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X.400(1988) for the Academic and Research Community in Europe

A report by the RARE Task Force on X.400(1988)
of the RARE Working Group on Mail & Messaging

Status of this Memo

This memo provides information for the Internet community. This memo does not specify an Internet standard of any kind. Distribution of this memo is unlimited.

1. Abstract

The European research and development community, as represented by the member research networks of RARE, has lead the deployment within the global R&D community of X.400 electronic messaging services, as specified in the international recommendations CCITT X.400(1984), for more than five years. As a result of providing such services to the European R&D users it has become clear that there is an existing and ever increasing demand from these users for new and enhanced electronic messaging services and product to be used to communicate within the R&D community but within commercial service providers and organisations as well.

It is also clear that new services, such as Multimedia messaging and Secure messaging, and the resulting products promise dramatic benefits and opportunities, for not only the R&D community but also for the wider commercial, industrial and public communities, in terms of facilitating innovative ways of working and living which can only enhance the missions and goals of the respective communities. Not least the establishment of globally pervasive messaging services between all users, R&D and commercial, is facilitated by the early adoption of such advanced new services. An indication of the importance of such a messaging service can be appreciated if one considers that in many organizations (especially commercially based) messaging may be the only method to communicate between independent organizations due to security considerations and lower layer network differences.

The Commission of European Communities (CEC) VALUE subprogram II has been established to support initiatives relating to the development and adaptation of R&D networks in member states. Amongst other

initiatives the VALUE program supports X.400 initiatives in certain countries. VALUE support has so far been limited to X.400(1984) initiatives, as X.400(1984) has up until now been the dominating OSI services. However as X.400(1988) implementations have started to appear a VALUE funded study of the X.400(1988) aspects of messaging and their impact on the R&D community was felt necessary. This report is one of the results of that study.

The report documents the results of a task force on X.400(1988) deployment of the RARE Mails and Messaging Work Group during the period from November 1992 until October 1993. Open reviews of the report have occurred in the RARE Mail and Messaging Work Group and within the IETF X.400ops Working Group.

The scope of the report is limited to deployment of X.400(1988) services, and as such the report does not contain any recommendations on development and deployment of Internet RFC 822 / MIME / PEM related (pilot) services. However, since the report shows that both X.400(1988) and RFC 822 / MIME / PEM will be developed and used within the European R&D community, such a pilot should also be considered. Note: RFC 822 is also known as Internet STD 11.

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Table of Contents

1. Abstract	1
2. Management Summary	3
3. Framework for the report	6
4. Present situation of European Messaging	7
4.1. Messaging services	7
4.2. Requirements for messaging	8
4.2.1. User Oriented	9
4.2.2. Service provider viewpoint	10
4.3. Messaging capabilities	11
5. Possible solutions for providing globally pervasive messaging	12
5.1. PC LAN E-mail systems	13
5.2. RFC 822, MIME and PEM services	15
5.3. X.400 - 1984 and 1988	19
6. Migration to X.400(1988)	23
6.1. PC LAN E-mail systems	25
6.2. RFC 822, MIME and PEM services	25
6.3. X.400(1984) services	27
6.4. Mail-11 services	28
7. Benefits of migrating to X.400(1988) and the involved costs	28
8. Main Recommendations	33
9. Security Considerations	34
10. Reading List and Bibliography	35
11. Terminology	37
Appendix A - Elaboration on the main recommendations	38
Appendix B - A number of detailed guidelines.	40
Authors' Addresses	44

2. Management Summary

This document reports the results of study of the X.400(1988) aspects of messaging and their impact on the R&D community. The study was funded by the CEC under VALUE Subprogram II and has been carried out by a task force on the RARE Mail Working Group. The document is targeted at technical decision makers as well as those who would fund activity in this area.

The document presents the existing situation as regards the predominate messaging technologies within Europe. These are presented within the context of a number of large messaging communities that are using these technologies:

- RFC 822,
- X.400(1984),
- Mail-11 and
- PC LAN messaging

Three major European communities are referenced:

- Commercial service providers
- R&D community
- Commercial organisations using messaging services.

The report states the following facts:

- The resources, human or financial, to operate multiple wide area messaging services connecting together independent organisations are high. As such it is desirable to try and keep to a minimum the number of such services. This statement is true for the R&D community but is also highly likely to be valid for the general European industry.
- There are two publicly available technological standards that can be used by open communities, such as the R&D community and public service providers: the X.400(1984 and 1988) recommendations and the Internet RFC 822 / MIME / PEM standards.
- There is an established very large global user base of Internet RFC 822 and X.400(1984) messaging services. Both services have their own momentum within different parts of the user community, both are still developing and growing fast.

The report concludes that X.400(1988) will be the preferred protocol for inter organizational connection for European industry and government and parts of the European R&D community. RFC 822 / MIME / PEM will be the preferred protocol suite for inter-organisational connection for the Internet community and, as products are already widely available, it is the preferred protocol for parts of the European R&D community.

The goal of European pervasive messaging - incorporating Industry, Government and Academia - would be best accommodated and reached by the establishment of a single messaging service. However taking the above into account, this is not feasible, as X.400(84 and 88) and RFC 822(and MIME) based services will be around for a long time to come. To increase the functionality of Wide Area E-mail services there is a clear necessity to:

- migrate RFC 822 services to a RFC 822 / MIME / PEM service.
A MIME based service offers more functionality to the user than a plain RFC 822 service.
- migrate existing X.400 services to a X.400(1988) service.

Due to the lack of scalability of the X.400(1984) service in terms of extra functionality, it will become increasingly difficult to meet the needs of research users of existing X.400(1984) services unless an X.400(1988) service is put into place.

- provide a transparent gateway between X.400(1988) and RFC 822/MIME/PEM. For the European R&D community it is essential to have a transparent gateway between the X.400(1988) service and the RFC 822 / MIME / PEM service, thus ensuring connectivity between these two services with a maximum functionality.

Such a gateway is technically feasible and it is an essential part of an unified E-mail service. Without such a standardised gateway the overall E-mail service would deteriorate.

The lack of open standards for the PC LAN messaging systems discourages their use as 'backbone' messaging technologies within open communities. However the products that these systems deliver to end users ensures that their already large share of the messaging market will continue to exist for some time. Thus it is also essential that strategies that allow these systems to be 'seamlessly' integrated within the global messaging community are put in place. Not least due to the indications that the main messaging vendors are developing X.400(1988) and RFC 822/MIME gateways, a strategy to link these systems together via X.400 and RFC 822 should be developed.

The report concludes with a set of recommendations, the main one being the establishment of a X.400(1988) European pilot messaging service for the R&D community. This pilot should include the establishment of a transparent gateway service between X.400(1988) and RFC 822/MIME. The goal of a European pilot is to ensure the successful deployment of a European wide operational X.400(1988) service that is pervasive and meets the needs of users. By collecting together the issues related to the establishment of a European X.400(1988) service, this report acts as a focal point and stimulant for discussion on this topic within the R&D community. In the report a summary of the benefits and problems of each of the above messaging technologies within the context of achieving a global messaging service, of which the R&D community is one part, is presented. Further the document identifies issues, strategies and recommendations related to the migration and coexistence of these technologies within the scope of mainly the European R&D community but also in relation to other messaging communities. A cost / benefit analysis on the establishment of a European wide pilot X.400(1988) messaging service is also presented. Finally a reading list of references related to this subject has been compiled.

The report does not include any recommendations on development and deployment of RFC 822 / MIME / PEM related (pilot) services, as these are outside of the scope of the Task Force. However, since the report shows that both X.400(1988) and RFC 822 / MIME / PEM will be developed and used within the European R&D community, such a pilot should also be considered.

3. Framework for the report

With the belief that user demands for new messaging services such as Multimedia and Secure Messaging would develop, the RARE community (together with other communities; most notably the Internet Engineering Task Force (IETF)) has over the preceding years experimented in new messaging and related technologies. Experiments and pilots, have been performed in messaging services e.g., as recommended by CCITT X.400(1988) and Directory Services based upon the CCITT X.500(1988) recommendations.

The results of such pilots and experiments indicate that it is now opportune to commence a pilot X.400(1988) messaging service for the European R&D community. The major goals of the pilot being, to

- establish a large scale European wide pilot messaging service based on X.400(1988).
- collaborate with and facilitate the commencement of similar pilot services within diverse communities; both R&D and non-R&D (e.g., commercial ADMDs and PRMDs, etc.); both European and non-European (e.g., North American , Asian, etc.).
- encourage and assist the development and deployment of a wide variety of commercial and public domain X.400(1988) messaging products that meet the user's needs, for instance X.400(1988) products such as User Agents (UAs), Message Stores (MSs), Message Transfer Agents (MTAs) and gateways between X.400(1988) services and other widespread messaging services i.e., RFC 822, Mail-11 and proprietary.
- prove that such a service and products efficiently meets the existing and expected demands for new messaging services by European R&D users. And as such determine the steps for a European deployment of an operational X.400(1988) messaging service.
- determine the needed steps to facilitate migration for the existing operational R&D X.400(1984) based messaging service, as represented by the R&D MHS service (the former COSINE MHS), RFC 822 / MIME / PEM based messaging services and the

HEPnet / SPAN Mail-11 based messaging service to an operational X.400(1988) messaging service. It is self evident that during such migrations, transition steps must be included that allow a period of coexistence, at the highest possible service level, between X.400(1988), X.400(1984), RFC 822 / MIME and HEPnet / SPAN Mail-11 services.

- determine the needed steps that allow proprietary messaging systems, that are widely deployed within the European R&D community to be integrated at as high as possible service level, by an X.400(1988) infrastructure.

This report identifies the issues involved in such a pilot service. It is not a concrete proposal for such a project but the report discusses advantages and disadvantages, costs and enefits and migration issues for deploying a X.400(1988) service. As such it is a discussion and feasibility paper on the creation of a large scale European wide pilot X.400(1988) messaging service for the European R&D community.

4. Present situation of European Messaging

4.1. Messaging services

Electronic messaging within Europe can be viewed as a number of messaging services communities. Three important communities comprise,

- Commercial e-mail networks,
- Research e-mail networks and
- PC LAN messaging systems.

Commercial e-mail networks are classified as either ADMDs or PRMDs. ADMDs and PRMDs are operating in nearly every European country.

- ADMD services (or public commercial e-mail services) are provided by over 50 service providers which have interconnected using the X.400(1984) protocols. The topology between these ADMDs, although not yet 'mesh', can be stated as progressing quite rapidly to this optimum goal. However there is still a way to go before ADMDs provide full European connectivity.
- PRMDs (or private commercial e-mail service providers) have interconnected to ADMDs and other PRMDs predominantly using the X.400(1984) protocols but also with proprietary protocols.

Research networks are providing messaging services in every European country. These R&D service providers are operated as either ADMDs or PRMDs and are using both X.400(1984) protocols and Internet RFC 822 protocols to connect to each other.

Moreover, there are also large R&D communities (i.e., HEPnet and SPAN) using proprietary protocols (i.e., DECnet Phase IV and Mail-11) as their main messaging systems. The DECnet IV based communities are now migrating to DECnet Phase V (OSI connectionless protocol stack), which provides X.400(1988) (plus X.400(1984)) as a major messaging system. In general, all these services are totally interconnected. As such it is a statement of fact that there exists within the European R&D community, two parallel interconnected messaging infrastructures based upon X.400(1984) and RFC 822. However interconnections between the R&D messaging community and the majority of the European commercial service providers use the X.400(1984) protocols.

It is also clear that the commercial world mostly makes inter-organizational messaging interconnections using the X.400(1984) protocols. And also that the commercial messaging world is not as totally interconnected as the R&D messaging community. Finally, for a number of commercial and public organisations there is often a mandatory requirement to use X.400 for messaging interconnections.

The usage of PC LAN messaging systems is increasing very rapidly within the academic and commercial communities. In general, PC LAN messaging services within both communities do not use X.400(1984) or RFC 822 messaging systems but systems based upon proprietary protocols. The PC LAN messaging systems can be considered more as 'Islands of Messaging' that gateway to the commercial and R&D messaging services by using X.400(1984) or RFC 822 gateways. PC LAN messaging systems within commercial organisations connect to commercial service providers also via proprietary protocols. The PC LAN messaging services, although probably comprising the largest number of users, are in general poorly integrated with the global messaging service (The Dutch, UK and Italian academic communities confirm that there appears to be many such 'Islands' of PC LAN messaging systems within their networks.).

4.2. Requirements for messaging

Experience with existing global e-mail services has proven that with the increased use of messaging, there follows an awareness of extra requirements for related services. These requirements can be classified into 'User based Requirements' and 'Service Provider based Requirements' to either support, or exploit, high quality messaging services. These requirements are elaborated upon within this chapter.

4.2.1. User Oriented

The only thing a user requires is an easy to use, well integrated, user interface to electronic mail. Usually the user does not care what protocol is used. However there are certain inherent requirements to the functionality that can be identified as user requirements. The main user requirements identified are:

- Distribution Lists (DLs)

A widely perceived omission from the X.400(1984) recommendations was the lack of support of DLs. Distribution lists allow users to enlist themselves onto electronic mail expander lists (distribution lists). A message to such a distribution list will automatically, and without significant delay, be sent on to anyone whose electronic mail address is on that list. Such a list can be a public list, that is meant for discussions on a specific subject, much like a sort of "magazine". However the list can also be a "closed" list, containing only a selected set of people who need to communicate privately, e.g., a project-team.

- Multinational language and Multimedia support

European users have for many years been frustrated in their inability to use their national character sets when communicating using messaging systems. The problems within e-mail systems that were causing this character set frustration are at their base the same problem that would get in the way of Multimedia messaging like:

- lack of binary data support
- lack of standardised encoding schema's
- definition of multiple body-parts

The enormous potential of Multimedia systems and services (especially within the commercial community as evidenced by the enormous press publicity and mega-mergers positioning companies to exploit this technology but also within the government spheres i.e., the U.S.A. Government's 'Information Superhighway' initiative) has acted as a spur to make rapid progress in solving the problems in this area.

- White pages Directory Service

A white pages directory service provides a unique but very basic and important service; a way to store and find information about people and resources that is analogous to a telephone service's paper based directory i.e., White Pages. User's E-mail addresses

can be stored for subsequent retrieval by E-mail systems.

- EDI

EDI today is not extensively used within the academic environment. However there is a distinct potential within the academic community to reduce costs and improve services with EDI. Potential EDI uses could be,

- EDI between universities
- EDI between universities and government
- EDI between universities and lower level educational institutions (e.g., student records)
- Commercial EDI using the Internet as an infrastructure.

The significance of maintaining end to end integrity (especially security aspects) of the EDI messages mandates that no gateways should be used between originator and recipient.

- Support of Security services

E-mail as it is currently used is far from secure. To allow for serious usage of E-mail security issues need to be addressed, like:

- integrity; making sure that the message is transferred intact, without any changes or additions.
- encryption; making sure the message content is only decipherable by the intended recipient.
- authentication; making sure that the originator and/or recipient are authenticated.

4.2.2. Service provider viewpoint

The task force believes the following points as being the most significant service provider requirements:

- Network Management

This area is still very new, in terms of offering standardised protocols, services and products for management. However a minimum 'goal' is to provide for central management functions that will allow providers to offer a better quality of service. There is presently ongoing work within the IETF Working Group MADMAN to define SNMP monitoring and managing of E-mail systems, gateways and X.500 directory systems. A number of management areas that need to be worked upon include: QOS, Service Level Agreements (SLAs), Multiple system queue management, Accounting, Routing Co-

ordination and Message Tracing.

- Support of MTA routing

Dynamic routing from MTA to MTA, relieves the necessity to maintain large routing tables, especially within a large PRMD, or community of PRMDs (like the R&D MHS community).

- Address mapping between RFC 822 and X.400

The widespread use of X.500 or DNS for mapping, allows a reduction of manpower for centrally co-ordinating globally consistent X.400-to-RFC-822 mapping tables and distributes the responsibility for updating the mapping rules. This should allow mapping rules to change when needed and to be available immediately.

- UA capabilities registration

The use of the directory to register UA capabilities for X.400(1988), X.400(1984) and RFC 822 / MIME / PEM systems is a very desirable benefit for users in terms of speeding the deployment of new messaging services (e.g., Multimedia Messaging).

4.3. Messaging capabilities

Due to the problems of gatewaying within a multi-protocol messaging environment, the great majority of R&D E-mail users are reduced to using only InterPersonal Messaging (IPM) services based upon the exchange of message body parts using CCITT character set IA5 (US ASCII).

Within the R&D community recent work to meet user requirements for non ASCII messaging services - as documented above - has resulted in enhancements to the messaging services based upon RFC 822 protocols. The enhancements provide Multimedia support via the Multipurpose Internet Mail Extensions (MIME) and the prospect in the very near future of secure messaging via Privacy Enhanced Mail (PEM). Deployment of the MIME enhanced RFC 822 based services, via distribution of software and the setting up of the needed organisational structures, has commenced. The PEM enhancements are in a large scale pilot phase e.g., VALUE PASSWORD project.

In the case of X.400(1984) the usage of non ASCII body parts is mostly effected by bilateral agreement between recipient and originator, through use of body part 14. In practice this restricts the exchange of non ASCII body parts to those cases where the recipient and the originator use the same bilateral agreement or else the originator includes an ASCII message explaining the included

content type. Besides IPM there is a growing usage of EDI on top of X.400(1984).

With the above X.400(1984) deficiencies in mind, X.400(1988) has been specified by the CCITT / ISO to meet new user demands. X.400(1988) provides support for various different body parts, enhanced security features, international character set support capabilities and support of X.500 Directory Services. Due to the technological potential of these standards to satisfy user needs for new messaging services, the R&D community has been experimenting and piloting X.400(1988) and X.500(1988) services. As there is a strong dependency of X.400(1988) messaging upon X.500(1988) directory services, the necessary precondition to supply these user demands is a deployed and operational X.500(1988) directory service. Piloting and deployment of the X.500(1988) directory service within the R&D community has been successfully initiated and co-ordinated by the COSINE and the VALUE PARADISE projects.

Similarly, secure messaging has been addressed by the VALUE PASSWORD project and the RARE and IETF communities. Work to solve problems related to directory support of X.400(1988) messaging has been pursued within the IETF and RARE. The relevant RARE and IETF work groups (e.g., RARE WG-MSG, IETF MHS-DS, etc.) have also worked to produce any needed enhancements to the base X.400(1988) and X.500(1988) standards. Last but not least it should not be overlooked that X.400(1988), as compared to X.400(1984), provides a comprehensive basis for gatewaying to and from RFC 822 / MIME / PEM and PC LAN messaging services. To that respect the IETF has defined standards for gatewaying Multimedia mail between RFC 822 / MIME / PEM and X.400(1988). As RFC 822 / MIME / PEM is now being deployed on the Internet, deployment of X.400(1988) services is needed to assure multimedia and secure messaging connectivity for the European R&D community.

5. Possible solutions for providing globally pervasive messaging

As can be now seen, a correlation of the present situation to the requirements of the user, shows that the current messaging services do not match the needs of users. To try to meet these needs a number of developments within various messaging technology areas are occurring. The following messaging technological areas, due to the present installed user base within the R&D community, are considered relevant:

- PC LAN E-mail systems such as Lotus cc:Mail, Microsoft Mail and Novell MHS
- RFC 822 / MIME / PEM E-mail services
- X.400(1988) messaging services

Ongoing developments within each of the above technological areas provide new messaging options for the R&D community. The ability of each technological area to provide solutions for user and service provider requirements is summarised within this chapter.

5.1. PC LAN E-mail systems

Currently the usage of PC LAN E-mail systems is mostly for internal communication within an organisation. External connections, if present at all, to public service providers or other organisations is mostly through gateways to X.400(1984) or RFC 822. The use of a PC LAN E-mail system in terms of an infrastructure for interconnecting E-mail systems of different hues is not common within the Research community. Recent experience, from amongst others the Dutch Research network - SURFnet - [14] and the Norwegian Directorate for Public Management - Statskonsult - [18], has shown that a number of problems (i.e., limited functionality, high operational management cost, etc.) can be expected should these PC LAN E-mail systems be used as an E-mail infrastructure. (The use of native X.400 protocols for PC LAN E-mail systems would avoid the usage of gateways and would thus alleviate many of these problems.) A summary of those problems and some relevant issues follows:

- Interconnecting heterogeneous PC LAN messaging systems

One very distinct benefit for E-mail users of all hues is the potential to integrate heterogeneous PC LAN messaging systems with a minimum loss of service (e.g., multimedia services) by connecting them via X.400(1988) (or RFC 822/MIME/SMTP). X.400(1988) is already being used, or under active development, for connecting together PC LAN messaging systems in a number of environments (e.g., Apple Macintoshes, DEC, Microsoft, Lotus, etc.). This tendency to gateway PC LAN messaging systems via X.400(1988) will increase and is one of the benefits that X.400(1988) brings to global multiprotocol messaging.

- Multimedia and binary data support

The benefit of E-mail systems using these PC LAN systems is that the user interfaces are usually well integrated in the users standard working environment. Using a proprietary protocol these systems allow not only text (ASCII) but also binary, word processor, video, audio and other types of files to be transported. To reap the benefits of this multimedia / binary data transfer it would normally require that the same type of gateway is used by sender and receiver. Transporting these same files to another type of PC LAN E-mail system is not possible through the

current gateways without some information loss. In effect PC LAN E-mail system's X.400 (or RFC 822) gateways from different vendors perform acceptably only for text body parts. True heterogeneous multimedia PC LAN messaging needs gateways to X.400(1988)'s service.

- Application Programming Interfaces

To help solve the problem of portability for Mail Enabled Applications Microsoft, Lotus, Novell, XAPIA and X/OPEN have been working on a number of standards for the Application Interface to mail transport protocols (i.e., Mail Application Programming Interface - MAPI, Vendor Independent Messaging - VIM, Common Mail Calls - CMC). These efforts are structured independent of the existing 'Wide-Area' or inter organisational E-mail protocols of X.400(1984) and RFC 822. However the MAPI, VIM and CMC efforts, due to their proposers (respectively Microsoft, Lotus and X/OPEN), do look like they will provide the stimulant to various software developers to develop more portable applications plus allow the rich functionality of X.400(1988) to be accessed by these applications thus reducing the need for gatewaying to X.400(1988).

- Security

As the PC LAN E-mail systems require gateways for connectivity, they pose a problem with regard to encrypted messages. Gatewaying of secure messages is normally not possible. The gatewaying of secure messages is a general problem of gatewaying from one mail system to any other system and is not specific to PC LAN E-mail systems.

- Directory Services

To date mostly proprietary directory services have been deployed that do not match the needs of the users in terms of access controls for data, distributed and decentralised across organisations. X.500 based services promise solutions to such needs. As a result various suppliers have announced support of X.500 directory services for their E-mail products. However, should these interfaces be delayed then support of an inter organisational 'White Pages' services requires either,

- directory information exchange products (i.e., directory gateways) deployed between a proprietary system and an X.500 directory system

- gateways between de-facto market based proprietary standards, such as Retix Directory Exchange (DX) or Soft*switch's Directory Synchronisation (DS), and X.500 protocols
- duplicated directories i.e., one proprietary and one X.500 need to be operated.

It should be stressed that gatewaying mechanisms and products are often problematic due to the lack of an open standard on the proprietary messaging system and or directory system. (As an aside it is thus essential to establish an operational X.500 infrastructure, including E-mail user interfaces that can transparently access this Directory Service, as soon as possible.)

5.2. RFC 822, MIME and PEM services

RFC 822 messaging services are widely deployed within the R&D community. There is ongoing work to extend RFC 822 to meet user requirements. Some of these extensions are elaborated upon within this chapter.

- Distribution lists

RFC 822 allows for the usage of DLs. Management of DLs is not (yet) standardised.

- RFC 822 multimedia messaging via MIME

With the arrival of MIME, the RFC 822 service has an additional protocol standard that addresses Multimedia messaging very comprehensively. In terms of user needs, MIME now allows messaging body parts to comprise multinational character sets and binary data. Multi-body part messages are also supported. One of MIME's real strengths, in terms of deployment within the existing RFC 822 service, is that it achieves its goals by overlaying its services over the existing RFC 822 service and thus mandating no changes to the in place RFC 822 infrastructure. This greatly simplifies the MIME deployment.

- RFC 822 secure messaging via PEM

Just as MIME has brought multimedia messaging to RFC 822 services, Privacy Enhanced Mail (PEM) is bringing secure messaging to RFC 822 services. PEM also has used the same approach as MIME to deploy secure messaging within RFC 822 services; overlay PEM services over the existing RFC 822 services without requiring changes to the RFC 822 infrastructure. PEM brings confidentiality

and integrity of messages to RFC 822 users. However a number of problems with PEM, and X.400(1988) as well, still need to be solved before secure messaging can be considered to be an operational service. These problems are independent of the secure messaging protocol (i.e., PEM or X.400(1988)) and deal mainly with distribution of secret keys to the end users. There is very active work going on within the IETF to solve these problems.

- MIME and PEM

There are still problems for messages that are simultaneously a multimedia message, as per MIME, and a secure message, as per PEM. A PEM encoded MIME message does not allow gatewaying to other messaging environments and therefore does not allow any of the features inherent within MIME to be exploited along the message path. A MIME message that contains PEM encoded body parts can be gatewayed but the integrity of the entire message is then not guaranteed. This is a real deficiency of both existing approaches as it is essential that users are able to simultaneously use multimedia and secure messaging. However, once again, the IETF is working very hard on solving these problems and solutions can be expected, although the solution of the gatewaying of PEM messages to other E-mail systems is still unclear.

- Dynamic and distributed messaging routing via the Domain Name System (DNS)

RFC 822 messaging benefits greatly by having a dynamic and distributed mechanism to assist in message routing i.e., Domain Name System (DNS). With the support of the DNS, RFC 822 MTAs are able to directly route to other RFC 822 MTAs and thus deliver messages with a minimum of delay. In practice mail often still traverses multiple RFC 822 MTAs for a number of reasons e.g., Mail Hubs provided for users who turn their machine off when they go home, Firewall Hubs for security reasons, etc. However it is commonly accepted that between RFC 822 mail hubs the delivery of messages is very fast. Typically resolution of routing decisions occurs in less than one minute and very often within seconds. In general the DNS service is a very valuable service that functions well in practice.

- Support for Character sets

Together with the MIME specification for content types, an extension for RFC 822 headers was defined that allows for usage of multiple character sets in names, subject etc. in RFC 822 headers [9]. This allows (European) users to use their preferred character set to support their language not only in the contents of a

message but also in the headers.

- MIME capable gateways

It is clear that to provide a seamless service to all users regardless of whether they are using RFC 822 or X.400 services, a widely available set of well run and standardised RFC 822 to X.400 gateways must be in place. For InterPersonal Messaging (IPM) based on US ASCII there are already a large number of such standardised (i.e., X.400-to-RFC 822) gateways deployed. To ensure seamless gatewaying between MIME and X.400 multimedia users, these existing text based gateways must be either upgraded to or replaced with multimedia messaging gateways. A number of proposed Internet standards to solve these problems, for both X.400(1984) and X.400(1988) and generated within the MIMEMHS work group of the IETF, have been completed [4].

- Access to fax, teletex, telex or physical delivery

For the moment, there is no standardised way for RFC 822 users to access gateways to the above services except by indirect access to X.400(1988) systems (i.e., concatenated gateways of RFC 822 to X.400(1988) and then onwards to the appropriate X.400(1988) Access Unit). Although even this indirect method would require some further work on standardising mappings between RFC 822 addresses and X.400(1992)'s X.121 addresses. As well some experiments within the RFC 822 world are occurring on routing fax messages.

- Operational support

Generally, RFC 822 messaging services are delivered on a 'best effort' basis and thus service level agreements requesting stringent response times to operational problems or guaranteed delivery times for messages are difficult to agree. This phenomena might be a result of the distribution and delegation of authority to organisations updating the RFC 822 MTA's routing mechanism i.e., DNS. As a result it makes it hard to reach a 'one stop shopping' agreement for RFC 822 messaging services.

- Notifications

The RFC 822 service provides a minimum amount of base protocol support for messaging users. It could be argued that the RFC 822 protocol is simplified by this choice and thus software that implements the standard need be smaller in size and easier to build. However some features e.g., delivery & receipt notifications and UA capabilities registration, would be commonly accepted as being desirable from a user standpoint and thus

desirable extensions to RFC 822. Some operational problems relating to reliability could be minimised by technology that has a standardised support for positive and negative notifications of messages. RFC 822, as compared to X.400, technology does not yet support positive notifications (although there is work starting within the IETF to extend RFC 822 to support delivery notifications). However within RFC 821 transport system (i.e., SMTP) there are standardised negative notifications that work well. Alternatively X.400 technology, deployed over TCP/IP (using STD 35, RFC 1006), may help to address the lack of adequate service quality - notification support - when using E-mail within the Internet.

- Portability of RFC 822 products

There are only a few mailbox formats in general use by RFC 822 software, one being the 'bin/mail' format and the other 'MH' format. This 'standard' mailbox format is a definite benefit for RFC 822 users as it allows them to change RFC 822 UAs (e.g., upgrading to MIME RFC 822 UAs) whilst not compromising or converting their existing archived mail, which may comprise 1000s of archived messages.

- System support for RFC 822 products

Normally, RFC 822 MTAs and UAs come pre-installed on UNIX workstations. As a result, users are spared the effort of installing RFC 822 MTA software. If for some reason, a user or mail administrator should wish to install a different MTA or UA to the pre-installed system, there exists a large number of easily available (i.e., via widespread distribution amongst many FTP and other information servers) public domain RFC 822 MTAs and UAs.

Both of the above points encourages the spread and eases the installation of software for the RFC 822 messaging service and in many ways explains the size and importance of the installed base of RFC 822 systems. To illustrate the extent of RFC 822 / MIME products, a non-comprehensive list of available MIME enhanced RFC 822 products follows; ELM 2.4, MH 6.8, Sun Mailtool, HP Mpower Desktop, Lotus cc:Mail (unconfirmed), Zcode Zmail, Frontier Super-TCP for Windows, PMDF (VAX VMS), Pine, C-Client (library routines), Metamail (viewer only), Andrew-MIME gateway.

- UA capability registration

The IETF MHS-DS working group has defined how X.400 and RFC 822 User Agent capabilities can be stored in X.500 directory services. This work is still ongoing.

5.3. X.400 - 1984 and 1988

X.400(1988) substantially upgrades and enhances the X.400(1984) standards. A number of new functions have been incorporated within X.400(1988). A description of the most important features of X.400 - 1984 and 1988 - follows.

- Notifications

X.400(1984) provides four notifications - positive and negative delivery notifications and positive and negative receipt notifications. These notifications allow users to ensure successful message delivery or that the message was read. The delivery notifications are also used by service operators in their fault escalation procedures.

- Binary Data Transfer

X.400(1984) allows binary data transfer to be transported without the necessity of character encoding. The ability to transfer files of whatever type is a valuable end user service. As well the lack of any necessary character encoding allows users to utilise the received data without needing any character decoding software.

- Multiple Body Parts

The ability to send multiple body parts within one message gives the user the ability to send multiple logical components within one message. This is a natural mechanism for users as it mirrors the real life situation of being able to send within one message, a letter, a word processor file, a spreadsheet file, etc.

- Feature rich messaging model

The features of X.400 are very rich. This provides benefits for users as vendors are able to provide applications that can utilise these extensive features in an interoperable manner due to the standardisation of the features within X.400.

- Clear messaging model

X.400(1984), as one of its most wide reaching achievements, has popularised within the market a consistent and clear model to describe message handling systems. The decomposition of a message handling system into UAs, MSs, MTAs, MTS - ADMDs and PRMDs and Access Units / Gateways has proved to be an extremely useful tool for users and vendors to understand and communicate their messaging needs or solutions.

- Multiple lower layer networks

X.400 has embraced the concept that there are different technology lower layer networks. This concept even allows multiple logical networks of the same technology to be supported. X.400 allows the messaging service to fully function even though the underlying network is varying. In the real world of a non-uniform network layer this is an extremely powerful capability.

The list of major X.400(1988) extensions to X.400(1984) follows:

- Distribution Lists (DLs)

A powerful mechanism for arbitrarily nested Distribution Lists including the ability for DL owners to control access to their lists and to control the destination of non delivery reports. The current endemic use of DLs in the R&D community makes this a fundamental requirement for any service. X.400(1988) uses X.500 to provide a standardised support for DLs, although there have been some needed standardised enhancements relating to the CCITT defined DLs by the IETF MHS-DS work group. The provision of powerful nesting capabilities plus management mechanisms for DL owners within X.400(1988) DLs are features providing attractive benefits for users and DL managers. There is already 'running code', via the COSINE Explode project which is implementing the MHS-DS based enhancements. The project builds upon experience gained within a number of networks e.g., JNT and provides:

- implementation of MHS-DS enhancements related to the X.400(1988) DLs
- archiving of messages received by a DL.
- access by users to the DL archive via e-mail.
- subscription to a DL by users via e-mail.

- Message Store (MS)

The Message Store provides a server for remote UAs on workstations and PCs enabling messages to be held for their recipient, solving the problems of non-continuous availability of such UAs. The message store allows mobile workers, small offices and local schools to become active messaging users in a cost effective manner. The message store provides powerful selection mechanisms allowing the user to select messages to be transferred between the store and the workstation. This facility is not catered for adequately by the P3 protocol of X.400(1984) and provides a major incentive for transition.

- X.500 Directory names

Support for use of Directory Names in MHS will allow a transition from use of O/R addresses to Directory Names when X.500 Directories become widespread, thus removing the need for users to know about MHS topological addressing components.

The ability for X.400(1988) messages to contain directory names instead of the O/R addresses is a powerful feature for users as it frees them of the necessity to insert O/R addresses containing routing information but allows them to insert the more natural directory names. However, the management of the large amounts of distributed data contained within the directory is problematic in that it involves a number of organisational issues and not just software issues. A number of X.400(1988) UAs which allow users to insert directory names instead of O/R addresses have already been developed.

- Support for EDI

Through the definition of Pedi, as defined in X.435, X.400(1988) offers integrated support for EDI messaging. The CEC TEDIS program has mandated X.400 as the main carrier for EDI, and standardised how EDI transactions are inserted into X.400 messages (i.e., Pedi and P2). This provides a strong incentive to provide native X.400(1988) services to users and applications thus encouraging commercial EDI traffic to migrate to X.400(1988).

- Secure Messaging

The provision of secure messaging services including authentication, confidentiality, integrity and non-repudiation as well as secure access between MHS components are important benefits for the R&D community. The base standards are adequate for security, however organisational and software issues need still to be solved. Organisational issues of globally scaling the distribution of secret keys is still unsolved. Software issues of how end users will be able to comfortably and securely input secret keys of length 512 -> 1024 bits into security software need to be solved.

- Multimedia

The definition of a number of additional body parts plus the ability to define new body parts (e.g., Word Processor formats, Excel documents, etc.) provides the basis for multimedia services over X.400(1988). As well, the newly defined General Text body part supports multinational character sets (except for ISO 10646)

without the need for transmission encoding. However, unlike MIME, X.400(1988) is only specifying a standard for multimedia messaging. To achieve multimedia document exchange, there is a further text exchange standard such as ODIF, Hytime, etc., needed.

- Character set support for extended addressing

A highly desirable potential benefit for European R&D users is provided by the extended character set support (i.e., T.61) within addresses. Nearly all European languages, except for Greek and Cyrillic, are supported by the T.61 teletex encoding. Further extensions to X.400 for support of extended character sets has been defined by the RARE WG on character sets and RARE WG on messaging [15].

- Physical Delivery Services

This standardised method for a message to be delivered on a physical medium, such as paper, through the normal postal service is useful when trying to reach a very wide number of (non-electronically reachable) recipients. In effect this service provides an ability to 'go the last mile' and communicate with users previously not easily reachable e.g., farmers, etc.

- General Extension Mechanism

One of the major assets of X.400(1988) is the extension mechanism. This is used to carry most of the extensions defined in these standards, but its principal benefit will be in reducing the trauma of transitions to future versions of the standards.

Provided that implementations of the X.400(1988) standards do not try to place restrictions on the values that may be present, any future extension will be relayed by these implementations when the extension is not critical, thus providing a painless migration to new versions (1992 and beyond) of the standards.

- UA Capability Registration

With the extra functionality available to X.400(1988 and especially 1992) UAs (i.e., extra non-IA5 body parts, secure messaging, etc.) it is expected that the demand to register UA capabilities will increase. In that respect X.400(1988)'s ability to query X.500, where such capabilities would be stored, is a significant potential benefit for users.

- X.500 support for MTA routing

The piloting of X.500 to support MTA routing within the R&D community has already commenced, on a small experimental scale, via the Longbud project co-ordinated by the IETF MHS-DS work group. Some concrete benefits promised by X.500 based routing are:

- routing based upon content types, security, transport stacks and other criteria allow optimum routing paths to a destination MTA to be chosen. (There is presently no such similar capability within the DNS).
- allowing the routing information to be inserted and modified in a distributed manner reduces (if not eliminates) the necessity of central distribution of static routing tables. The consequent reduction in manpower to co-ordinate MTA routing plus the increase in scalability of the service allows a truly global messaging service to be put in place.

6. Migration to X.400(1988)

What is clear from the previous chapters is that;

- The resources, human or financial, to operate multiple wide area messaging services connecting together independent organisations are high. As such it is desirable to try and keep to a minimum the number of such services. This statement is true for the R&D community but is also highly likely to be valid for the general European industry.
- There are two publicly available technological standards that can be used by open communities, such as the R&D community and public service providers: the X.400(1984 and 1988) recommendations and the Internet RFC 822 / MIME / PEM standards.
- There is an established very large global user base of Internet RFC 822 and X.400(1984) messaging services. Both services have their own momentum within different parts of the user community, both are still developing and growing fast.

From the above discussion, it is clear that the infrastructure services that have to be supported within these open communities, and especially within the R&D community, are RFC 822 / MIME / PEM, X.400(1984) and X.400(1988). X.400(1988) will be the preferred protocol for inter-organisational connection for European industry and government and parts of the European R&D community. RFC 822 /

MIME / PEM will be the preferred protocol suite for inter-organisational connection for the Internet community and, as products are already widely available, it is the preferred protocol for parts of the European R&D community.

The goal of European pervasive messaging - incorporating Industry, Government and Academia - would be best accommodated and reached by the establishment of a single messaging service. However taking the above into account, this is not feasible, as X.400 and RFC 822 based services will be around for a long time to come. To increase the functionality of Wide Area E-mail services there is a clear necessity to:

- migrate RFC 822 services to a RFC 822 / MIME / PEM service. A MIME based service offers more functionality to the user than a plain RFC 822 service.
- migrate existing X.400 services to a X.400(1988) service. Due to the lack of scalability of the X.400(1984) service in terms of extra functionality, it will become increasingly difficult to meet the needs of research users of existing X.400(1984) services unless an X.400(1988) service is put into place.
- provide a transparent gateway between X.400(1988) and RFC 822/MIME/PEM. For the European R&D community it is essential to have a transparent gateway between the X.400(1988) service and the RFC 822 / MIME / PEM service, thus ensuring connectivity between these two services with a maximum functionality.

Such a gateway is technically feasible and it is an essential part of an unified E-mail service. Without such a standardised gateway the overall E-mail service would deteriorate.

The lack of open standards for the PC LAN messaging systems discourages their use as 'backbone' messaging technologies within open communities. However the products that these systems deliver to end users ensures that their already large share of the messaging market will continue to exist for some time. Thus it is also essential that strategies that allow these systems to be 'seamlessly' integrated within the global messaging community are put in place. Not least due to the indications that the main messaging vendors are developing X.400(1988) and RFC 822/MIME gateways, a strategy to link these systems together via X.400(1988) and RFC 822/MIME should be developed.

To make migration to a X.400(1988) service feasible, extensive migration and coexistence options for various non-X.400(1988) users have to be developed. Main issue in each migration strategy remains the co-operation of the users. The migration needs to be user-driven, i.e., the users need to be convinced of the added functionality (versus the cost) of migrating towards X.400(1988). A detailed summary of the different issues and possible problems involved in the transition to a X.400(1988) based messaging service, with respect to what are commonly accepted as the four most important messaging services: RFC 822, MIME and PEM; X.400(1984); MAIL-11 and PC LAN messaging systems are presented in this chapter.

6.1. PC LAN E-mail systems

To provide coexistence and migration the usage of gateways is unavoidable. The quality of these gateways, with regard to:

- Transparency (gatewaying multimedia messages, transparent addressing)
- Manageability
- Reliability

has to be improved. Ultimately through usage of APIs like MAPI and CMC, the users interface hopefully will become independent of the mail protocol that is used. It will then be expected to be possible to let the user retain his preferred mail user interface, while the protocol used migrates to X.400(1988).

Via the use of these APIs it may be possible to access the full features of X.400(1988) while retaining a proprietary PC LAN UAs. This way a PC LAN can be easily connected to a X.400(1988) backbone. This usage of APIs to ease migration for end users should be encouraged.

The migration of PC LAN E-mail systems will likely be driven by the commercial vendors of mail enabled applications, such as UAs, Work Group Systems, Task Flow Systems plus X.400(1988) MTAs and gateways able to serve these applications via these new APIs.

6.2. RFC 822, MIME and PEM services

A migration from RFC 822 / MIME and PEM services to X.400(1988) needs to be formulated for those management domains that wish to effect this change. As well a long term transition and coexistence phase needs to be accommodated due to the existing base of RFC 822 users. An understanding of the issues involved in migrating from RFC 822 to X.400(1988) messaging services is essential before any rational decisions on migration can occur. Certainly one, if not the main,

issue in such a migration is that the migration must allow a transition period where maximum functionality between both services exists. Any migration must be aware that RFC 822 messaging services are a 'moving target'.

- Ease of transition as perceived by an RFC 822 user mandates that the user's existing mail folders are converted into the new mail product's folder system flawlessly.
- The RFC 822's user's e-mail address should remain the same even after a migration. (i.e., the user keeps the same address that has two different notation forms: X.400 and RFC 822).
- Users contemplating a migration will be stimulated to do so if they experience no loss of service as regards MIME and X.400(1988) gatewaying; are still able to insert RFC 822 style addresses into the X.400(1988) UA and are provided with high performance X.400-to-RFC 822 gateways.
- The added connectivity provided by X.400(1984 or 1988) gateways to fax, telex, post etc. plus additional X.400 users that the user is able to reach easily (whilst not losing connectivity to RFC 822 addresses) plus the additional functionality of X.400(1988) possible when communicating with X.400(1988) users will also act as a stimulant to a migration.
- The functionality provided by RFC 822 / MIME products will be the yardstick that an RFC 822 user compares an offered X.400(1988) product with. As such X.400(1988) products must provide some basic and important functions like: Character Set support via GeneralText; Multimedia capability via Extended Body Parts; low message delays within the seconds time scales and ease of configuration of products. At present there is no RFC 822 equivalent to X.400 delivery and receipt notifications and as such these functions are seen as extra functionality by the user.
- A follow on to the extra functionality point above is that present RFC 822 users, most likely commercial users, that want to be able to use EDI or other mail enabled applications that need security, message audits and positive confirmations will be encouraged to migrate to X.400(1988). A decision to use X.400(1988) in this case would be especially attractive for those commercial RFC 822 users that are already operating multiple lower layer networks. As X.400(1988) accommodates multiple different network layers easily, the cost to migrate could be considered quite small.

6.3. X.400(1984) services

A number of problems can be identified in a migration from X.400(1984) to X.400(1988). They are summarised as,

- OSI supporting layers are mandatory in the ISO10021 MOTIS standard, while the support of the complete OSI stack (normal mode) is optional in the otherwise equivalent CCITT X.400(1988) specifications. It is thus recommended that the migration from X.400(1984) should be straight to ISO 10021 i.e., straight to use of the full OSI stack with normal mode RTS.
- There is a negative impact on quality of service caused by implementation decisions related to the 'General Extension Mechanism'. To overcome this negative impact no minimal X.400(1988) MTAs, which relay the syntax but understand none of the semantics of extensions, should be used.
- All X.400(1988) MTAs should generate reports containing the extensions that are present in the original message and route such reports through the DL expansion hierarchy where appropriate.
- Choice of standards to be used within mixed X.400(1984 and 1988) management domains needs to accommodate in one option the danger of undetectable routing loops from incorrectly configured routing entries and in another option the problem that systems that have fixed the routing loop problem may not all be consistently implemented due to ambiguities within the standards. The choice of which of these two options a management domain uses internally has no impact on external management domains.
- DDA support is needed by X.400(1984) systems to address X.400(1988) Common Name Attribute users [2].
- Minimum loss of service quality mandates that downgrading of X.400(1988) body parts to X.400(1984) bodyparts be done according to the MIMEMHS specifications [4].
- To enhance connectivity to both X.400(1984 and 1988) management domains without degradation of X.400(1988) service, management domain entry points that support both X.400(1984 and 1988) are recommended.

- Ensuring that no X.400(1988) MTAs transit via X.400(1984) MTAs. This allows no degradation of X.400(1988) service quality [17].

The consequence of the last point is that the existing European Research X.400(1984) - formerly COSINE MHS - MTA RELAY backbone should be one of the first MTA communities to migrate to X.400(1988).

6.4. Mail-11 services

The Mail-11 (also known as DECnet mail) e-mail service is the major e-mail service used within the High Energy Physics and Space Physics Analysis Networks (i.e., HEPnet and SPAN) and is the native e-mail service present on VMS operating systems. The Mail-11 service is considered the most popular service by the large HEPnet / SPAN community. Mail-11 provides also large and easy to use gateways to other E-mail protocols, like X.400 (84), RFC 822 (SMTP over TCP/IP, DECnet and X.25, BSMTTP over NJE), and PC LAN E-mail services.

Jointly with the "old style" Mail-11 UA, the DECnet Phase V (OSI CLNS) service provides the native capability to run X.400 (88) and X.400(1984) services. There is thus the potential for X.400 (88) services to become available as soon as the HEPnet / SPAN community migrates to DECnet Phase V. However the availability of VMS based UAs for the X.400(1988) service is still very limited and is thus forcing users to continue to stay with their Mail-11 UA (and thus the Mail-11 service).

Users in HEPnet / SPAN are demanding enhancements to their mail services to support multimedia and delivery / read receipt services. This is a strong driving factor for good X.400(1988) UAs to become available soon to allow users to properly use the available X.400(1988) service of DECnet Phase V.

7. Benefits of migrating to X.400(1988) and the involved costs

The actual as compared to the potential benefits of migrating from one's existing mail system to a new mail protocol is very dependent on good products, good organisation of the migration and a degree of commitment that the transition is worth the cost. Quantifiable and accurate cost / benefit ratios for such a migration are not possible within the decentralised European R&D environment and as such are not generated.

We have in this chapter listed the benefits that such a migration to X.400(1988) achieves. We have also given an indication of the relative costs of such a migration. Provided that there are good products, and taken in conjunction with the recommendations of

Chapter 8 and Appendices A and B, the task force is confident that these potential benefits will translate into actual benefits and be worth the costs incurred.

Benefits

Below is a list of non-technically oriented benefits and the features of X.400(1988) that enable these benefits to occur. The benefit of,

- efficient and innovative communication within Europe is assisted by establishing an X.400(1988) messaging service that integrates European industry, government and academia;
- an increase in business efficiency by the use of EDI (for example automatic processing of business forms, exchange of business contracts, etc.) is enhanced by the security aspects of X.400(1988) i.e., non-repudiation, authentication, confidentiality, integrity plus secure access between MHS components.
- allowing European users to communicate in their native European languages is brought about by the GeneralText body part of X.400(1988).
- remote users and Small and Medium size Enterprises(SME) using e-mail for electronic commerce is encouraged by reducing the entry level costs for use of e-mail. An SME's use of Remote UAs in conjunction with a service provider's MS -instead of purchasing their own MTA - is accommodated by X.400(1988).
- providing global messaging for all e-mail users, but recognising the existing market realities of heterogeneous e-mail systems, would be enhanced by the establishment of gateways to X.400(1988).
- being able to recover costs by charging and accounting for messaging services back to users - this is especially important for commercial service providers - is brought about by the message auditing capabilities of X.400(1988).
- communication with users that have no access to E-mail (for example if such users are defined within Distribution Lists) is enhanced by X.400(1988)'s support for gateways to physical delivery, fax, telex, teletex, etc.

- building upon the existing X.400(1984) infrastructure (i.e., reduction of establishment costs) is brought about by migrating the X.400(1984) infrastructure to X.400(1988).
- a reduction in manpower (and thus costs) to manage a global messaging service is brought about by the messaging service's ability to utilise the global distributed directory for management information.
- the messaging infrastructure to meet new user requirements is enhanced by the support for General Extensible Mechanism.
- making E-mail more user friendly is brought about by a messaging service that allows the use of the more natural directory names in E-mail addresses.
- increased effectiveness of messaging by the use of DLs is brought about by X.400(1988)'s support of powerful nesting capabilities and management for DLs.
- an increase in global message delivery performance and reliability is enhanced by the ability of X.400(1988) to use X.500 for MTA routing.
- more messages being successfully delivered to mobile or transient users is enhanced by the provision of the Message Store.
- multimedia use is enhanced by the ability to define new body parts and to support multiple types of binary data such as audio and video.
- establishing optimum and seamless conversion of messages based upon the capabilities of a user is brought about by the ability of X.400(1988) to act upon UA capabilities.

Costs

The generic costs to establish an X.400(1988) pilot service can be broken down into:

- a cost per backbone of RELAY MTAs (as used by the European research community - the former Cosine MHS service),
- a cost per service provider,
- a cost per organisation,
- a cost per user and
- a cost per user MTA for migrating to X.400(1988).

To bring about the benefits, mentioned above, certain costs will be incurred and they are summarised below:

- Cost per backbone of RELAY MTAs (as used by the European research community - the former Cosine MHS service)
 - The equipment costs of migrating backbone RELAY MTAs.
 - The establishment of some sort of organisational / project group to oversee a backbone RELAY MTA pilot.

As most of the RELAY MTAs are already X.400(1988) capable, there is already a MHS Co-ordination service in place that could be used for this function and the number of backbone RELAY MTAs is less than 100 in number the cost for migrating the RELAY MTA backbone is considered relatively low.

- Cost per service provider
 - If the RELAY MTA backbone (formerly Cosine MHS) is migrated towards X.400(1988), then the remaining cost for a service provider for migrating the infrastructure towards X.400(1988) is relatively low.
 - The operational costs for organisational issues, for example dealing with OID registrations, is low if national R&D service providers act as a clearinghouse for their own national R&D institutions e.g., Universities.
- Cost per organisation, end user and MTA
 - The operational costs of migrating end users and their MTAs in management domains to X.400(1988) are higher than the costs involved with migrating the infrastructure. This is due to the order of at least 10 to 100 times more MTAs, as compared to the service providers, that would be involved with a migration to X.400(1988). As the infrastructure needs to migrate first, the costs for the end user MTAs can be reduced by profiting from the migration experience of the service providers.
 - The education and training costs for users and system managers are significant, due to the amount of end users and end user MTAs. Any marginal cost savings per user which can be made, e.g., by deployment of automated tools, should be considered due to the large overall

savings that accrue.

- The costs of any potential disruption of the end user's messaging service are high - due to the huge numbers of end users involved - and as such only a very well managed, phased and planned migration should be considered.

- Software costs

- The costs for software development are outside the scope of this report. However it is clear that cost needs to be incurred in order to provide software that is easy to install and use. As a result of the work of the task force a list of possibly needed components and likely changes to existing components can be proposed,

Modifications, but not new developments, to software for:

- X.400(1988) MTAs, X.400(1988) UAs, DSAs, DUAs and MSs.

New software developments for:

- MIME to MHS Gateways, X.400(1988) network management, mailbox conversion, PC LAN directory synchronisation, PC LAN gateways and UA capability registration.
- The distribution costs for any new software (for the European R&D community) are low if usual academic distribution methods - FTP servers, E-mail Based servers, Gopher, World Wide Web and Archie - are used.

Summary

Migration towards a X.400(1988) service needs to evolve from the inside (the messaging backbone) outward (to the end user MTAs and end users themselves). Due to the numbers involved both the costs and the benefits associated with the migration increase as the migration evolves towards the end users.

The benefits of migrating to a X.400(1988) service are a feature rich well defined open standard with high functionality , scalability, use of directory, multimedia and secure messaging capability. The costs for migrating a RELAY MTA backbone can be considered relatively low whilst the migration of end user MTAs and the migration of the end

users themselves are relatively high. These costs should of course be balanced against the cost of a disrupted service that one might get if no migration occurs at all and the current service (e.g., X.400(1984)) reaches the limits of its scalability and/or functionality.

It is important to realise that if end users themselves do not experience direct feedback of the benefits from X.400(1988), this may make the organisational motivation needed to effect such a migration difficult to achieve. In effect, the establishment of a pilot X.400(1988) service is and should be driven by the requirements of end users and thus achieving end user benefits - as listed above - must be given a higher priority within a X.400(1988) service than solely the extra service provider benefits.

8. Main Recommendations

The RARE WG-MSG Task Force on 'The Establishment of an X.400(1988) Pan European Pilot Messaging Service' has identified a number of high level recommendations for establishing such a

service. The main high level recommendations are listed within this chapter. A more detailed elaboration of these main recommendations is given in Appendix A. Appendix A is provided for policy makers wishing more background on the main recommendations. As well, a list of very detailed guidelines, plus some issues requiring further investigation, is given in Appendix B. Appendix B will be especially useful for personnel seeking detailed technical guidelines which are consistent with the main high level recommendations.

Recommendations

- Establish a X.400(1988) pilot service encompassing European Commercial, Government and Academic bodies. Such a pilot service to be co-ordinated by using an industry forum where all parties could meet. The use of an existing forum, where user organisations are well represented, is desirable if commercial end users organisation's requirements are to be met. The forum should also be open to non-European participants.
- X.400(1988) end user services should be provided as well as a X.400(1988) backbone RELAY MTA service within a X.400(1988) pilot service. The end user services should be given a high priority.
- Help an already emerging market place in X.400(1988) products to prosper by ensuring that a suitable supply of high quality X.400(1988) public domain software is available.

The Internet has proven, that public domain software, free of any commercial restrictions, is further rapidly developed, by Small and Medium Size Enterprises (SMEs), into derivative products suitable for the commercial market.

- Any pilot service should be well co-ordinated and result driven but utilise a distributed market oriented approach. It is considered very difficult to organise and plan such a pilot under the assumption of a single centrally funded body i.e., driven from the 'top'. A more 'market driven' or distributed organisation is considered feasible, and likely to succeed, if all the market 'players' are fully involved i.e., a 'bottom' up approach.
- For the academic community - and ever more for the commercial community - there is a business need to ensure near total and 'perfect' integration with the existing and also evolving RFC 822 based services.
- For the academic community a rapid migration of the existing X.400(1984) backbone RELAY MTAs, used within the European R&D X.400(1984) service, - formerly the COSINE MHS service - is considered urgent. This migration will provide a 'bootstrap' path for academic organisations to internationally pilot X.400(1988) services. Such end user piloting is not considered feasible if X.400(1984) backbone RELAY MTAs are used for an X.400(1988) service (see Reference [17] for technical details).

The report does not include any recommendations on development and deployment of RFC 822 / MIME / PEM related (pilot) services, as these are outside of the scope of the Task Force. However, since both X.400(1988) and RFC 822 / MIME / PEM will be developed and used within the European R&D community, such a pilot should also be considered.

9. Security Considerations

Security issues are not discussed in this memo.

10. Reading List and Bibliography

This section contains a list of relevant reference documents that can be used for further reading.

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- [18] Nagelhus, I. et al., "Survey of E-mail systems with X.400 capability".
- [19] "A White Paper on X.400(1988)", EMA Report.
- [20] IAB, IESG, "The Internet Standards Process -- Revision 2", RFC 1602, March 1994.

11. Terminology

ADMD	Administration Management Domain
ASCII	American Standard Code for Information Exchange
ASN.1	Abstract Syntax Notation One
AU	Access Unit
CCITT	Comite Consultatif International de Telegraphique et Telephonique
CEN	Comite Europeen de Normalisation
CENELEC	Comite Europeen de Normalisation Electrotechnique
CEPT	Conference Europeene des Postes et Telecommunications
CONS	Connection Oriented Network Service
COSINE	Co-operation for OSI networking in Europe
DL	Distribution List
DIS	Draft International Standard
EMA	Electronic Messaging Association
EN	European Norm
ENV	Draft EN, European functional standard
IEC	International Electrotechnical Commission
IETF	Internet Engineering Task Force [20]
IPM	Inter-Personal Message
IPMS	Inter-Personal Messaging Service
IPN	Inter-Personal Notification
ISO	International Organisation for Standardisation
JNT	Joint Network Team (UK)
JTC	Joint Technical Committee (ISO/IEC)
MD	Management Domain (either an ADMD or a PRMD)
MHS	Message Handling System
MHS-DS	Message Handling Systems use of Directory Service Working Group from the IETF
MIME	Multi-purpose Internet Mail Extensions (extensions to RFC 822) [6]
MOTIS	Message-Oriented Text Interchange Systems
MTA	Message Transfer Agent
MTL	Message Transfer Layer
MTS	Message Transfer System
NBS	National Bureau of Standardization
OSI	Open Systems Interconnection
PEM	Privacy Enhanced Mail [10]
PRMD	Private Management Domain
RARE	Reseaux Associes pour la Recherche Europeenne
RFC	Request For Comments (series of Internet publications)
RFC 822	RFC describing Internet Message format for Electronic mail
RTR	RARE Technical Report (series of RARE publications)
RTS	Reliable Transfer Service
WG-MSG	RARE Working Group on Mail and Messaging

Appendix A - Elaboration on the main recommendations

The main recommendations of the report are elaborated upon in more detail within this appendix.

- In order to provide a globally pervasive messaging service, it is recommended to establish a well operated Pan-European X.400(1988) pilot backbone comprising MTAs and MSs, connecting partners within Industry, Commercial Service Providers, Academia and Public Bodies (CEC, National Governments, etc.). The pilot should be open to global participation.
- In order to maintain the widest connectivity with the highest possible functionality, gateways should be installed that gateway between X.400(1988) and RFC 822/MIME. These gateways should follow the specifications of RFC 1327 [1] and RFC 1494 et al. [4]. Experience with these gateways should be fed back into the appropriate RARE and IETF Working Groups to improve the standards.
- In order that the 'business needs' of non-R&D organisations can be inserted at an early stage into the goals of the pilot and ensuring that the success of the pilot in meeting these goals can be measured and disseminated i.e., to encourage the active participation of non-R&D organisations within the pilot, it is recommended that an open forum comprising industry, service providers, public bodies and academia should be used. Preferably an existing forum where end users are heavily involved is desirable.
- In order for meaningful co-operation between bodies affected by the pilot to occur and thus hopefully reducing unnecessary duplications, it is recommended that there are close liaisons and contacts between at least the IETF, RARE, EARN, EUnet, RIPE, Y-NET, EEMA, EMA, EWOS, OIW, CEN/CENELEC, ISO, CCITT, CEC and European governmental bodies and those involved within the pilot. The suggested mechanism for a meaningful liaison is that enough participants of the above organisations attend the common forum mentioned above. It is also suggested that as much as possible e-mail distribution lists be used to communicate between forum participants.
- In order that the pilot have measurable results, it is recommended that the pilot shall be implemented in phases. It is considered that at least two phases are needed:

- phase 1 - initial short start up phase with a small number of participants. The result of this phase is that any needed procedures, co-ordination mechanisms, etc. are put into place for the large scale piloting of phase 2.
- phase 2 - phase with a wide Pan-European participation. The result of this phase should be a proof of scaling of the pilot X.400(1988) service i.e., the goals of the pilot as defined in Chapter 1 are met. It is expected that upon successful completion of this phase a natural evolution to a global deployment of a X.400(1988) service will have started.
- In order to rapidly complete phase 1 of the pilot and that the pilot is at least Pan-European in scope, it is recommended that; a number of R&D service providers, one each from several European countries; at least 2 North American R&D service providers; at least 1 Japanese R&D service provider and a small number of commercial service providers and commercial organisations are actively involved in phase 1.
- In order to stimulate the creation of an economically viable market place for X.400(1988) products (i.e., MTAs, UAs, etc.) (i.e., users are willing to purchase such products), it is recommended that a suitable minimum number of new software implementations and or modifications to existing software implementations be funded. The resulting software to be inserted into the Public Domain free of any financial restrictions on further commercial exploitation. By using this mechanism, Small and Medium Size Enterprises (SMEs) will be encouraged to commercially exploit such products.
- Due to the strong influence of the R&D community within the pilot plus the desire to produce standardised products quickly and pragmatically, it is recommended that any standards proposed within the scope of an X.400(1988) pilot (for example standards re: character sets and body parts gatewayed to and from X.400(1988) and RFC 822 / MIME) are conformant to and candidates for Internet standardisation. As a concrete example of the standardisation process, this means that at least two independent software implementations, for each product category, (of which one product preferably in the Public Domain) must be proven as interworking to a proposed standard before the proposed standard can be elevated to draft standard [20].

- To ensure that there is a market driven demand for X.400(1988) products within the commercial market place, it is recommended that the maximum number of Public Domain implementations that are funded, by any one public funding organisation, is two. It is desirable that at least one other product, preferably commercially based and not within the Public Domain, is produced.
- In order that any necessary information required for the effective operation of the X.400(1988) pilot, including not least OID assignments, mapping rules, information about interconnection partners, naming authority information be made widely available, it is recommended that an electronically accessible information base be established.
- In order that any necessary organisational issues needed for a deployment of an X.400(1988) service have a body in place to deal with this issue, it is recommended that the pilot either identify and list which bodies are responsible for which issues or else actively ensure that a suitable body is being put in place.

Appendix B - A number of detailed guidelines.

The Task Force has the following detailed guidelines:

Product and operational service guidelines

- To ensure that there is no degradation of X.400(1988) service between X.400(1988) originators and destinations, the topology of the MTS must be such that no X.400(1984) MTA acts as a relay between any two X.400(1988) users.
- As the existing R&D X.400(1984) service (formerly COSINE MHS) now comprises a large number of X.400(1988) capable RELAYs, it would be relatively straight forward that the existing COSINE MHS RELAYs be one of the first communities that are migrated to X.400(1988) capabilities. This would ensure that X.400(1988) MTAs using the RELAY backbone experience no loss of service.
- To be able to operate an X.400(1988) service a properly operated X.400(1988) infrastructure should be established, consisting of X.400(1988) MTAs, X.400(1988) MTAs with downgrading capabilities according to RTR 3, Message Store services and gateways to RFC 822 based upon RTR 2 and extended gatewaying functionality for multimedia mail.

- To ensure maximum use of the OSI supporting layers plus support of normal mode RTS, it is recommended that a migration to ISO 10021 is effected i.e., straight to use of the full OSI stack with normal mode RTS.
- To ensure maximum quality of service as impacted by implementation decisions related to the 'General Extension Mechanism', it is recommended that no minimal X.400(1988) MTAs, which relay the syntax but understand none of the semantics of extensions, should be used.
- It is recommended that all X.400(1988) MTAs should generate reports containing extensions copied from the subject message and route reports through the DL expansion hierarchy where appropriate.
- It is recommended that all X.400(1984) UAs are able to generate and display DDAs. This will allow such systems to address X.400(1988) Common Name Attribute users.
- To enhance connectivity to both X.400(1984 and 1988) management domains without degradation of X.400(1988) service, management domain entry points that support both X.400(1984 and 1988) are recommended.
- To ensure total connectivity between RFC 822 domains migrating to X.400(1988), it is recommended that a local X.400-to-RFC-822 gateway is made operational or a reliable service agreement for the external provision of such a gateway is effected before any migration begins.

Migration utilities needed

- It is considered very helpful if conversion utilities that allow a flawless conversion of an RFC 822 user's existing mail folders to a X.400(1988) product's folder system be implemented. However further investigation is needed before recommending that such tools be made a mandatory part of any funded software development.
- It is recommended that the ease of configuration of X.400(1988) products is made as automatic as possible. Consideration should be given to a) modern user interfaces b) automatic processing of 'old RFC 822' configuration files into the 'new X.400(1988)' configuration files i.e., a reuse of the user's previous options and configurations should be the result. If a 'simple' configuration interface is needed it should be as compatible as possible with the present RFC

822 mailer's i.e., this concretely means editing of ASCII files.

Issues for further study

The pilot X.400(1988) messaging service must ensure that the issues listed below are either being investigated by an appropriate body or if not initiate actions to properly address them. The issues have been grouped under Products, Organisational and Deployment.

- Products

- Any X.500 DSAs, DUAs, APIs e.g., LDAP, etc. changes needed to support X.400(1988) messaging.
- X.400(1988) MTAs, UAs, MSs, gateways to RFC 822/MIME and X.400(1984) plus gateways to other messaging systems e.g., Microsoft Mail, Lotus cc:Mail, etc.
- User Interfaces that integrate X.400(1988) UAs and X.500 DUAs with user applications such as Word Processors, etc.
- E-mail network management software both for users and administrators

- Organisational

- trusted network for security (i.e., the distribution of security keys) and whether this trusted network should or can be the same as the PEM trusted network presently under deployment.
- usage of PEM within X.400(1988).
- PEM to and from X.400(1988) gatewaying.
- how to register and publicise object IDs for X.400(1988).
- addresses are well publicised of PRMD and ADMD registration authorities.
- creation and modification authority for X.400-to-RFC-822 mapping rules is defined.
- creation and modification authority for MTA routing rules is defined.

- what methods should be used to liaison to other bodies like IETF, ISO, EEMA, EMA, etc.
- ensuring that any Public Domain software needed for the X.400(1988) service is distributed widely, quickly and efficiently.
- Deployment
 - which services should start such a migration (i.e., COSINE MHS RELAYS, Universities, other).
 - the topology of the X.400(1988) MTS.
 - addressing of users between X.400(1984 and 1988) and RFC 822 e.g., how will X.400(1988) T.61 address components be processed by X.400(1984) and RFC 822 systems.
 - which X.400(1988) body parts MUST be supported by the research community.
 - if any new APIs - or modified APIs - are needed for X.400(1988) and messaging in general.
 - the specifications and development of any needed Public Domain software.
 - what existing Public Domain software should be modified to accommodate X.400(1988) systems.
 - how rapidly to deploy the X.400(1988) service.
 - ensuring that there is 'little or no loss of service' in any migration from X.400(1984), or RFC 822, to X.400(1988).
 - considering what Value Added Services, based upon X.400(1988), could be started to encourage uptake of X.400(1988).

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