ABSTRACT
The University of Pittsburgh began the Internet Message Access Protocol (IMAP) Project in the spring of 1997 as an evaluation project investigating the replacement options for the legacy e-mail systems and a POP3 service. The project was initially divided into two phases---Phase 1 to deploy an IMAP server for campus-wide use and Phase 2 to identify and provide a reliable, high quality, enterprise-wide IMAP client. A sub-group of the IMAP project team was formed to identify requirements and evaluate clients. Cyrusoft International's Mulberry was found to meet the ever changing requirements of the campus computing labs and have sufficient features and functionality that users would be compelled to switch from their legacy clients to the new environment.

A critical third phase was added to the IMAP project which required a phase-out of the legacy e-mail systems by April 1, 2000 and the provision of a standard graphical client-server e-mail system for both the Macintosh and Windows platforms to all students, faculty and staff.

The presentation will describe the third and final phase of the project in detail, discuss the issues surrounding how legacy e-mail users were kept informed, trained and migrated to new IMAP client. The presenters will identify the obstacles as we approached the deadline for full conversion to the IMAP protocol and the phase-out of all other e-mail systems on the University of Pittsburgh campus. Extensive use of user logs, forwarding data and distribution was critical to the process. The final phase involved the migration of 25,000 users from VMS Mail, Unix Pine and POP mail to the new environment by April 1, 2000.

Keywords
IMAP, e-mail, POP, legacy, client-server

1. INTRODUCTION
Electronic mail has become a primary tool used by many large organizations to enhance daily communication. E-mail between managers, workers, customers, students, teachers or parents often serves as a more efficient, cost effective and convenient form of interaction. On the University of Pittsburgh campuses, electronic mail is used in many different ways by students, faculty and staff, and is by far one of the most highly utilized electronically distributed service provided by Computing Services and Systems Development (web browsing is the most frequently launched application on our campus). Many faculty require students to submit reports and assignments attached to e-mail messages rather than submitting the materials in the more convention fashion---printed on paper. An increasing number of courses require students to participate in on-line discussions and chat sessions using their e-mail accounts. Problem-based and learner-centered curriculums are placing more emphasis on collaboration and student teams (some virtual), all of which require extensive use of electronic communication. Students use e-mail to stay in touch with each other over the term breaks rather than writing letters and placing long-distance phone calls. Faculty collaborate with colleagues around the globe, using e-mail as a means to transfer images, jointly author documents and articles, compare data and even review video segments. E-mail has become the most ubiquitous form of place and time independent communication ever available to our students, faculty and staff.
During the next five years electronic mail service at the University of Pittsburgh will be enhanced by standardizing on the IMAP protocol. This process will involve consolidating and the elimination any of our legacy mail delivery systems, primarily VMS, UNIX/Pine and POP. The effort involved in this process is enormous and the issues are challenging. The University of Pittsburgh IMAP project proposes to build an enterprise-wide electronic mail system that is centered on high reliability, extensive availability, and large scalability, using both existing and emerging Internet standards.

Computing Services and Systems Development in cooperation with Network Services assembled a IMAP project team to explore the migration issues, set project goals, identify a timetable and plan the implementation. Team members were selected from portions of both organizations representing systems, network, account management, support services, Help Desk and training staff. Emphasis was placed on standards compliance, overcoming technical barriers, training for the end-user community and meeting the implementation deadline.

The technologies initially recommended by the IMAP project team are Internet Message Access Protocol Version 4, Simple Mail Transport Protocol, RFC 822, Kerberos, Cyrus IMAP server from Carnegie Mellon University, and Multipurpose Internet Mail Extensions. The University of Pittsburgh is currently incorporating a Centralized Directory Service based on the Lightweight Directory Access Protocol, as well as using both Digital Certificates and Pretty Good Privacy for privacy enhanced messaging into its overall electronic messaging strategy.

The IMAP project team is carefully tracking the IMAP standards. The team will adjust its planning to implement some of the emerging Internet standards as they become available and/or mature. Those standards include, but are not limited to, the Internet Calendaring standard and other extensions to the IMAP protocol such as voice and the sieve filtering and workflow standard.

The system will be centrally managed and will scale from student, faculty and staff end-users to wide-scale departmental use. Migration paths and tools will be provided for conversion from the legacy mail stores to the new IMAP client environment. University departments that currently operate decentralized mail servers will be able to inter-operate between the centralized IMAP server(s) and their preexisting IMAP compliant mail systems and clients. Extensive documentation will be provided on-line as well as instructor-led training on the configuration and use of the new client in the IMAP environment. This training will initially focus on student users.

2. Project Goal

The principal goal of the IMAP project is to provide a broadly available, robust, scalable, enterprise-wide electronic mail service to the University community. The service must be easy to use and have very low administrative cost. A second goal is to provide inter-operability with a wide variety of IMAP clients in order that users can communicate with anyone, anywhere, using multimedia enabled electronic mail. Supported clients include Pine, Mulberry, Outlook/Express, Netscape Messenger, and Eudora. All of these clients are provided without cost to users on the University of Pittsburgh campus with the exception of Eudora Pro v4.x.

3. Project Requirements

The IMAP project has an ever expanding list of requirements as new Internet Standards are adopted and additional functionality is built into the supported IMAP clients. An early version of this list was the initial set of requirements provided by the IMAP project team in 1995. First, the IMAP service must adhere to all current or de facto standards. This includes Network protocols such as TCP/IP and other Open Internet Messaging protocols such as SMTP and ESMTP for mail transport and Message header Format (RFC822). Second, the service had to be based on all current or de facto standards. Fifth, the service must employ and adhere to the current Network Authorization Account model and also support the future Single Sign-on account model. Currently, this support is provided by Kerberos v4 which also handles authentication above and beyond plain-text authentication. Sixth, the introduction of this service must not give users yet another mailbox without their knowledge. One of the goals of the IMAP project is to reduce and simplify the University of Pittsburgh's electronic mail environment by eliminating redundant electronic mail services. Currently, three existing central mail services (Unix, VMS, and POP) are built automatically when a user's mailbox is created into the supported IMAP clients. An early version of this list was the initial set of requirements provided by the IMAP project team in 1995.
intellectual collaboration between students and faculty. The mail delivery agent must support and enforce the quota in the expected fashion and possibly alert the user that he/she is approaching his/her quota. End-users must have the ability to perform quota checking. Quota checking must be easy and provided internally by the clients. Additionally, users must be able to share and access mailboxes without the need to know other users’ passwords. Central mailboxes will also be provided, eliminating the need for users to individually subscribe to many of the popular mailing lists. Lastly, the service must support the three message access paradigms, namely, online mode, offline mode, and disconnected mode. Support from the server side meets the required message access paradigms, while the majority of our IMAP clients currently support two of the three criteria.

4. The Migration Process

The process of migrating users of three legacy systems (VMS, UNIX and POP) to the new IMAP service began in late 1999 and continued into the spring of 2000. Tools were developed to assist in automating this process. For example, the VMS2IMAP utility was developed to allow users of the VMS Mail system to migrate their existing mail to the IMAP server retaining any folder hierarchy that existed on the VMS mail service. Documentation and training began in April of 1999. A large scale student focused training effort took place during the Fall 1999 term. Targeted notices were sent to the user community prior to the migration warning them of the various mail service phase-out schedules and directing them to our 24-hour Help Desk and 24-hour Campus Computing Labs for assistance converting to the new service. A number of faculty and staff have developed custom applications that rely on and integrate legacy mail services to their research projects. We provided consulting assistance to help them migrate and rewrite those applications to conform to the new IMAP service. As the April 1, 2000 final migration deadline approached, we were faced with moving nearly 25,000 users from old mail systems to the IMAP environment.

5. Lessons Learned So Far...

- People will not migrate from a degrading service automatically no matter how bad it degrades
- IMAP is a hard sell to POP users without the disconnected and offline modes
- VMS Mail users will migrate to Pine instead of a GUI client
- Quota policy and quota tools for help desk staff should be one of the first things established
- Most incoming students will use a GUI or web-based client
- The perfect e-mail client does not exist
- IMAP Clients are still maturing
- You can never have too much publicity for a new service
- There is never enough training for a new service
- Communication is critical and can make or break an enterprise implementation effort

6. Final Stage of the Project - Migrating 25,000 Users to IMAP

The presentation will briefly outline the planning process used by the IMAP project team and the early and middle stages of the implementation of the IMAP solution on the University of Pittsburgh campuses. The focus of the presentation will detail the final phase of the project from late 1999 through September 2000. Particular attention will be given to the effort to migrate the remaining 25,000 VMS Mail, Unix Pine and POP mail users into the IMAP environment. The project will also be dissected on the basis of its ability to meet the success criteria outlined below:

1) To what extent were end-users involved in the IMAP project?
2. Were small project landmarks established?
3. Did the IMAP project team have ownership of the project?
4. How was the IMAP project planned?
5. Was the IMAP team a diligent, focused group?
6. Did senior management support the IMAP project?
7. Was there a clear vision for the project and were clear project objectives set?
8. Did the IMAP project team have a clear statement of requirements?
9. Were the IMAP project staff capable and competent?
10. Did the IMAP project have a realistic set of expectations?

7. Hardware Configuration

7.1 Current Server Configuration

- Sun Enterprise 450
- 4 UltraSPARC-II 400Mhz processors
- 3.5GB physical memory
- Multiple UltraSCSI adapter cards to Sun A7000 Storage array -6 SCSI buses
- Sun A7000 LUNs for IMAP configured as 4-member RAID sets
- 350GB currently mapped on A7000. Expect to eventually go to 800GB drives.

Internal disks are used for system disk, mqueue disk and a separate internal disk for /var/imap partition. Note that the A7000
LUNs are structured as 8GB partitions. This was done rather than have a few large partitions to ease recoverability in the event of an analyst's error, OS problem or other catastrophic event wiped out a partition.

7.2 Future Server Configuration

- Sun machine with expandability past 4 processors - 3500, 4500 class machine just for example, although this is an I/O bound application, so it may not require processor expansion.
- An electronic disk for /var/imap. This is a very hot partition as it contains the 'mailboxes' file and the quota files for all users.
- Fibrechannel disk arrays (100 MB/sec. transfer rate)
- Redundancy that includes multiple IMAP servers.
- The IMAP server is backed up using IBM's ADSM backup software. Backup is done to AIT (Advanced Intelligent Tape) media served by a Qualstar Robotic Tape Library System.

8. Sample Statistics

- There are currently 46,725 top level user mailboxes on the IMAP server.
- There are a total of 144,378 total user folders including inboxes. All accounts we created since Apr 1, 1999 got an IMAP mailbox. It is estimated that 50% of the mailboxes are used. The remainder are not used because users have their mail forwarded to another service (third party) or no longer have an affiliation with the University.
- At the end of the Spring 2000 term it was not uncommon to see 2000-3500 imapd processes on the IMAP server during the work day.

9. Barriers to Success

- An enterprise migration of this magnitude must have a well-developed project scope and project plan in advance of any modification(s) that might impact the user community. The scope document should include:
  1) Pre-assessment or readiness study
  2) Project background information
     a) History
     b) Motivating factors and drivers
     c) Justification and consequences
     d) Connect to other institutional priorities or mission(s)
  3) Project statement or goal
     a) Short-range strategy
     b) Medium-range strategy
     c) Long-range strategy
     d) Stakeholders or constituents
  4) Key deliverables and/or features
     a) Evaluation or comparison of competing solutions
        i) IMAP
        ii) Others
  5) Phasing or staging
  6) Boundaries and constraints
  7) Role of external specialists or consultants
  8) Key issues and risk assessment
  9) Contingency plan and mitigation measures
10) Resources
    a) Human
    b) Capital
    c) Space
11) Primary contact person or liaison
12) Project champion or sponsor (typically CIO, Provost, Vice-President)
13) Communication Plan

Optional Items:
1) Customer support requirements
2) Team members
3) Critical support individual and/or teams

- A comprehensive communication plan is an absolute requirement. All stakeholder groups must be accounted for and detailed methods for all forms of interaction with those groups must be documented.
- It is absolutely imperative that quota tools & troubleshooting tools for the Help Desk analysts are developed, tested and deployed for the first day of service.
- Sufficient time must be allotted in the project plan for the development of training materials and training sessions.
- Sufficient time must be allotted in the project plan for all required documentation, on-line information, FAQs and entries to a knowledgebase.