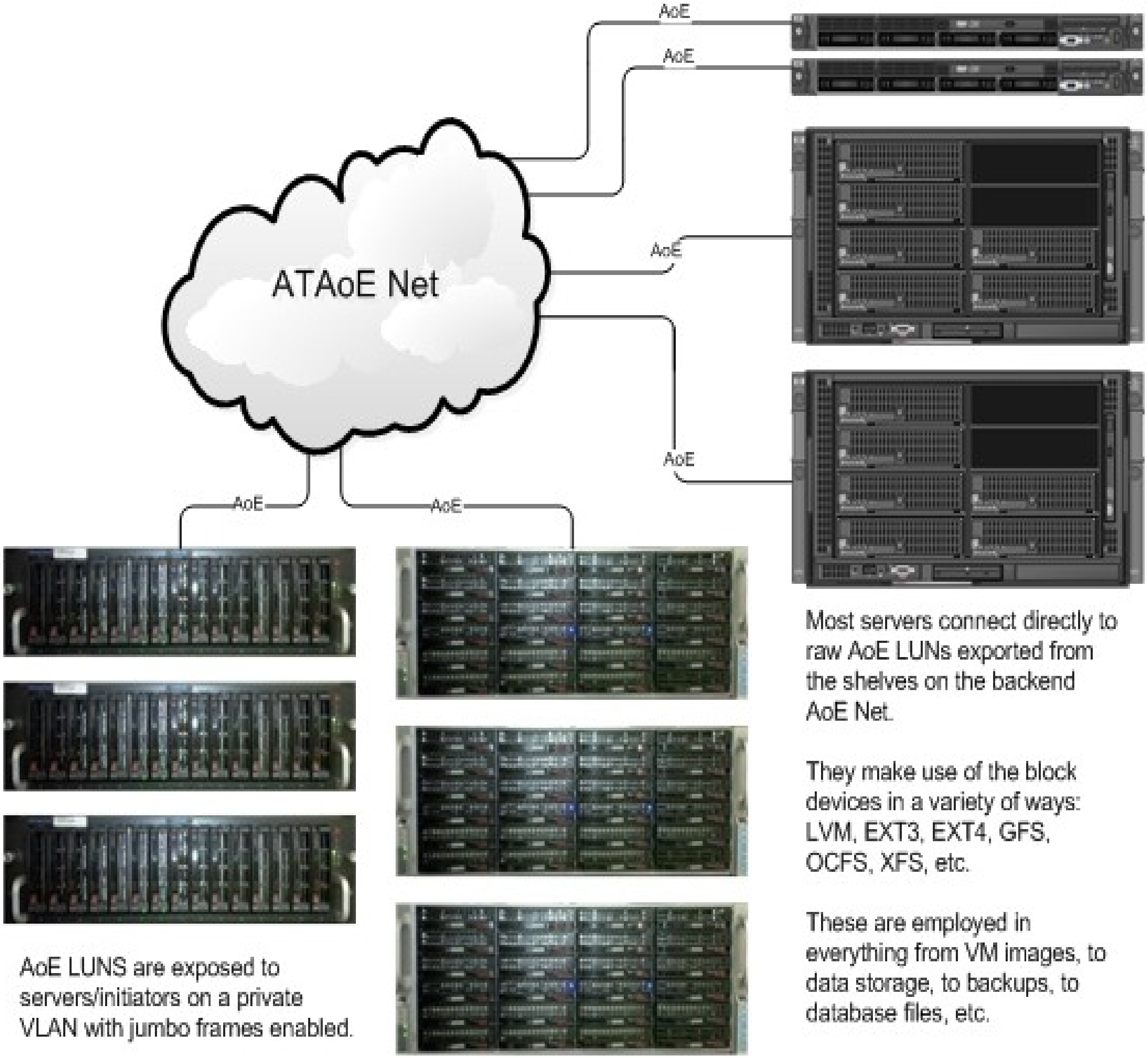


POP/IMAP Proxying

- Dovecot POP/IMAP/Managesieve
- Dovecot is configured to use checkpassword auth and our own perl chkpassldap script
- Chkpassldap sets environment variable 'host' to the LDAP attribute mailHost, and enables proxying to this host. Completely transparent login and configuration for users
- Login script adds user home and Maildir at time of POP and IMAP login, and touches a lastlogin file for user tracking



Storage: ATA over Ethernet



Most servers connect directly to raw AoE LUNs exported from the shelves on the backend AoE Net.

They make use of the block devices in a variety of ways: LVM, EXT3, EXT4, GFS, OCFS, XFS, etc.

These are employed in everything from VM images, to data storage, to backups, to database files, etc.

AoE LUNS are exposed to servers/initiators on a private VLAN with jumbo frames enabled.

- All mail on SAN
- Mailstores mount SAS RAID10 LUNs
- LVM VGs, XFS

- No quotas
- 10K users, 3.6TB

active employees: 1185, 1.3TB

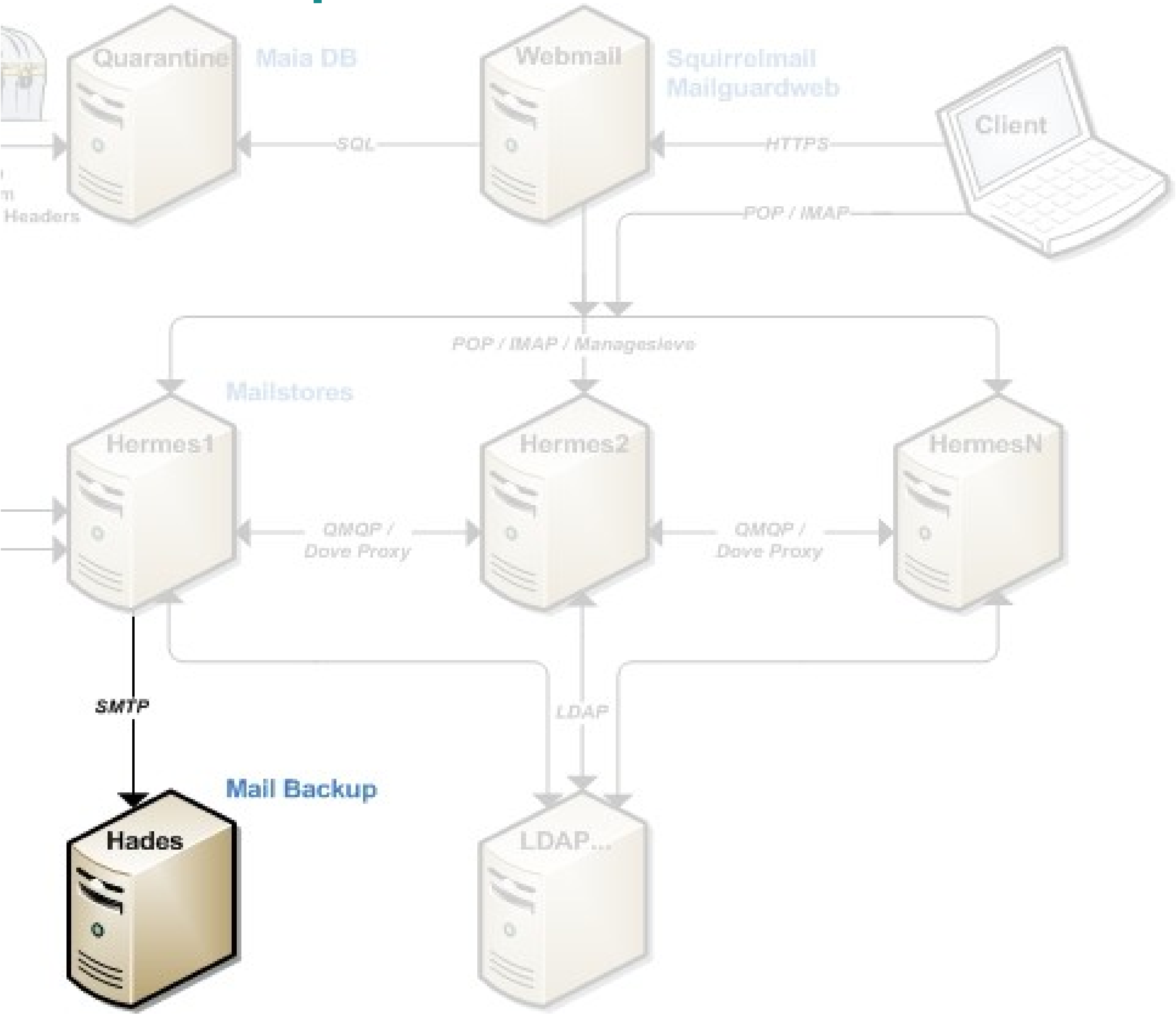
emeriti: 91, 50GB

active students: 4301, 0.6TB

inactive students: 628, 0.7TB

alumni: 3701, 1.4TB

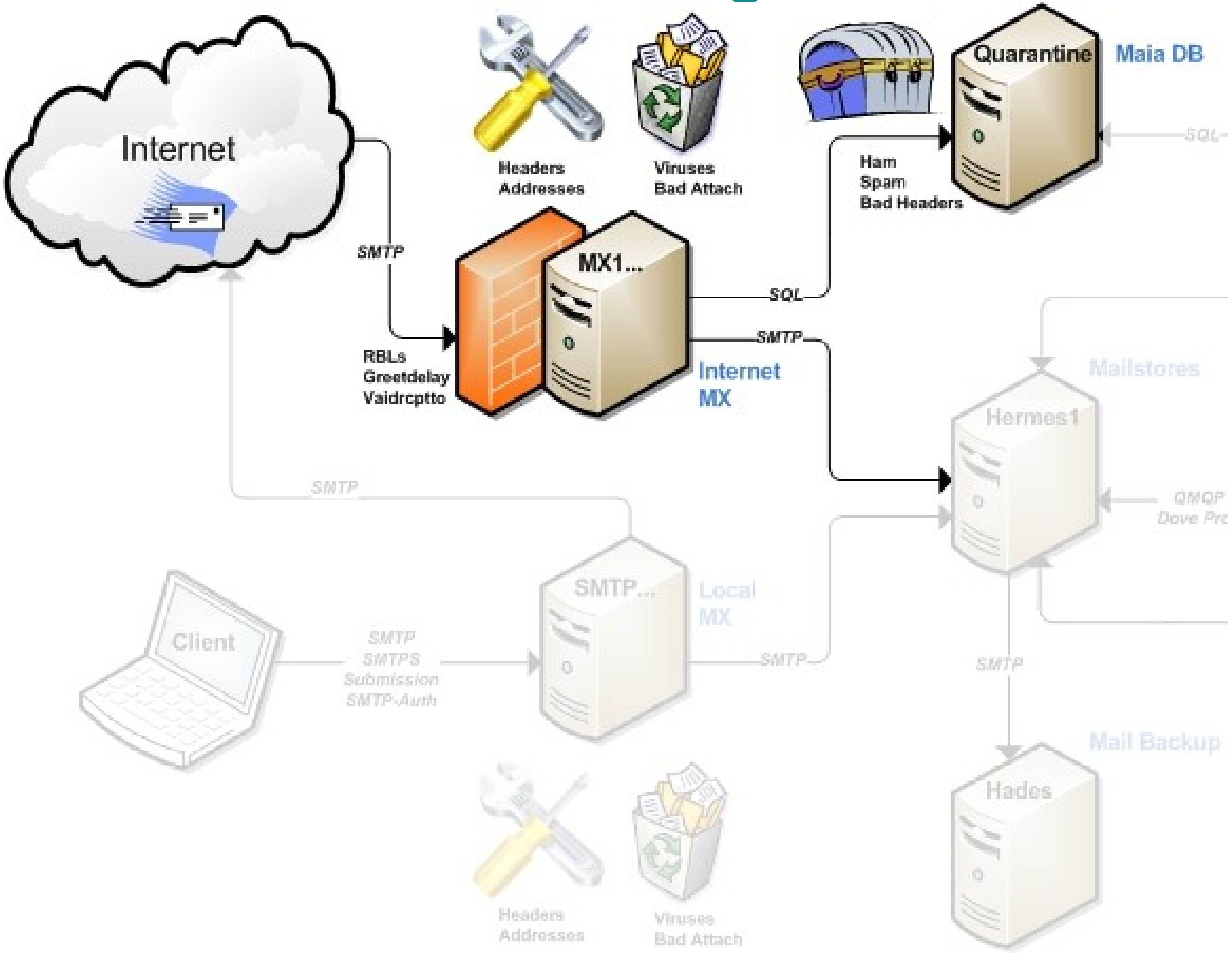
Mail Backup


Quarantine
Maia DB
Webmail
Squirrelmail
Mailguardweb
Client
SQL
HTTPS
Headers
POP / IMAP
POP / IMAP / Managesieve
Mailstores
Hermes1
Hermes2
HermesN
QMQP / Dove Proxy
QMQP / Dove Proxy
SMTP
LDAP
Mail Backup
Hades
LDAP...

Mail Backup

- Mail backup is conducted via double-delivery from the mailstores
- Second qmail instance on each mail store injected with copy of message, and routes all mail to the backup box
- In addition to double-delivery of all received mail, script copies Sent folder nightly
- All mail older than 30 days is culled from backup set

Internet Mail Exchangers



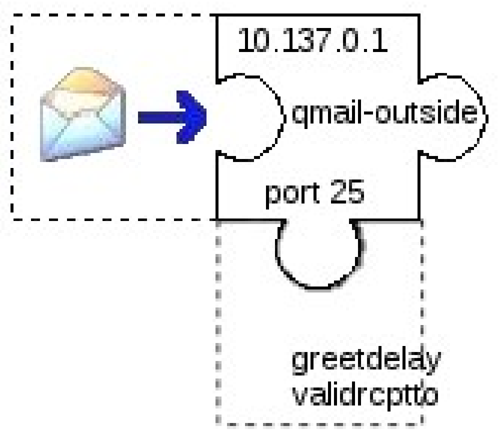
Mail Exchangers

The Internet mail exchangers provide an array of features geared towards handling the never-ending onslaught of Internet mail:

- Real-time blacklists
- SMTP tricks
- Valid recipient checks
- Antivirus scanning
- Anti-spam examination
- Message quarantine

DNS MX records for the domain will point to these machines.

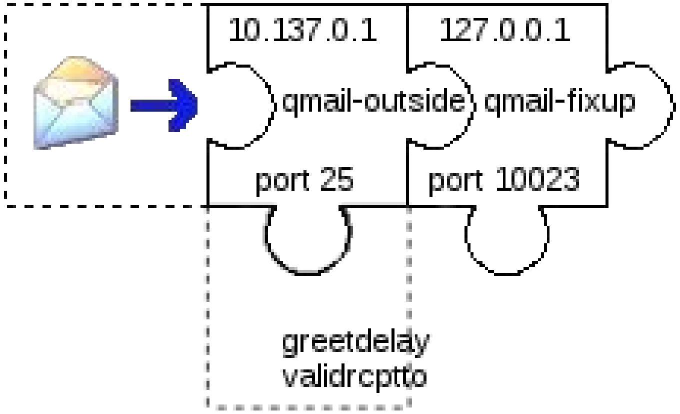
Mail Exchangers: qmail-outside



JMS qmail instance offering SMTP on Internet-facing port 25

- Takes full brunt of all incoming mail to the domain
- Provides greetdelay connection slowdown
- Provides validrcptto checking
- Host of other patches offering modern SMTP features
- SMTP routes all mail to qmail-fixup on port 10023

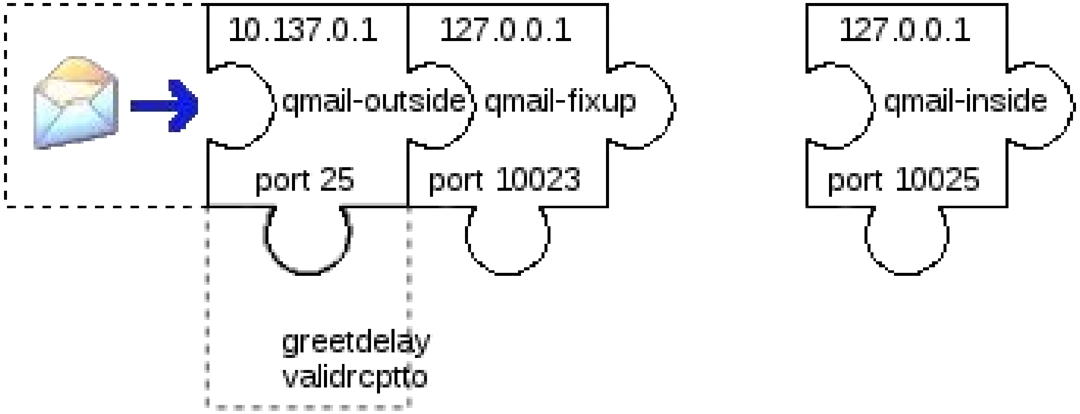
Mail Exchangers: qmail-fixup



Netqmail instance offering SMTP on localhost port 10023

- Uses ofmipd in place of qmail-smtpd: “Old-fashioned Mail Injection Protocol Daemon”
- Offers rewrite features to collapse various domains down to the potsdam domain in headers (ex: hardyjm@mail.potsdam.edu -> hardyjm@potsdam.edu). This is essential to unify addresses for the user before mail hits quarantine database
- SMTP routes all mail to amavis/maia on 10024

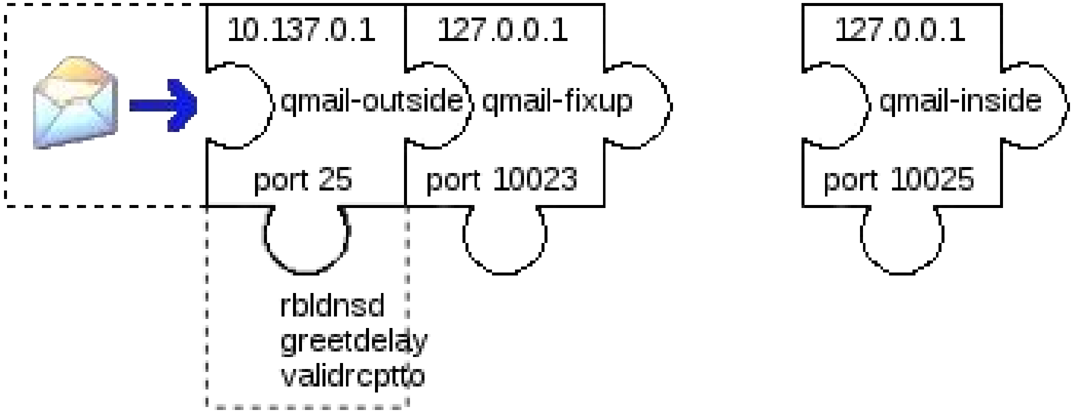
Mail Exchangers: qmail-inside



Netqmail instance offering SMTP on localhost port 10025

- SMTP delivery off-box to domain mailstores / Internet

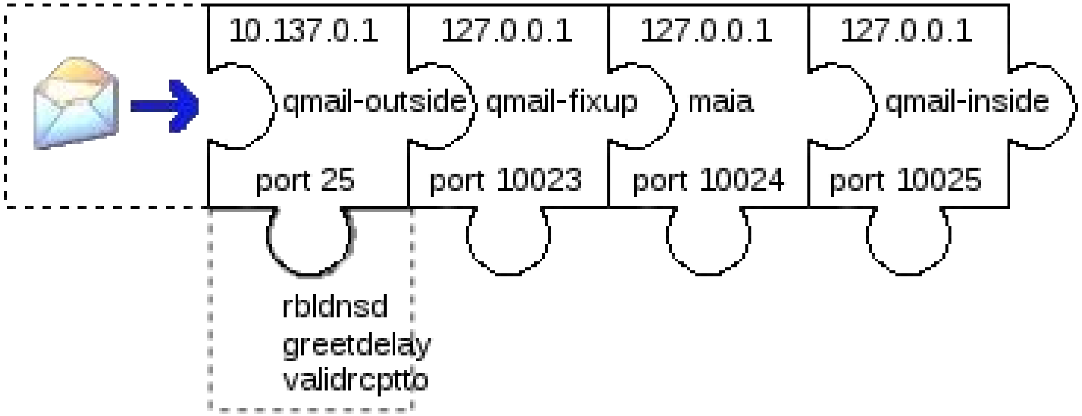
Mail Exchangers: RBLs



Add RBL checking to qmail-outside

- Add call to rblsmtpd in the qmail-smtpd run script
- Uses rbldnsd to look up sending IP address. Machine also setup as as a local caching nameserver with BIND, both to spare the domain DNS infrastructure from queries, and to enable spam checks against the RBLs
- Scales to any number of RBLs
- Spamhaus subscription

Mail Exchangers: Maia Mailguard



Maia Mailguard / Amavisd on localhost port 10024

- Takes messages in on SMTP
- Breaks message apart at MIME boundaries and does header, attachment, antivirus, and anti-spam checks
- Quarantines all mail to database for later review, so false negatives can be Bayes-trained as spam, and false positives can be rescued (and Bayes-trained as ham)
- Good mail forwarded on to qmail-inside instance for delivery to the mailstores

Amavis vs Maia Mailguard

Amavisd-new is the current branch that is actively developed. As such, the project name Amavis is largely interchangeable with amavisd-new.

- Virus scanning, spam scanning, file-based quarantine, later a database quarantine
- We ran Amavis for years doing virus scanning, later spam tagging
- Current version: amavisd-new-2.7.1 (2012-04-29)

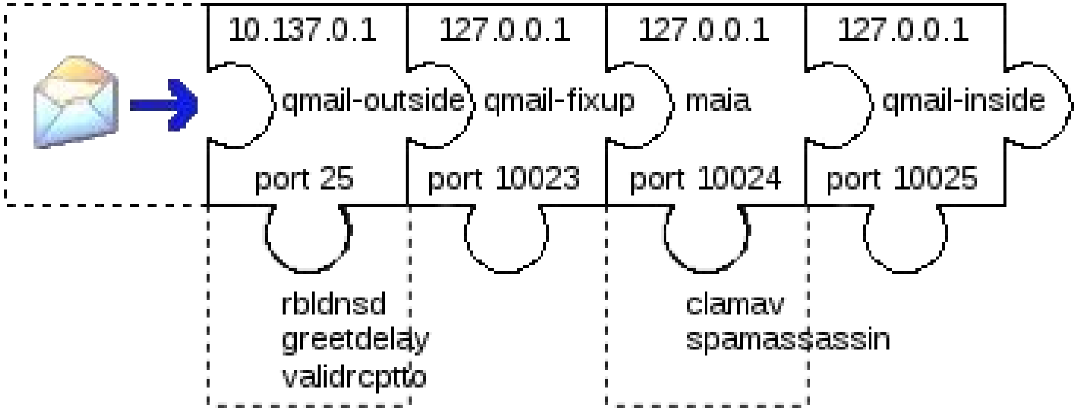
Maia Mailguard is a patch/fork of Amavis.

- Patch to amavisd-new-2.2.1
- All the features of Amavis with a concentration on user database preferences and quarantine, plus a web frontend
- Current version: maia-1.02c (2011-04-14)

Amavis vs Maia Mailguard

- Amavis was mostly geared toward central sysadmin control of spam thresholds and quarantine, with less/no reliance on database
- Maia Mailguard is geared towards putting users in control of spam decisions and quarantine management
- Disagreement over how to reconcile the two goals led to the entirely new project
- Over the last several years, Amavis has trended towards providing more and more of the features that Maia Mailguard offers
- Several different frontends for Amavis quarantine and settings are now available
- Maia Mailguard development a question, though basically feature-complete, and there is still list traffic

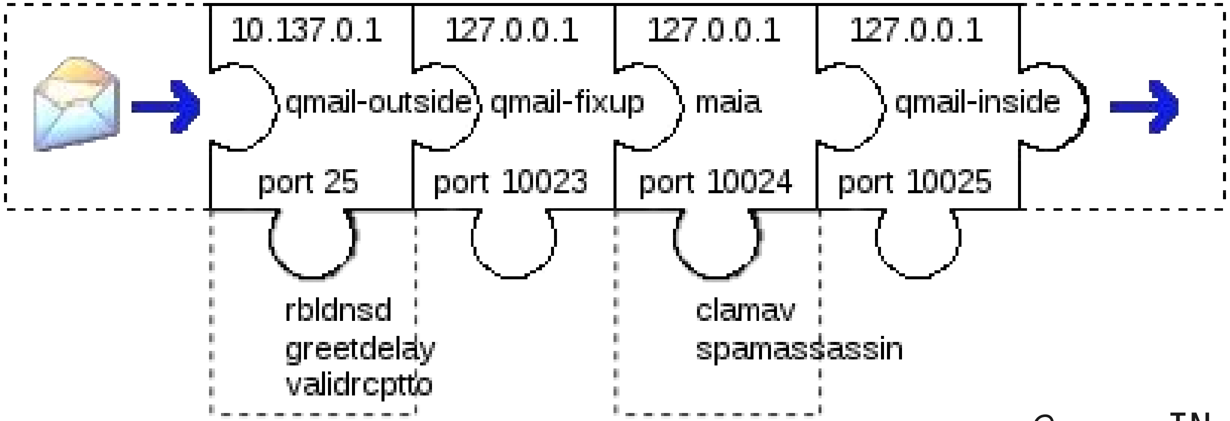
Mail Exchangers: AV, Antispam



Maia Mailguard / Amavis requires external engines for antivirus and anti-spam

- ClamAV is open-source and widely used, but you can use several external antivirus packages at once. Can fall back to non-daemonized versions (not recommended)
- SpamAssassin is required for spam intelligence, and Maia/Amavis use its modules internally to preserve performance
- Both ClamAV and SpamAssassin require definition/rule updates to be effective, and we use some external sources as well

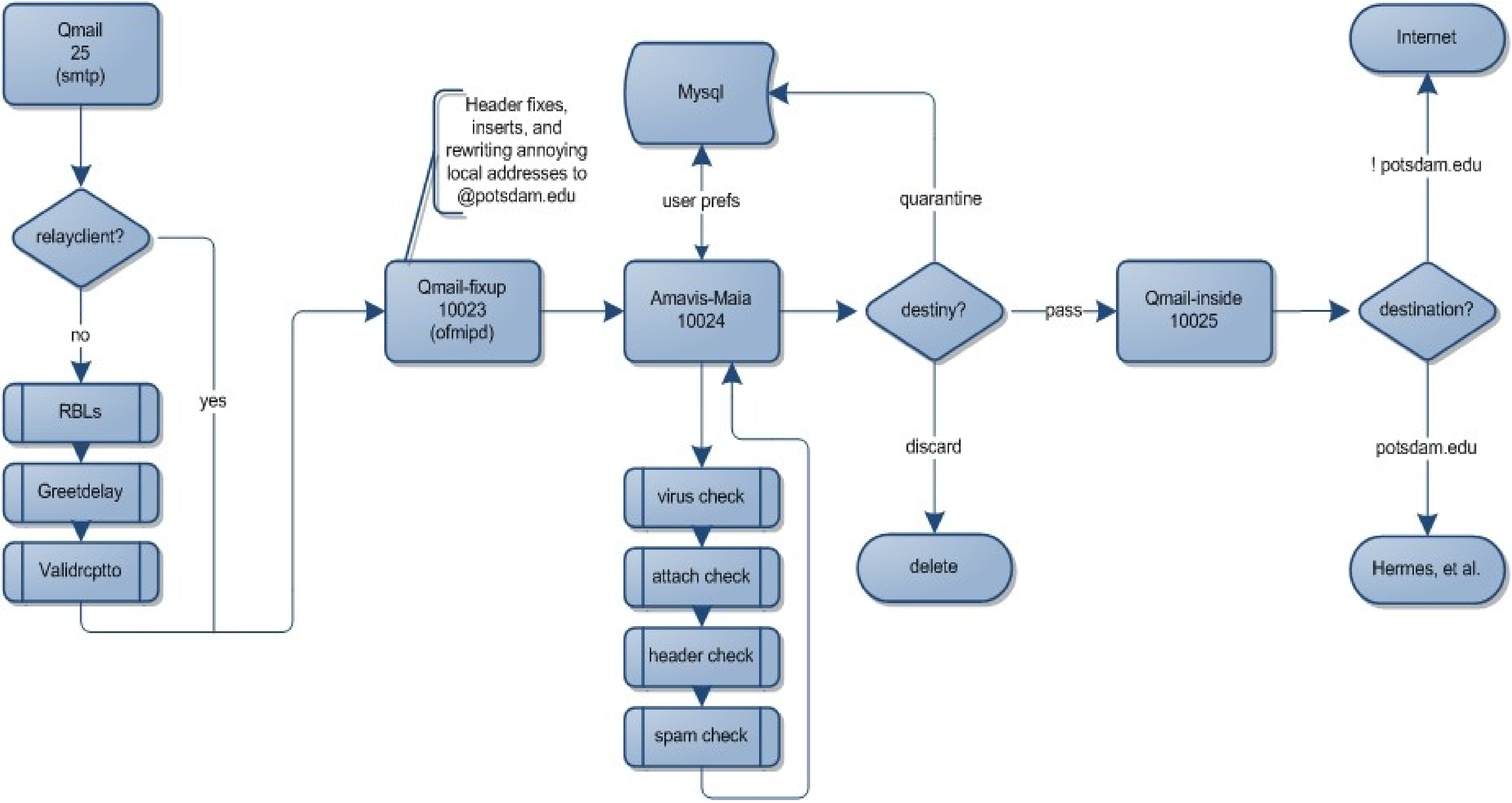
Mail Exchangers: Full Picture



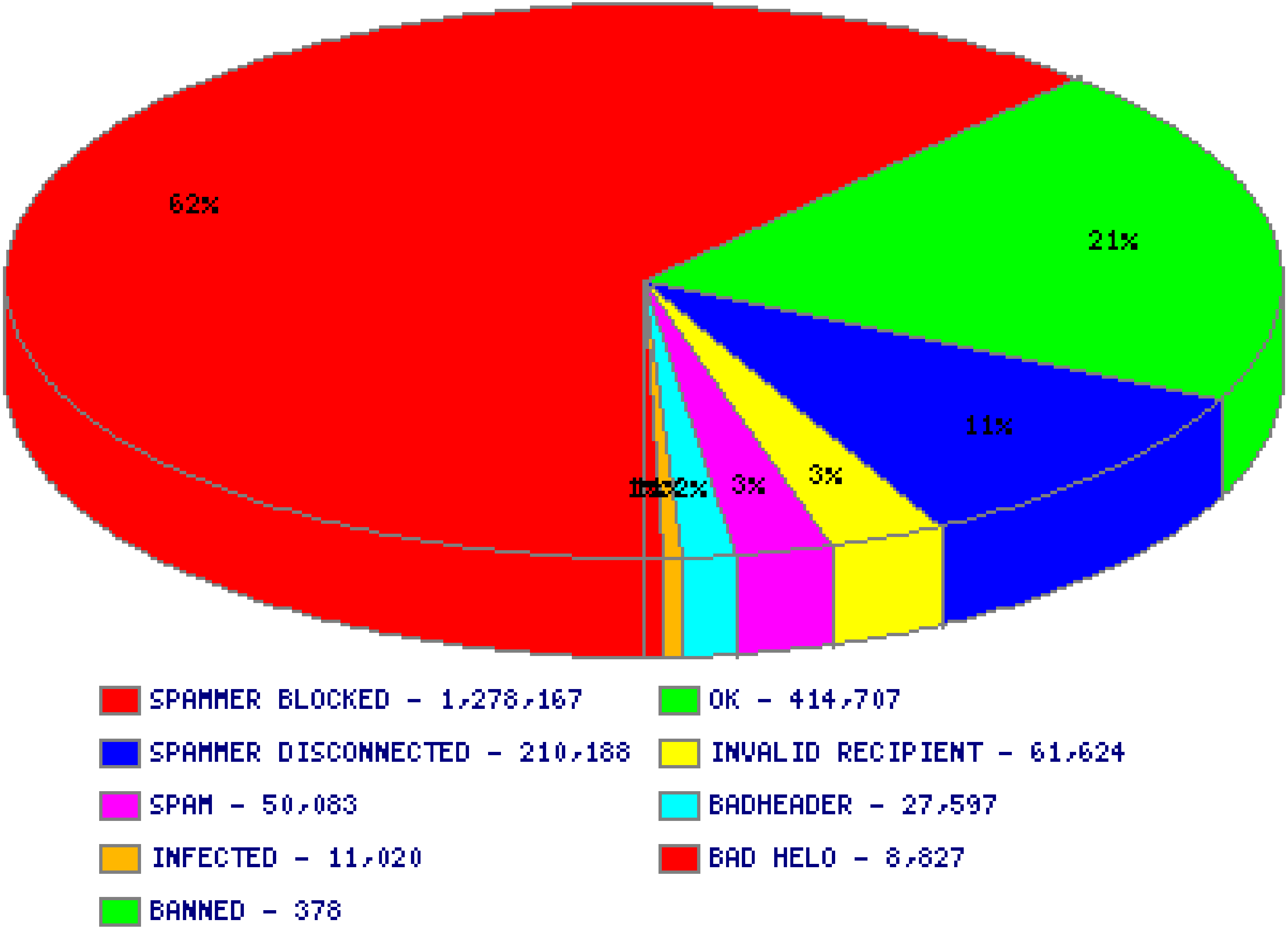
```
@       IN      MX      0 mx1.potsdam.edu.
@       IN      MX      0 mx2.potsdam.edu.
```

- DNS-listed mail exchangers for the domain
- Qmail-outside subjects connections to tcpserver restrictions and RBL check of sending IP. SMTP session subject to greetdelay to fake a slow SMTP server, badhelo, badmailfrom, valid recipient checking, etc
- Qmail-fixup rewrites headers to unified domain potsdam.edu
- Maia/Amavis is responsible for content-scanning, antivirus, anti-spam according to user database preferences, quarantine to database
- Qmail-inside delivers surviving mail to users at the mailstore
- Open-source Barracuda

Mail Exchangers: Detailed Picture

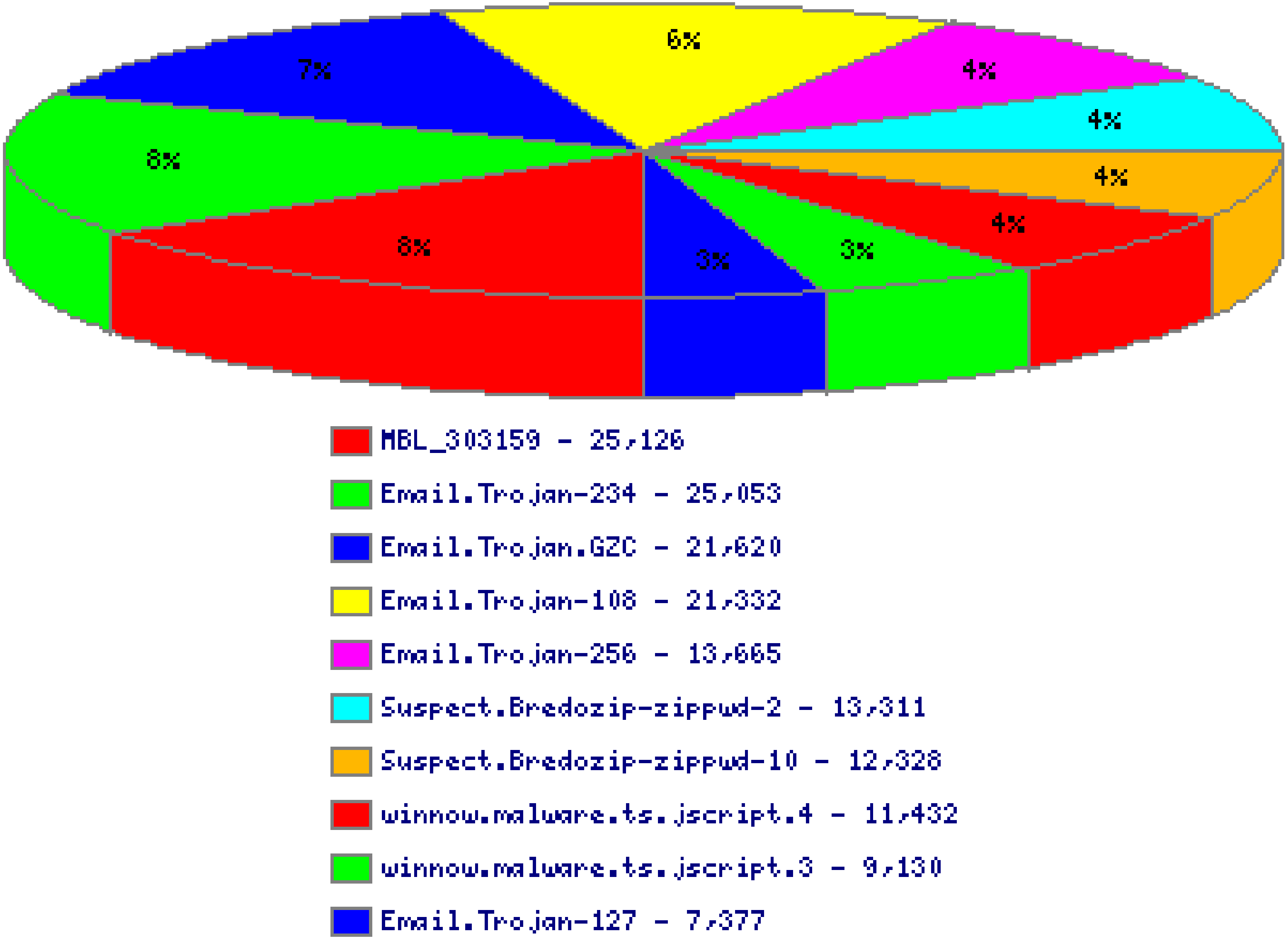


Top 10 e-Mail Fates in 7 Days: 2,062,591 Total



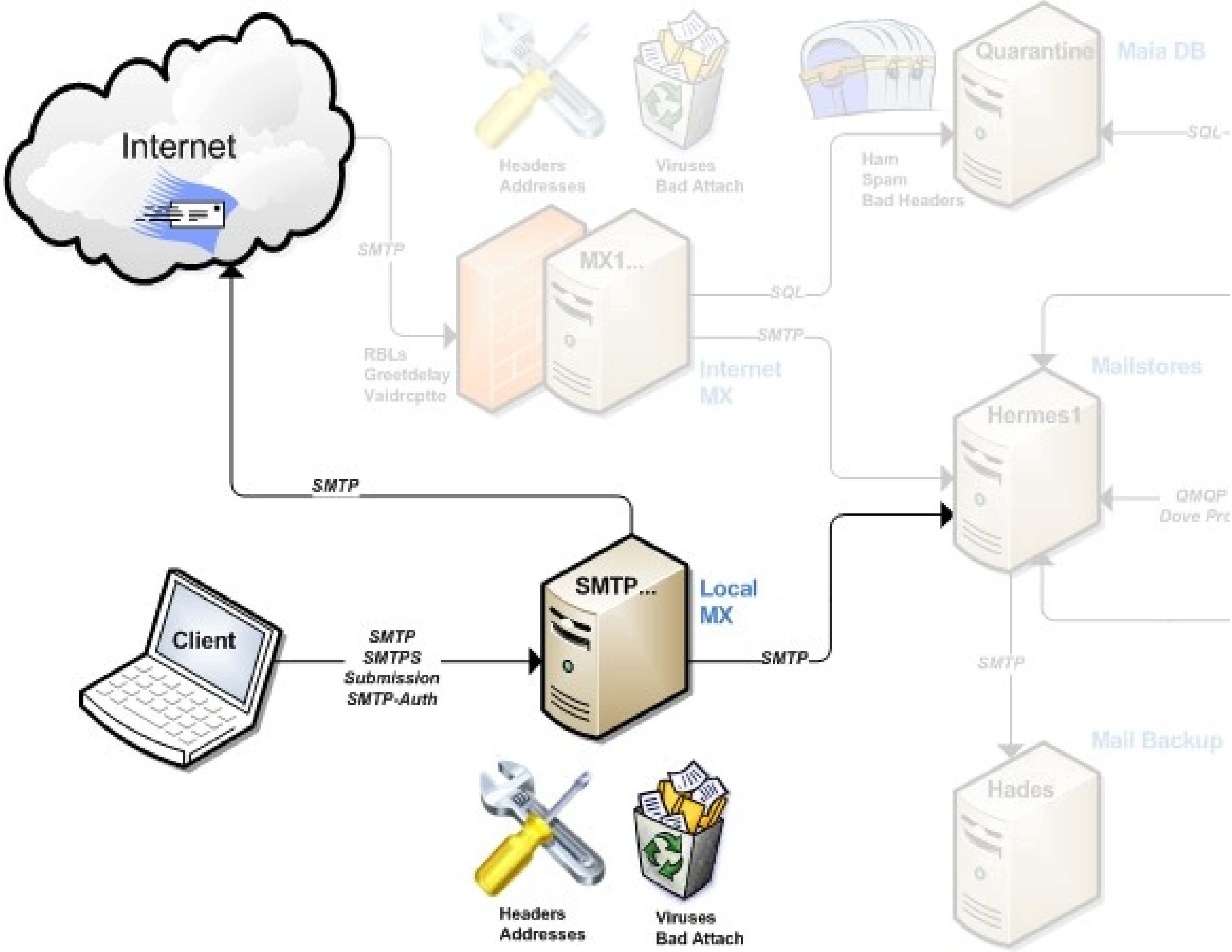
2012-11-13

Top 10 e-Mail Viruses in 317 Days: 357,600 Total



2012-11-13

Local SMTP / Mail Exchanger



Local SMTP / Mail Exchanger

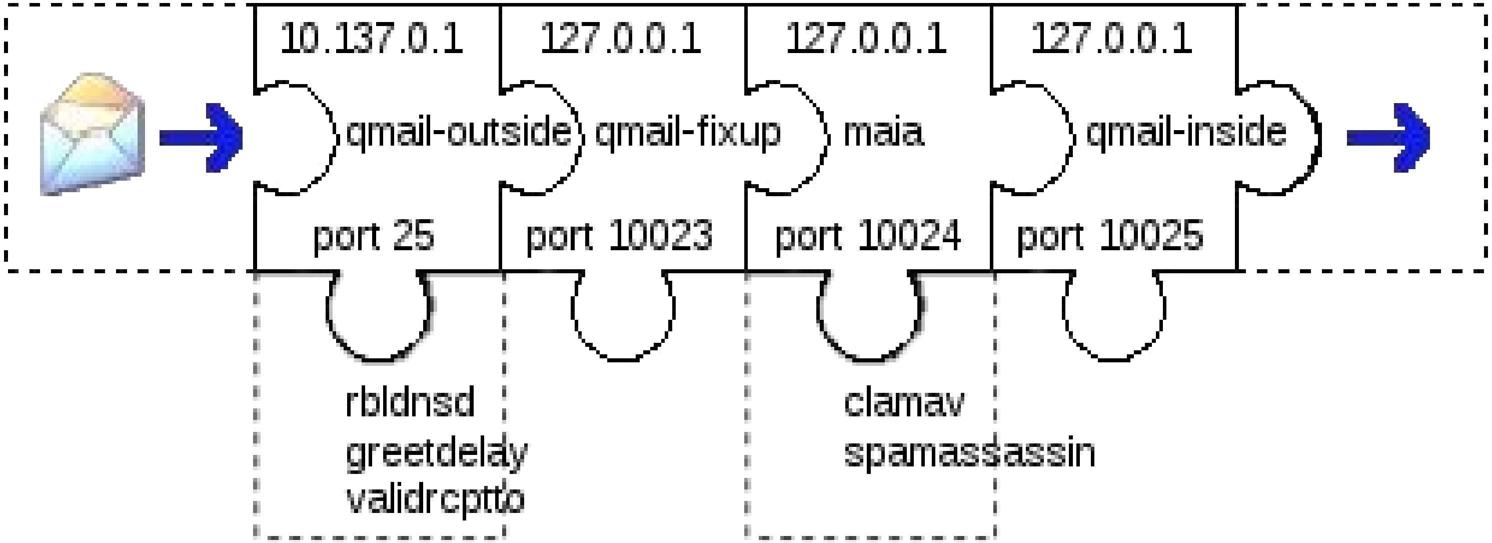
The local mail exchangers exist to concentrate SMTP user delivery services. Nearly identical to Internet mail exchangers, with some key differences:

- Standard SMTP on port 25, blocked from Internet
- SMTP-Auth via SSL on port 465
- SMTP-Auth via SSL on port 587 (STARTTLS would be better)
- Antivirus scanning only

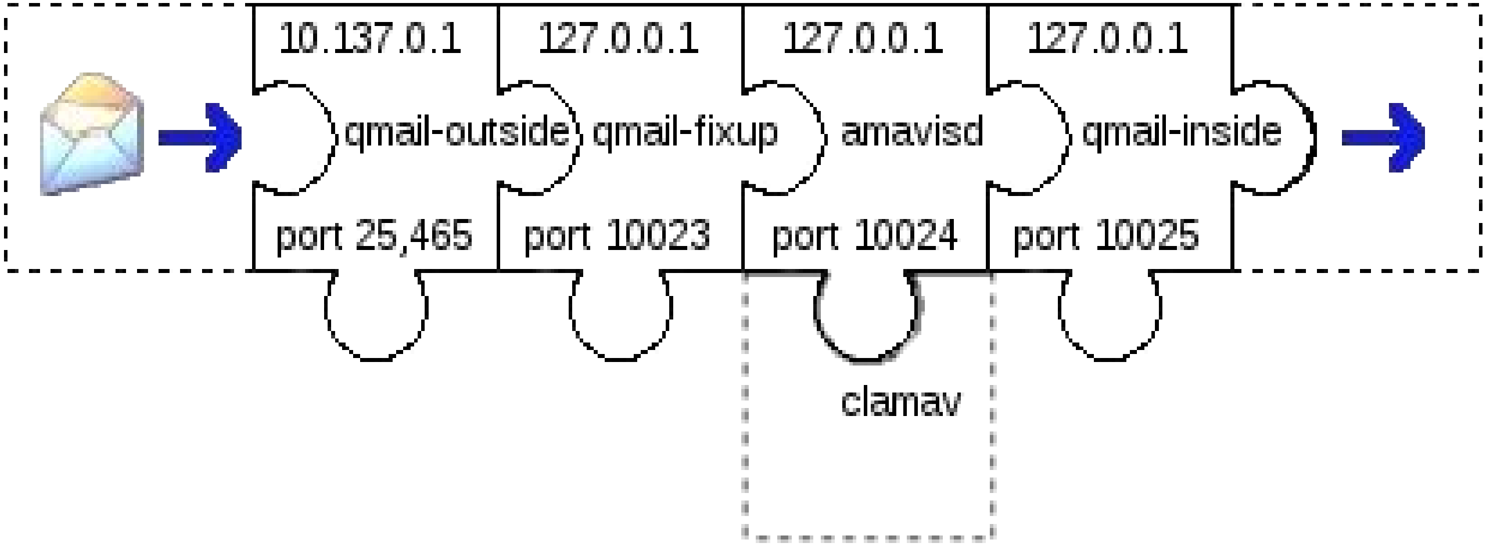
Users will use these machines for their outgoing SMTP server in their email clients.

With split-zone DNS, also advertise these as the mail exchangers for on-campus machines.

Internet MX / Local MX Comparison

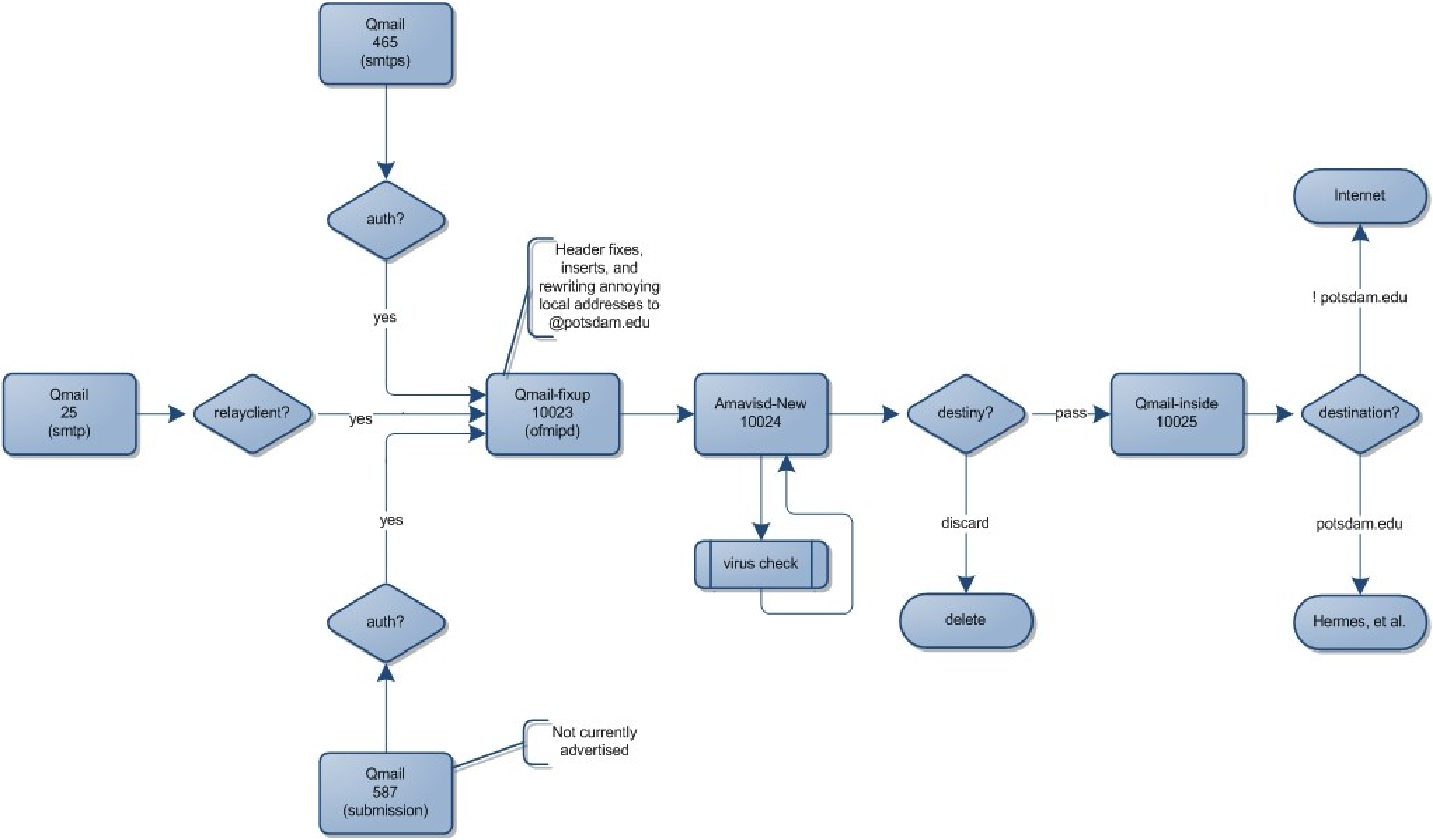


Internet MX

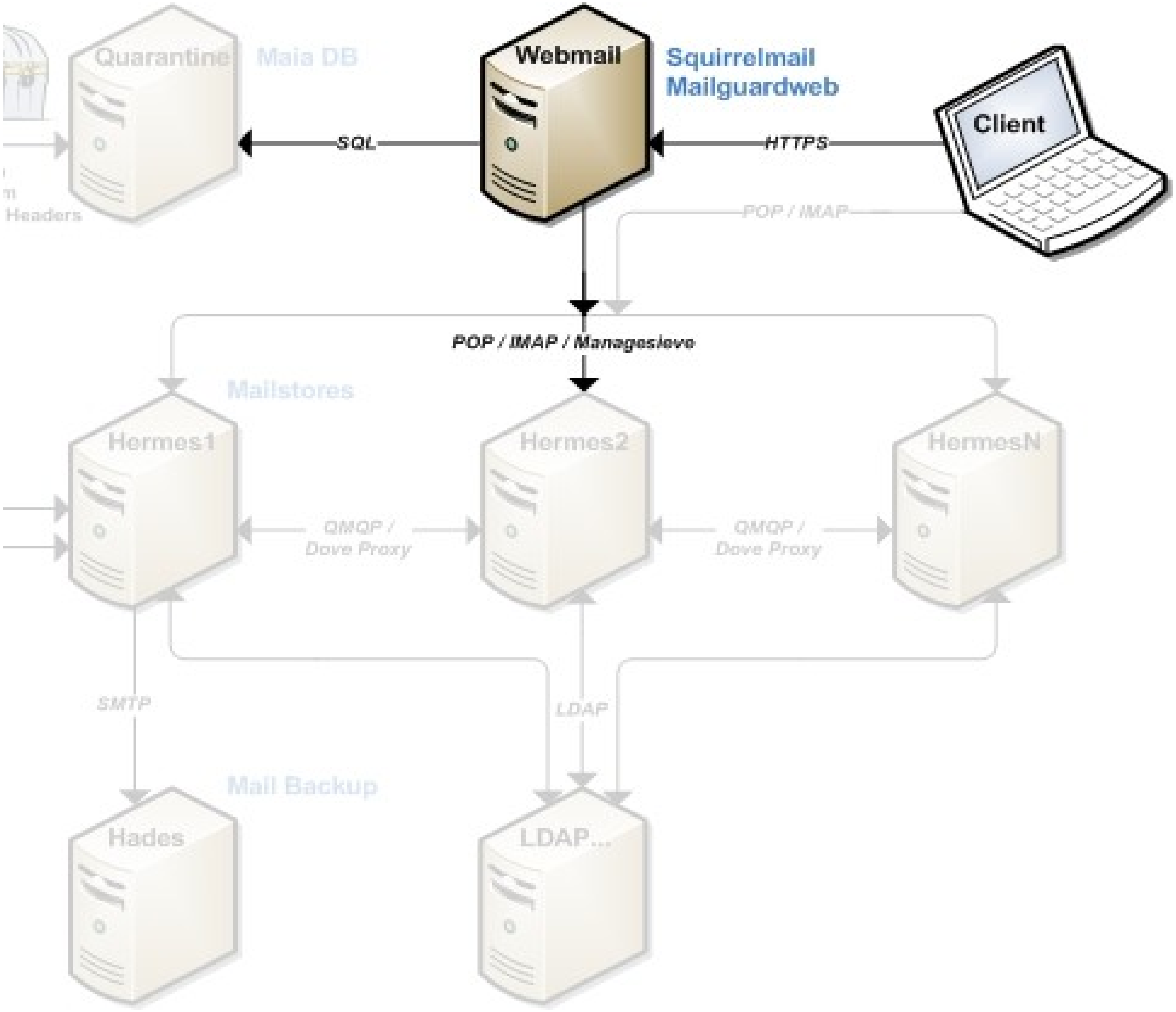


Local MX

Local SMTP / MX: Detailed Picture



Webmail


Quarantine
Maia DB
Headers
Webmail
Squirrelmail
Mailguardweb
SQL
HTTPS
Client
POP / IMAP
POP / IMAP / Managesieve
Mailstores
Hermes1
Hermes2
HermesN
QMQP /
Dove Proxy
QMQP /
Dove Proxy
SMTP
LDAP
Mail Backup
Hades
LDAP...

Webmail: Squirrelmail / Mailguard

Squirrelmail is an IMAP webmail client written in PHP. Pure HTML, no JavaScript required.

- No frills install with a selection of desired plugins for appearance enhancements, sysadmin relief, and logging visibility
- One key plugin: Avelsieve for server-side filtering via Managesieve protocol on mailstores
- Venerable, stable interface. Soon to be replaced by next-gen calendar web interface

Maia Mailguard has its own PHP frontend to enable user management of preferences and quarantine.

- Standard install
- Add local patch to share PHP session with Squirrelmail login: poor man's single-sign-on

Phish

Scenario: Account compromised

Behavior: Spam sent via webmailer or SMTP-Auth

Result: Reputation hit for domain

Some patterns have emerged with regard to the use of compromised accounts to send spam email:

- Account logins often originate from different countries in a relatively short amount of time
- Sending mail where envelope-sender does not match from header, and there is a large number of recipients

Phish: Phishhook

Phishhook SquirrelMail plugin

- Attached both to SquirrelMail login and to email send

On login:

- If this login outside North America
- If last login inside North America (parses log)
- If time difference between two logins < 8 hours
- SNAG!

On send:

- If envelope-sender != from header and > 100 recipients
- SNAG!

Phish: qmail-skim

Qmail-skim qmail queue replacement

- Attached to mail exchanger qmail-outside at queue time

Checks SMTP-Auth login:

- If this login outside North America
- If last login inside North America (parses log)
- If time difference between two logins < 8 hours
- SNAG!

Checks from and number of recipients:

- If envelope-sender != from header and > 100 recipients
- SNAG!

Phish Phood

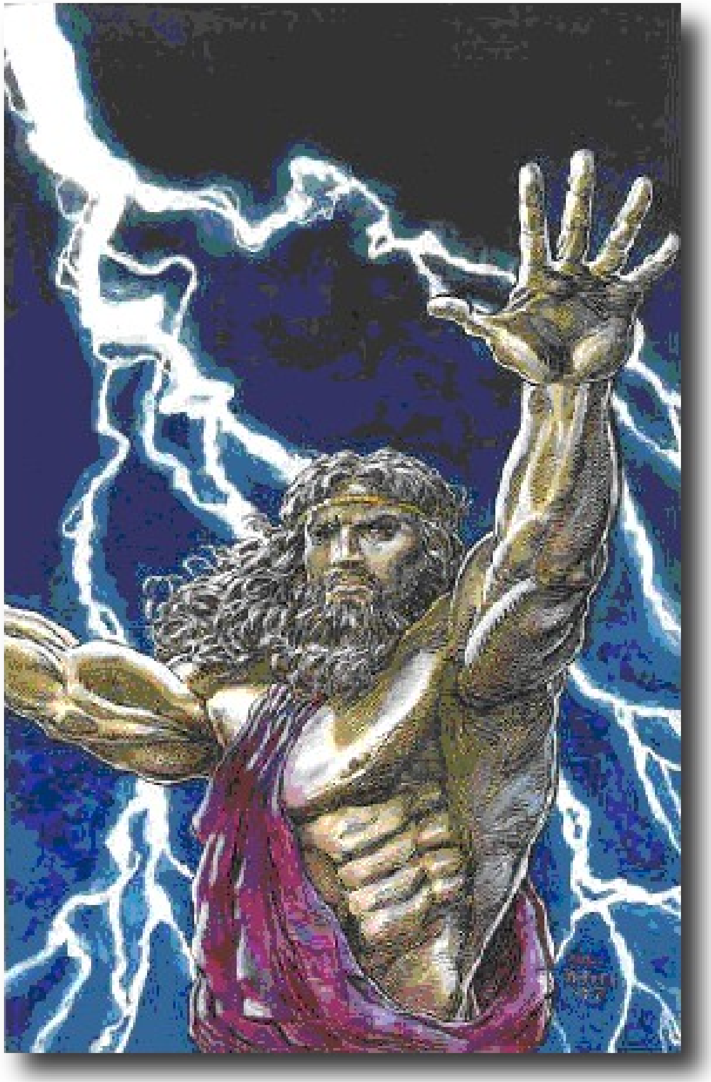
When a phished account is snagged due to one of the criteria:

- Account removed from all service groups
- Account password is scrambled
- Source IP address is blocked at border firewall (expires in one month)
- Ticket created in tracking
- Account added to phish group, flagged as a phish in account management interface so Helpdesk personnel know to counsel the affected user: “you gave your account to criminals”

Generally average a few a week, sometimes surges in dozens.

Not without issue: students/faculty traveling abroad have been snagged. Often this is due to an AUP violation, with friends/family using their account from home.

Federating Management



Postmaster

One staff carries part-time postmaster-ish duties:

- Monitoring mail queue issues
- List/alias administration
- Special requests for forwarding/aliasing
- Campus mass-mailings
- Access to host of command-line tools

Part of larger responsibilities for accounts in-general:

- Employee account management
- DMCA notice handling

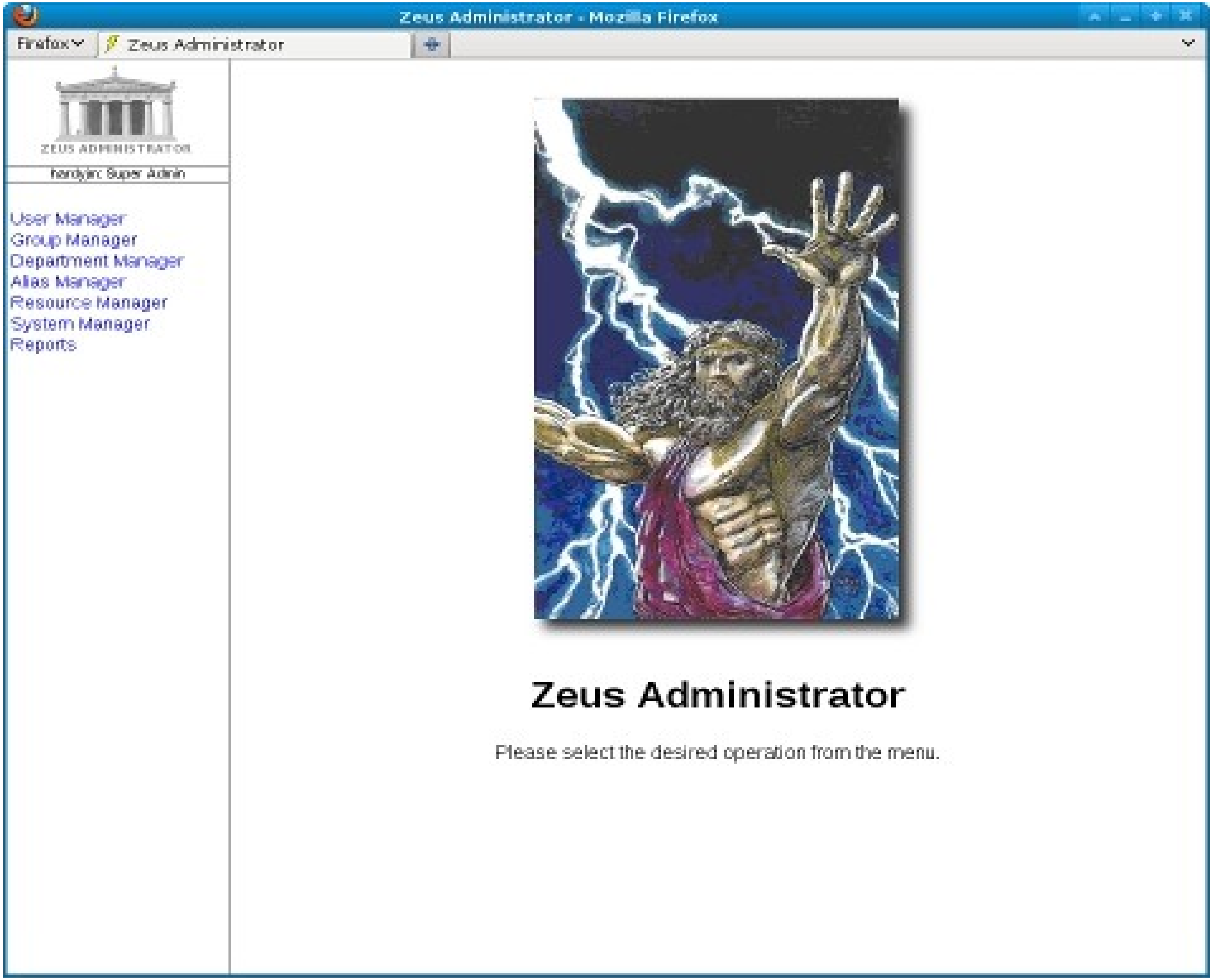
Zeus Administrator

The Zeus Administrator suite is a Perl frontend sandbox to the LDAP infrastructure.

- Modules for users, groups, departments, email aliases, calendar resources, systems, buildings, reports
- Role-based access control

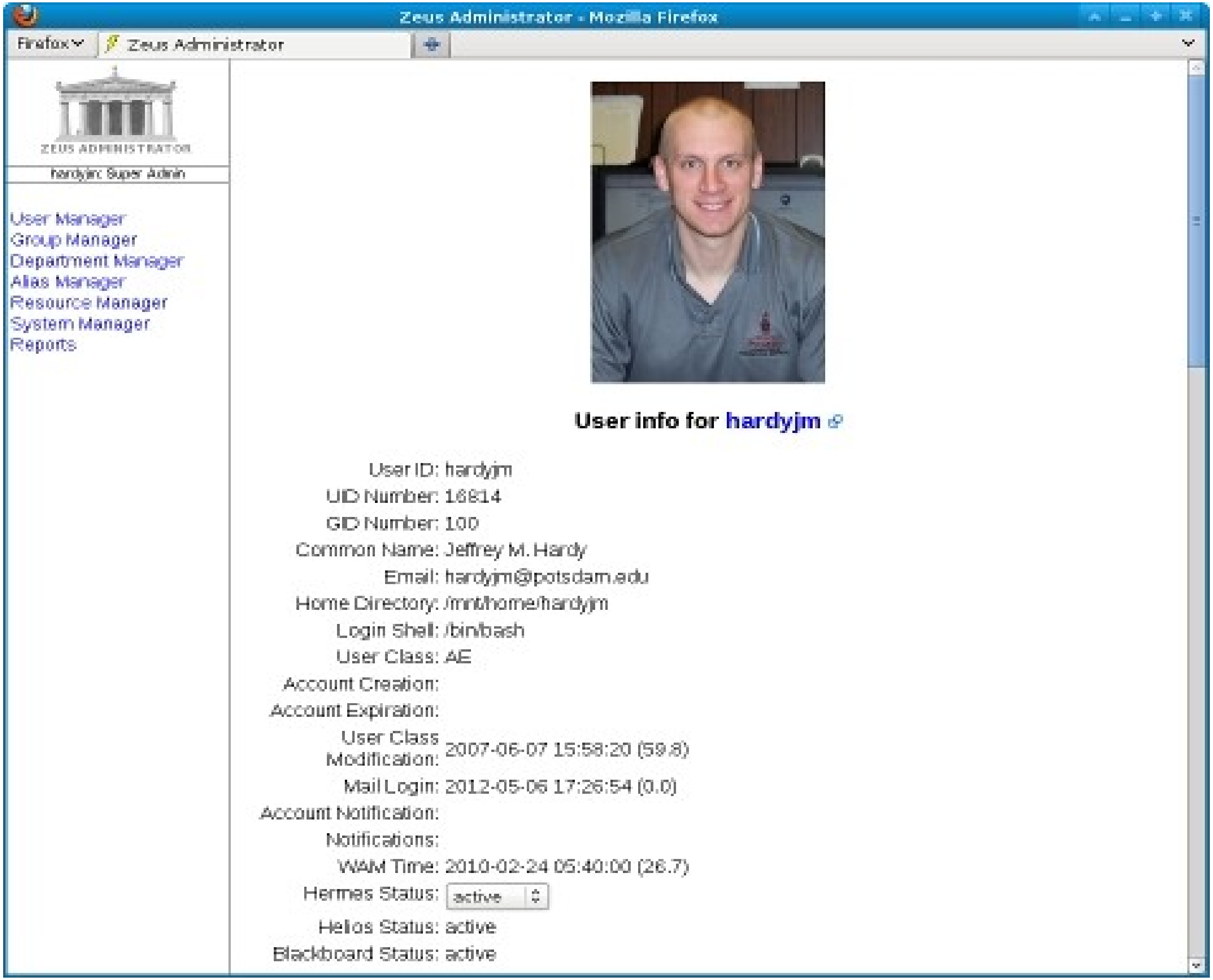
Roles for Helpdesk, student workers, web directory admins, lab managers, super admins: allow/deny access to entire modules and fine-grained control down to individual LDAP attributes and functions (ex: change password).

Zeus Administrator



Please select the desired operation from the menu.

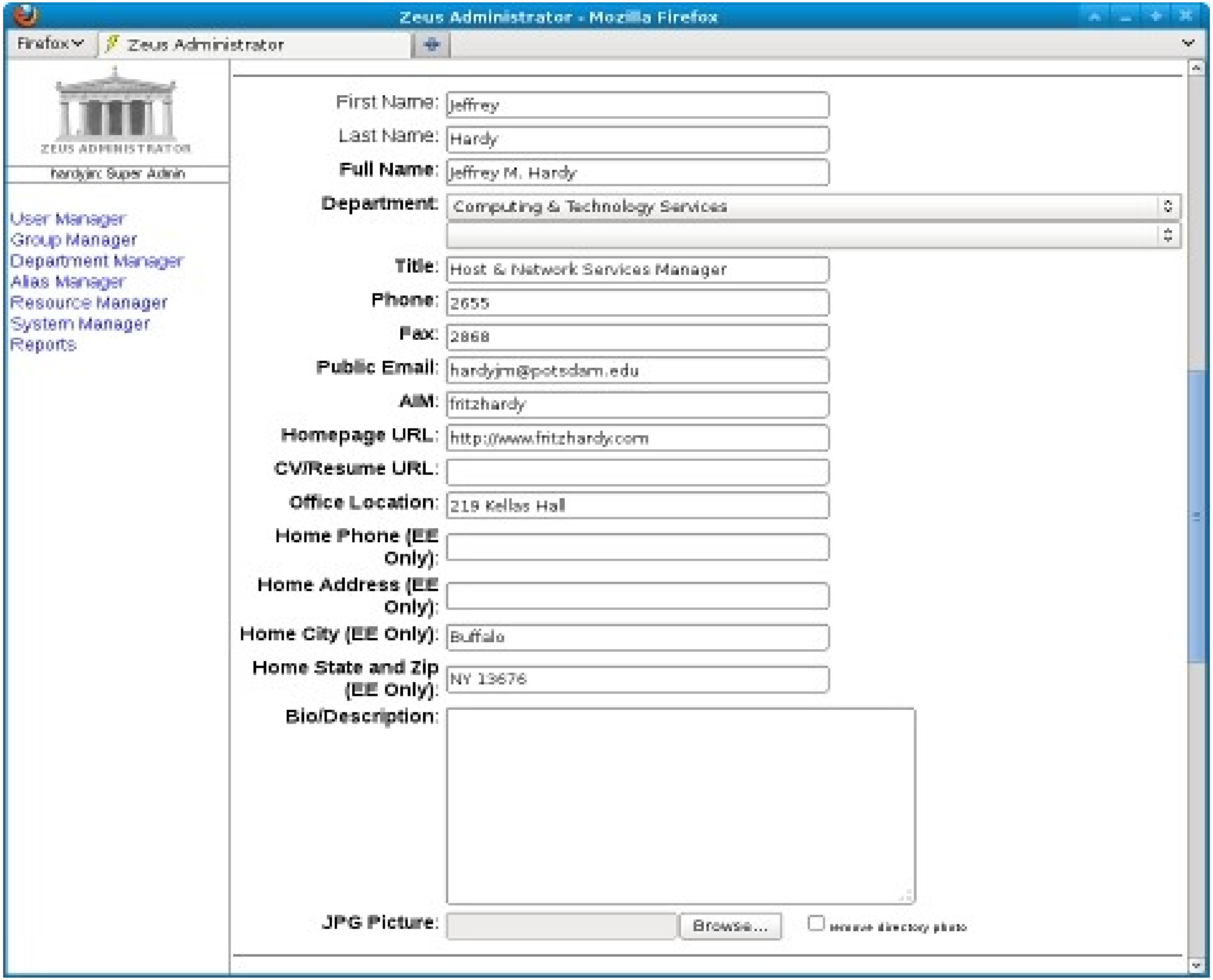
Zeus Administrator



User info for hardyjm

User ID: hardyjm
UID Number: 16814
GID Number: 100
Common Name: Jeffrey M. Hardy
Email: hardyjm@potsdam.edu
Home Directory: /mnt/home/hardyjm
Login Shell: /bin/bash
User Class: AE
Account Creation:
Account Expiration:
User Class Modification: 2007-06-07 15:58:20 (59.8)
Mail Login: 2012-05-06 17:26:54 (0.0)
Account Notification:
Notifications:
WAM Time: 2010-02-24 05:40:00 (26.7)
Hermes Status: active
Helios Status: active
Blackboard Status: active

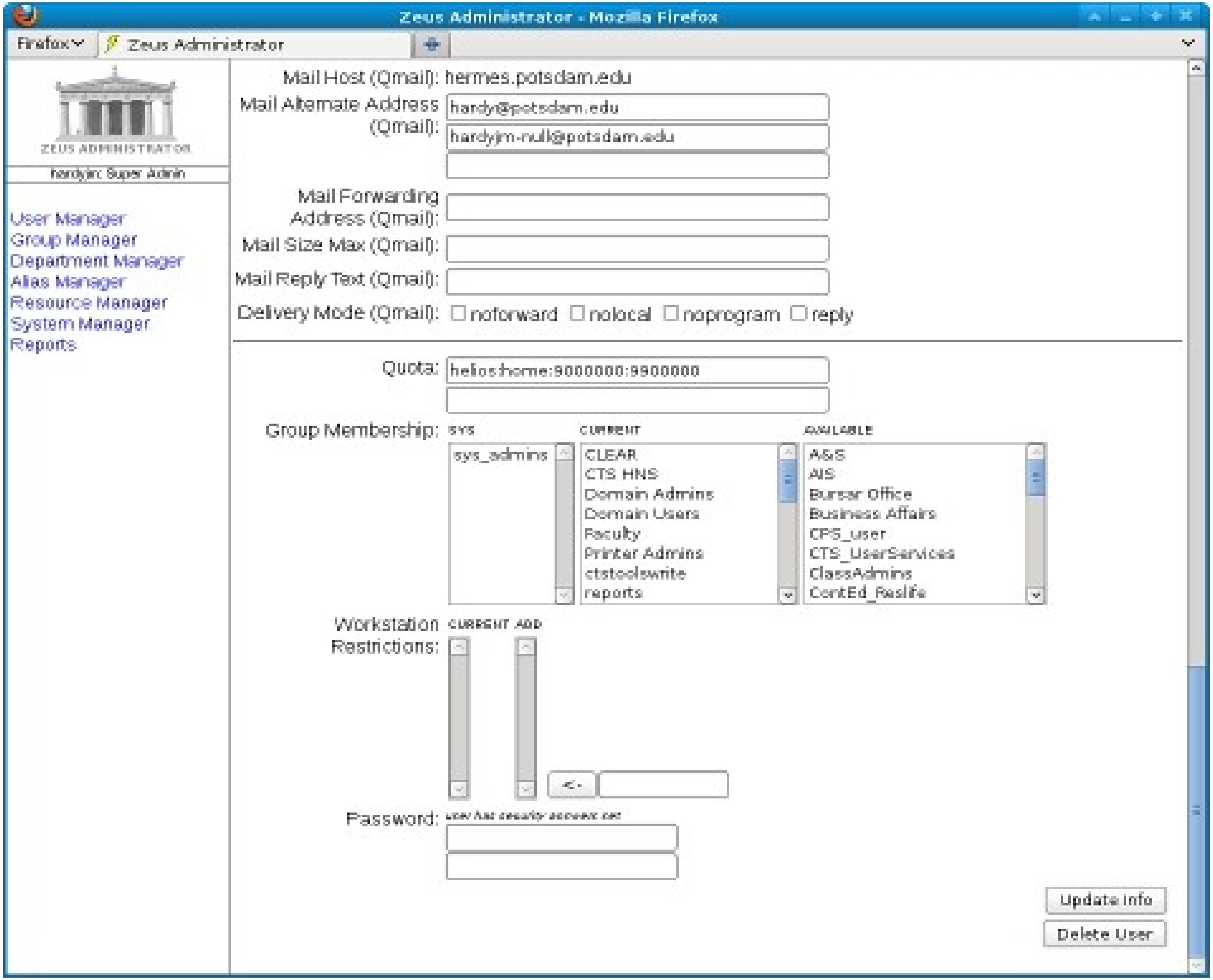
Zeus Administrator



First Name:	Jeffrey
Last Name:	Hardy
Full Name:	Jeffrey M. Hardy
Department:	Computing & Technology Services
Title:	Host & Network Services Manager
Phone:	2655
Fax:	2868
Public Email:	hardyjm@potsdam.edu
AIM:	fritzhardy
Homepage URL:	http://www.fritzhardy.com
CV/Resume URL:	
Office Location:	219 Kellas Hall
Home Phone (EE Only):	
Home Address (EE Only):	
Home City (EE Only):	Buffalo
Home State and Zip (EE Only):	NY 13676
Bio/Description:	
JPG Picture:	

□ remove directory photo

Zeus Administrator



hardyjm: Super Admin

Mail Host (Qmail): hermes.potsdam.edu

Mail Alternate Address (Qmail): hardy@potsdam.edu
hardyjm-null@potsdam.edu

Mail Forwarding Address (Qmail):

Mail Size Max (Qmail):

Mail Reply Text (Qmail):

Delivery Mode (Qmail): □ noforward □ nolocal □ noprogram □ reply

Quota: helios:home:9000000:9900000

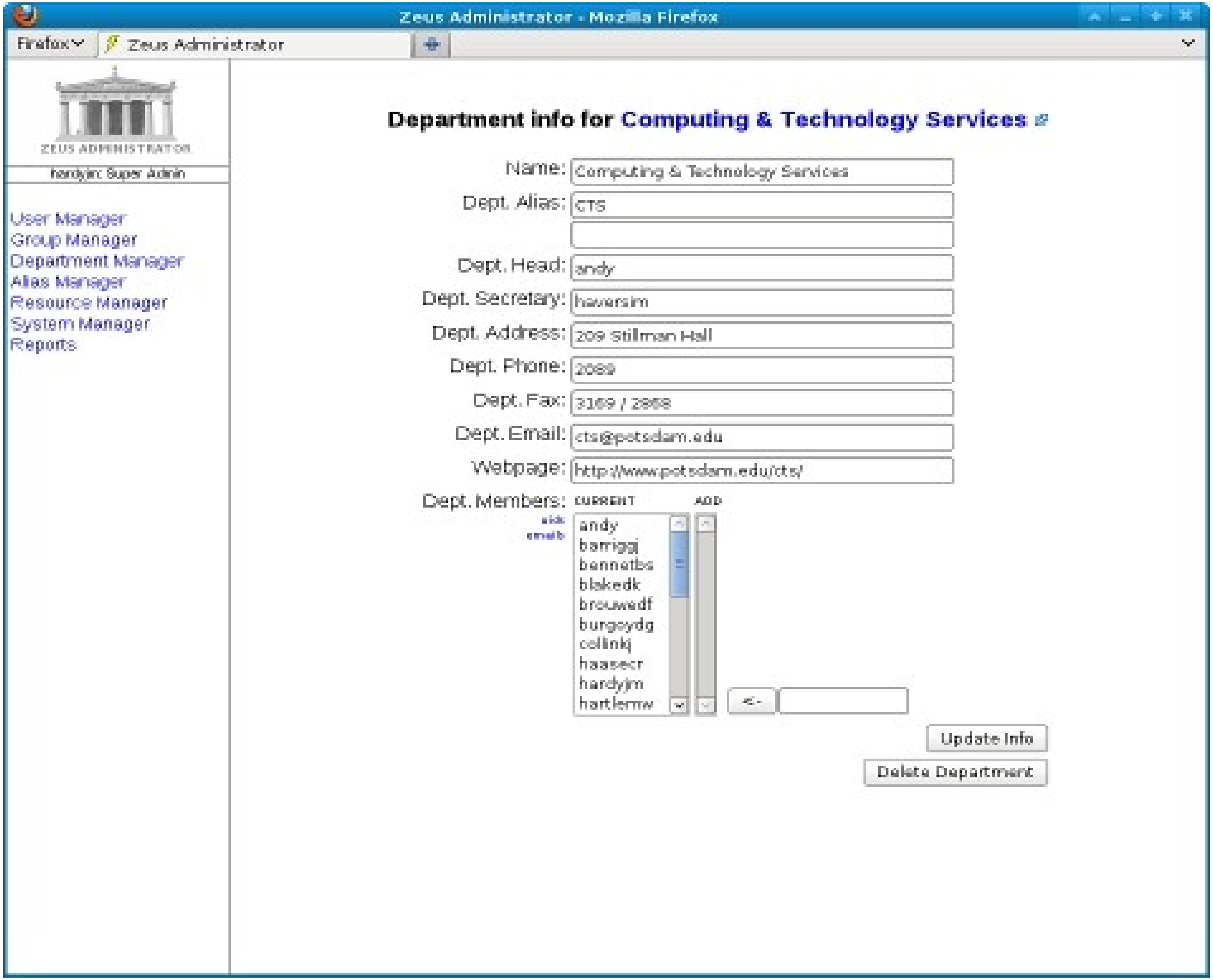
Group Membership:

SYS	CURRENT	AVAILABLE
sys_admins	CLEAR	A&S
	CTS HNS	AIS
	Domain Admins	Bursar Office
	Domain Users	Business Affairs
	Faculty	CPS_user
	Printer Admins	CTS_UserServices
	ctstoolswrite	ClassAdmins
	reports	ContEd_Reslife

Workstation Restrictions: CURRENT ADD

Password: user has security account set

Zeus Administrator

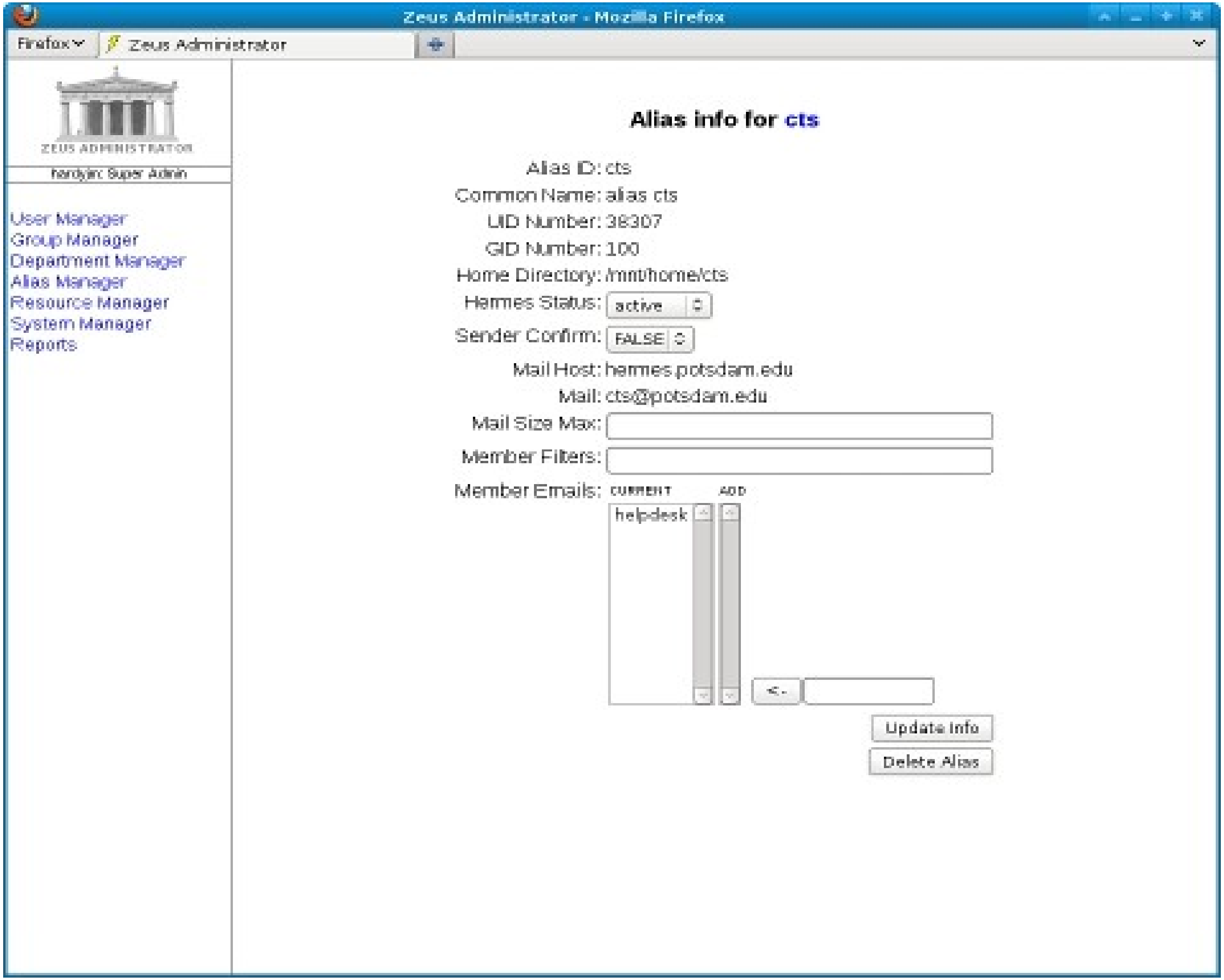


Department info for Computing & Technology Services

Name:	Computing & Technology Services
Dept. Alias:	CTS
Dept. Head:	andy
Dept. Secretary:	haversim
Dept. Address:	209 Stillman Hall
Dept. Phone:	2089
Dept. Fax:	3169 / 2868
Dept. Email:	cts@potsdam.edu
Webpage:	http://www.potsdam.edu/cts/

Dept. Members: CURRENT: andy, barrigqj, bennetbs, blakedk, brouwedf, burgoydg, collinkj, haasecr, hardyjm, hartlemw

Zeus Administrator



Alias info for cts

Alias ID: cts
Common Name: alias cts
UID Number: 38307
GID Number: 100
Home Directory: /mnt/home/cts
Hermes Status: active
Sender Confirm: FALSE
Mail Host: hermes.potsdam.edu
Mail: cts@potsdam.edu
Mail Size Max:
Member Filters:
Member Emails: helpdesk

Account Synchronization

Banner

LDAP

Account Sync: Creation/Modification

Account Request Form / Registrar Processes

- Web form for requests to HR for employee accounts in Banner; Admissions/Registrar processing creates student accounts in Banner. Jobs and table triggers kick off CASL processes

CASL: Centralized Authentication System for Linux

- Interprets codes in files FTP'ed from Banner systems to create/modify users in LDAP with given userClass (CASL was once responsible for much much more)

```
# cat 20121112-085737.CC2DC
+:smithzb196:d3xsqzhn:Smith:Zachary
E:johnsoae:gfz297yt5:7552:Johnson:Ann:E:P00311393
```

Account Sync: Creation/Modification

WAM: Whack-a-Mole Account Manager

- Software responsible for determining service access for a user based on userClass: the user lifecycle
- Changes users over time: user attributes, group and department memberships, notifications of impending service loss, userClass itself, deletions, etc.

```
AS=Active_Student
   -all services always
IS=Inactive_Student
   -notified at 5, service lost at 6, data deleted at 15
   -email deleted at 15 months inactivity
GS=Graduated_Student
   -email forever
   -notified at 5, services lost at 6 (except email), data deleted at 15
   -email deleted at 9 months of inactivity, access restored at login
```

Account Mapping

Banner	LDAP
GAOEMAL	UserClass
FACT	AE: Active Employee EE: Emeritus Employee LE: Legacy Employee XE: Cross-reg Employee IE: Inactive Employee DE: Deferred Employee
ON	AS: Active Student IS: Inactive Student GS: Graduated Student LS: Legacy Student
-----	TMP: Temporary Account WTF: System/Misc Accounts QFD: Queued for Deletion

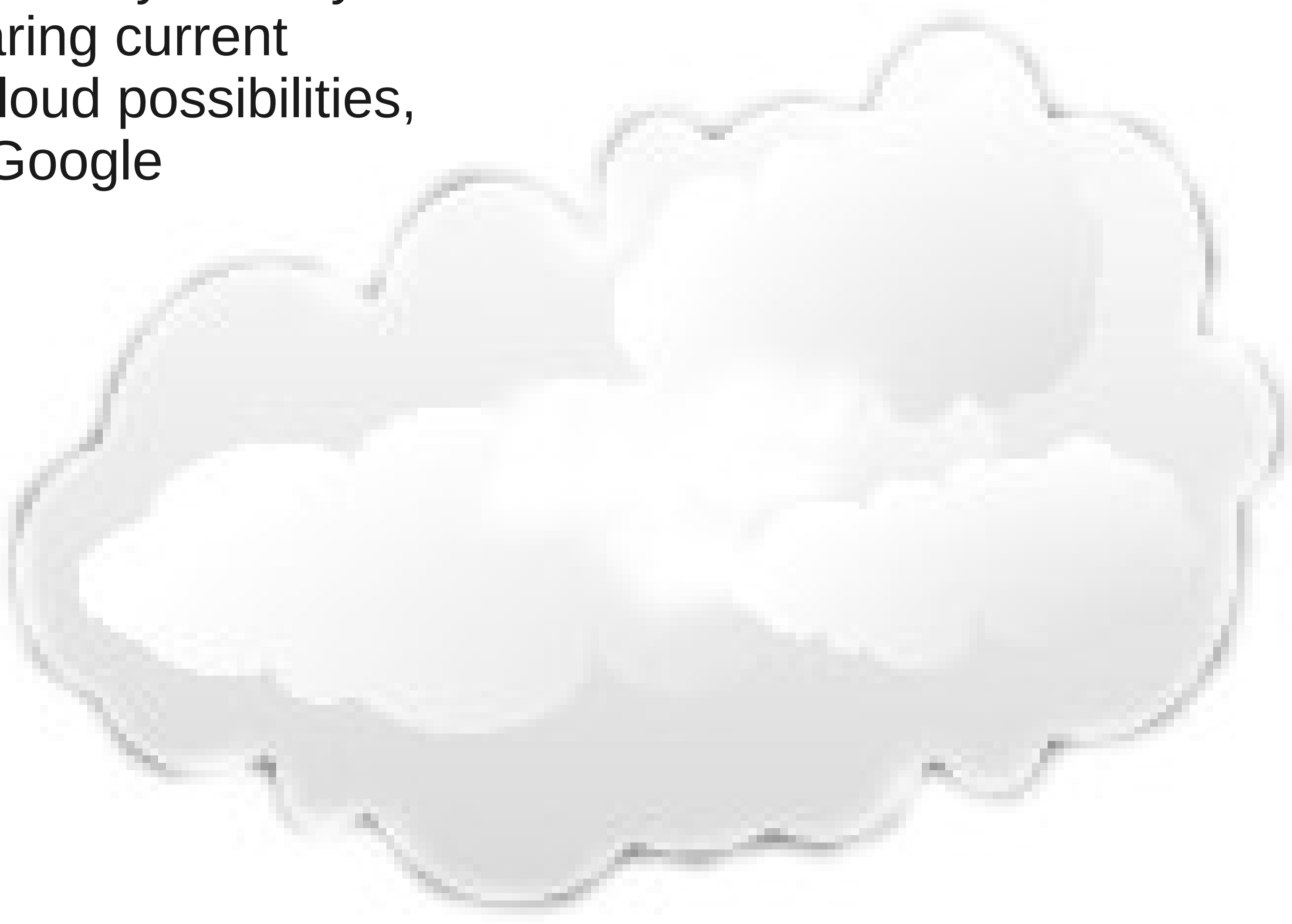
Directory Unification

“Goatpad” workgroup spent five years unifying various directory sources on campus, perfecting workflows, and changing business processes.

- Closed the account gap
  - All departing employees are deleted or granted emeritus
  - All departing students are deactivated or granted alumnus
- HR is the gatekeeper for employee accounts
  - No services granted until account request processed
- Registrar is the gatekeeper for student accounts
  - Any questions about standing: “You must speak to the Registrar”
- Unified the directory beneath desire for online accuracy
  - Employees must be in a department, all departments displayed in online directory. Departments have impetus for this information to be accurate
  - Students can opt-out of directory via Banner

The Cloud

Conducted a study in early 2012 comparing current solution to cloud possibilities, specifically Google



Cloud Comparison

Pros:

- Cost savings – Approximately $5000 per year in hardware costs and approximately 1 person-week per year of system administrator time
- Phish cleanup – Burden of monitoring, cleanup, and reputation restoration on Google rather than us
- Fewer restrictions on message size and volume during peak business hours
- Possibility for future cost savings on calendar software with bundled apps
- More hardware redundancy on critical systems
- From a staff succession planning standpoint: Less reliance on local staff expertise for some critical systems (however, trending towards a reduction in technical demands may make positions less attractive to qualified applicants.)

Cloud Comparison

Cons:

- Phish damage – Compromised accounts may not be disabled in a timely manner allowing criminal access to confidential information.
- Diminished ability to monitor mail queues to identify blocks or problems with incoming or outgoing mail
- Diminished ability to search logs to determine if messages were sent or received
- Diminished flexibility to manage email accounts with aliases, lists, etc.
- Potential issues with automated processes for account creation and deletion
- Privacy issues: HIPAA, etc.
- Records retention and discovery: DMCA, FOIL, FOIA, etc. subject to Google
- Bandwidth and WAN issues: Email traffic would have to travel over WAN connection subject to WAN outages or bandwidth constrictions. Impact on campus bandwith is uncertain, as we will see a dropoff in delivery (SMTP) traffic, but a likely increase in reception (IMAP) traffic.
- Any system administrator time savings would be countered by additional time necessary to adapt current systems to new paradigm
- Transition to new systems would require significant staff time, user training and possible disruptions
- No technical support available from Google other than on-line docs

Email Timeline

Email was a struggle for years.

- Storage always the biggest issue. Initial introduction of SAN storage was a balancing act. Things generally ok until each year's new batch of Fall users led to inevitable backlogs.

2007-2008 a particularly bad year. If cloud offerings had been more mature and well-accepted, migration would have been unavoidable.

- Constant load-induced problems on the mailstores led to backlogs
- Introducing spam database quarantine led to delivery delays, tuning, re-adjustment, split-zone DNS, separate exchangers, all in a short time in a cascading difficult transition
- Mailstore instability led to filesystem crashes, re-introduction of direct-attached storage (DAS)

Ultimately, 2008 was a turning point for the better. Living off of interest.

Future Work on Hold

Phish countermeasures and further work on qmail-skim

Outgoing spam filtering

Next generation calendar introduces a new webmail client and doubtless new challenges

Mail storage is resilient, needs work to be redundant:

- HA SAN storage
- Redundant qmail forwarding/Dovecot proxying machines
- Re-visit backup scheme. Lower tier storage means a full restore would take some time.

The Cloud?

Early discussions with ITEC about their email offerings

Transition to anything not driven by mail, but associated services such as calendar

In a position to let the dust settle...