X.400 MHS: First Steps Towards an EDI Communication Standard

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Abstract

Electronic Data Interchange (EDI) is an increasingly important application of computer communications. Until recently, EDI has developed independently of the communications technology and related standards. EDI users coped with this situation by setting up bilateral communications agreements or by using the services of Value Added Data Services centres, which provided protocol conversion. The introduction of X.400 MHS based systems and services is slowly modifying the general attitude towards EDI communications. For the first time, a CCITT rapporteur group is drafting a recommendation for EDI communications within the context of X.400 MHS. More importantly, there already exist official guidelines, both in the U.S.A. and in Europe, which explain how to take advantage of X.400 MHS systems today.

The purpose of this paper is to comment upon these first approaches to an EDI communication standard. For this reason, and because we expect only a few readers to be familiar with both EDI and X.400 MHS, we begin with introductions to both subjects.

Keywords: Data communications, Computer communications, Standardization, Electronic mail, EDI, X.400 MHS, MOTIS.

1 Introduction

This may not be apparent to everyone familiar with both acronyms, but OSI and EDI have some fundamental goals in common : both intend to facilitate the exchange of meaningful information between application processes. OSI, standing for Open Systems Interconnection, is a well defined model created by ISO, the International Standards Organization, to serve as a framework for the definition of communication services and protocols: it defines a stack of seven layers from the physical layer at the bottom to the application layer at the top. Users see only the services offered by the application layer, whose purpose is to serve as a window between correspondent application processes that are using the OSI to exchange meaningful information [9]. EDI, standing for Electronic Data Interchange, is an increasingly important three letter acronym for which it is difficult to find a good definition. Some people see in it a new way to do business, while others think of it as a new information technology. For the scope of this paper, we will limit ourselves to saying that EDI is essentially concerned with the exchange of meaningful information between application processes. This statement should not be controversial. Another point that is not controversial is that EDI has a lot to do with standards: in particular, there are standards dedicated to it, such as ISO EDIFACT [10] or ANSI X12 [1]. However, EDI is not and probably should not be limited to these standards.

Until now EDI and OSI standards have been developed independently with the consequence that there is now some overlapping and inconsistencies between them. Proponents of EDI or OSI standards are starting to debate about whether this situation is normal and tolerable, or whether standards will have to be aligned in the future [17, 18]. The solution to such an argument may well depend on the nature and requirements of the various EDI applications that are emerging.

Until this issue is resolved, users who wish to use OSI standard protocols for transporting EDI messages need to find ad-hoc methods to do so. This may not be technically difficult, but it is not convenient for users to be isolated. There is an imperative need for coordination between the users themselves as well as between the users and the software manufacturers. The NIST (National Institute for Standards and Technology, previously known as the National Bureau of Standards) in the U.S.A. and the CEC (Commission of the European Communities) in Europe have established guidelines which describe how to take advantage of new public or private networks, known as X.400 MHS (Message Handling Systems), to transport EDI messages [8, 13].

These guidelines have been established for the short term; they are therefore very simple and indeed fairly short. Also, both guidelines are intended for systems currently available, i.e. for systems based on the 1984 version of the X.400 series of recommendations. On the other hand, perhaps because EDI is perceived differently in the U.S.A than in Europe, they recommend two radically different approaches for using X.400 MHS. Fortunately, care has been taken to make them compatible through a simple gateway.

On the longer term, EDI users will benefit from a better adapted, more powerful, communication solution. A CCITT rapporteur group is currently drafting a recommendation that will indicate how to support EDI communications within the context of X.400.

2 Electronic Data Interchange

Companies normally exchange documents such as purchase orders, invoices, customs declarations, and technical specifications, by physical mail. When these documents are processed by computers at both ends, it is more logical to transfer them electronically (fig. 1).

Figure 1: Physical Mail vs EDI

The costs created when using paper documents, which can be identified as paper handling costs, typing costs, and costs caused by typing errors, can be minimized by transmitting data electronically. This represents significant savings: a survey ordered by the United Nations Organization has evaluated paper related costs to represent 7% of the price of shipped merchandise (up to 200 paper documents need to be produced during the exporting/importing of one set of goods). Note that we do not mention mailing costs, as they are comparatively insignificant: cost reductions are to be made directly on the company premises, not on the communication channels.

In fact, the advantages of exchanging data electronically go well beyond these simple cost reductions. Physical mail and data reentry are characterised by long and unpredictable delays for the transmission which prevent companies from organizing their business in a much more effective manner. When these delays can be reduced to hours or minutes (in general, it is perfectly acceptable for documents to be delivered overnight, as long as there is no uncertainty about this delay), companies can make a better use of human, material, and capital resources.

It is of this kind of application that most people think when they say "EDI", although they certainly realize that EDI covers several more aspects than just this one. Nevertheless, it is precisely this aspect of EDI that is most compatible with X.400 communication mechanisms. For the scope of this paper, we call it *asynchronous EDI*, or simply *EDI*, and we define it to be the asynchronous exchange, from computer to computer, of inter-company business documents and information.

3 Fundamental Difficulties of Using EDI

There are several good reasons that companies may have for starting to use EDI. Sometimes, companies hope that this will result in an increased competitiveness (a recent study suggests however that this advantage, if it exists, will only be temporary [3]). More often, they want to use EDI for specific applications where savings are guaranteed to be significant. Yet, companies may also be forced into EDI, because their clients demand it, or because their competitors start using EDI and are successful with it. In any case, companies hesitate because switching to EDI is not an easy process.

3.1 Data Structures and Formats

It is difficult to exchange meaningful data between EDI application processes. One of the most fundamental reasons is that the processes we call EDI applications in this article (a consistent naming scheme or reference model is lacking for EDI) are in fact business management programs that have been developed for a specific purpose, without consideration for standards or other applications. These applications are therefore all different from one another. Moreover, the data formats and structures that they use are quite particular, and generally not suitable for communications.

Without a reference basis, it is very difficult for different companies to agree on something more than the kind of data that need to be exchanged. So companies look for appropriate standards, such as EDIFACT (Electronic Data Interchange For Administration, Commerce, and Transport¹), for suggestions concerning data elements and data structures [10, 11, 19, 20, 21]. Then, they use special programs, called EDI translators, to reformat their own data accordingly.

However, standards are still undergoing development and are sometimes difficult to interpret correctly. They cannot be implemented overnight, even when using translators. These are not magic programs; they can be difficult to use or have major limitations in what they can do. Changes to an EDI application to make it standard compatible cannot

¹ EDIFACT designates, in fact, a set of standards that are currently being developed by UNECE (United Nations, Economic Commission for Europe) in cooperation with ANSI X12; it covers: the syntax rules (ISO #9735), the data elements and their formats (EDED: EDIFACT Data Element Directory, *in development*), the message components (EDSD: EDIFACT Data Segment Directory, *in development*), and the messages (EDMD: EDIFACT Data Messages Directory, *in development*).

generally be limited to the translator; it is often necessary to write a special translation module to complement the translator, or to make significant changes in the application. Also, trading partners who are using different translators may discover that there are incompatibilities between them; care must be taken to ensure that no truncation of data or similar problems occur.

3.2 Applicability of Standard Messages

A more fundamental problem is that the data to be exchanged are very dependent on the nature of the business in which the companies are involved, and even on the administrative methods used by these companies.

Therefore, it is impossible for standards to describe messages that are treatable (i.e. not overly complex), and that meet all the business, administrative, and operative requirements of all companies. Universal standards can only provide a framework that helps corporate groups and individual companies design EDI messages. For example, EDIFACT messages, at least those which are called UNSMs (United Nations Standard Messages), are supersets of messages used in practice; they contain all possible pieces of information that may be required in almost any business scenario. Users must compare them with their business requirements in order to derive their own messages which might be, but are not necessarily, proper subsets of the UNSMs. Finding an agreement on a UNSM subset that will be functional, sufficient, and well understood, is not easy.

3.3 Legal Considerations

Using EDI instead of paper changes the legal context in which transactions take place. In fact, this new context is not clear at all, and it can be quite different from one country to another. In France, for example, only paper documents have a legal value. Other countries are more flexible, as they accept telex or computer data as legal evidence, provided some security provisions have been respected. Things naturally get worse when EDI is done over national borders. Also, computer and network security, as it is implemented today, is too weak to have a strong and definitive legal significance.

Companies tend therefore to use EDI only with partners that they can trust, after signing a specific contract with them. NORDIPRO, the Trade Facilitation Committee of the Nordic Countries, has published the UNCID rules (the Uniform Rules of Conduct for Interchange of Trade Data by Teletransmission [14]) which can serve as a reference to establish this EDI contract.

3.4 Communication Aspects of EDI

EDI standards are designed to be totally independent of the communication technology, whether it is based on open (OSI) or proprietary solutions; today, even tapes or telex are being used. EDI standard messages are self-contained, including all the necessary service elements, such as address indications, message number, password, etc.. Coding is based almost exclusively (EDIFACT level B syntax) or totally (level A syntax) on printable characters. It has been said, quite correctly, that OSI standards are intended to enable systems to interwork, while (current) EDI standards are intended to enable data to be interchanged without interworking [18].

In most cases, EDI communication is essentially a bulk transfer of printable character files. This does not sound complicated, but it is more easily said than done. Trading partners have to find communication methods which are effective, reliable, practical, and reusable for other purposes. This may be difficult or easy, depending on particular cases, but it is always an annoying problem for the users because it is generally not within the scope of their business.

The first users of EDI (a few large companies and national administrations) were happy to exchange very large amounts of data with only a few partners, making use of one of two simple methods: the physical transfer of magnetic tapes (or punched cards) or the use of leased lines. Nowadays, these methods are inadequate: the timeliness of communications has become more important; the size of the data to be exchanged has varied; and companies cooperate with more trading partners than before.

Using existing data communication networks, such as X.25 networks, is a good idea, and in effect, users take advantage of them whenever they are available at an acceptable cost. However, this is only part of the solution. Data

communication networks solve communication problems which are confined to the lower layers of the OSI model (up to layer 3 or 4). To allow different application programs running on different, heterogeneous, computers to exchange data, it is necessary to define and to implement protocols up to the application layer. Also, communication may need to take place over not only one, but several networks which do not necessarily run the same low level protocols. Therefore, there is a need for higher level protocols to cope with all these differences and associated difficulties.

Another problem, that has already appeared to be quite significant, is that most communication protocols, and in particular all low level protocols, are *synchronous*, i.e. both computers, sender and recipient, must be available at the same time for communication to take place. A sender may need several attempts to establish a session with a recipient computer, simply because this computer is overloaded by other requests, or is disconnected for backups and maintenance. For the sender, this communication approach is more cumbersome than using mail, and can be costly over long distances.

Today, in order to solve their communication problems, trading partners have to analyze their particular requirements and capabilities. After comparing the various possible solutions, they select one that is acceptable for them both.

3.5 Bilateral Agreements

Message design, resolution of legal requirements, communication means, and even message coding, are activities that can be handled essentially on a case by case basis. Companies are therefore very selective about how and where they start to use EDI: at first, they choose to use EDI with a small number of trading partners which account for a large percent of their commercial exchanges. They sign a document with them, generally called a bilateral EDI agreement, which covers all the questions mentioned above. Often, companies group themselves into sectorial associations and try to agree on a multilateral EDI agreement: such a document may lower or eliminate the need for further bilateral agreements.

As companies try to use EDI with more and more partners, sometimes outside of their main sectorial domain, they will be able to do so faster and more smoothly if they can reuse the same software and hardware equipment used with their other EDI partners. This is difficult to achieve because business requirements, practices, and methods vary from one sectorial domain to another, or from one country to another. However, there are no fundamental reasons that prevent companies from using the same coding techniques and the same communication methods for asynchronous EDI.

4 Favoured Communication Methods for EDI

In this paper, we intend to discuss how and why X.400 MHS can be used for *asynchronous* EDI. We present short term solutions which have a long term perspective. Nevertheless, today there is a widely accepted approach to EDI communications which is likely to remain important in the future: it consists in using VADS (Value Added Data Services) centres. We will first describe this well known approach in order to compare the use of X.400 MHS with it.

X.400 MHS and the VADS are clearly in competition with one another, but they are not incompatible. In fact, it is very likely that they will be integrated in the future. How well this will be done, however, is an important question that remains to be answered.

4.1 Value Added Data Services

Several companies, generally known as VADS (Value Added Data Services) companies, are taking advantage of their large computer centres to offer several services to EDI users, to help them cope with most EDI communication problems. Basic services are the renting of mailboxes and the conversion of protocols, this latter service being almost implicit. In fact, VADS simply give access to mailboxes through several communication protocols.

With VADS, EDI communication between partners becomes asynchronous. The sender simply establishes a connection to the VADS centre, which is always available, and submits messages which will be distributed by the VADS system to the addressees' mailboxes. Recipients can check and read the contents of their mailbox whenever

they want, or if they request it, they can be notified of any mail that they receive. VADS centres offer other additional services, such as reports on the status of expedited messages, logging, auditing, some security services, as well as the translation of syntaxes and formats of EDI messages.

The VADS role is even more important than it might appear at first glance. When using the services of a VADS company, a company sending an EDI message (e.g. an invoice or a purchase order) is confident that its message will be received and stored in its recipient's mailbox; it will then be the responsibility of the recipient company to read the contents of its mailbox. It is impossible, for example, for a recipient company to temporarily refuse to receive an invoice or an order by refusing communications or even shutting down a computer. When establishing their EDI bilateral agreement, trading partners can agree to consider the VADS company as a trusted third party, thereby simplifying some legal questions.

VADS companies solve the communication problems of their clients as long as communication is limited to within their system. So far, they have been reluctant to communicate with other competitive VADS systems, and even more with companies which are not clients of any VADS centre. Even if they agree in principle to do so, VADS companies find it difficult to establish tariffs that are both consistent and acceptable to their clients. Also, there are some services that are difficult to implement when more than one VADS center is involved in the communication: for example, the status indication (retrieved, not retrieved, etc.) of messages.

Until recently, VADS companies did not have to interconnect their systems, because EDI was confined to sectorial domains or national borders. This is no longer true, because EDI domain is enlarging constantly.

Moreover, another challenge that VADS companies must face today is the emergence of new universal standards in messages and communications (OSI, X.400). These standards, provided they are well accepted by EDI users, can lower the need of services that VADS companies currently offer. On the other hand, VADS companies may benefit from these standards, with solutions to technical problems, and with a new range of services to be offered. In any case, there will be an increase in the EDI traffic, and VADS companies could attract some of it.

4.2 The X.400 Message Handling System

It is well known and quite understandable that computer manufacturers are reluctant to implement and to support communication products that give a direct advantage to a competitor. They prefer to implement their own solutions or they choose to implement communication systems which are based on standard protocols, preferably those developed by the International Standards Organization (ISO). Users themselves have discovered that, if they intend not to be restricted in their choice of new computer equipment, they have to commit themselves to using standard protocols. For inter-company communications, this is even a necessity since communication takes place between all possible kinds of computers.

In 1984, ISO and CCITT introduced a universally applicable, logical communications structure which is now known as the Open Systems Interconnection (OSI, [9]). OSI is now serving as reference for the development of new communication protocols and services. At the same time, ISO and CCITT standardized a first version of a service situated at the application layer (the top level of the OSI structure)¹. This service, which is today essentially known under its CCITT appellation X.400 MHS (Message Handling System), or simply X.400, is based on a store-and-forward communication system [4]. In other words, X.400 can be seen as an *asynchronous* communication system. It is therefore of great interest to EDI users. Another advantage of X.400 is that it is specified up to the application layer: it is therefore relatively easy to design a simple interface between the X.400 software and the EDI application processes.

X.400 MHS was developed primarily for the purpose of supporting electronic mail and related services, but its design was made open to supporting other applications. Recognizing the growing importance of EDI, CCITT is currently working on an EDI extension to the X.400 series of recommendations [15, 16]. Products and services based on this

¹ X.400 has been updated in 1988. However, systems and services conformant to this new version will not replace current ones before several years from now.

new recommendations are expected to be available within a few years. However, EDI users do not have to wait until then; current X.400 products can be adapted to provide a reasonably good support to EDI communications.

4.2.1 Architecture

Figure 2 shows the architecture of the X.400 MHS. The most important component of X.400 is the MTS (Message Transfer System), which provides the store-and-forward communication. The MTS conveys a message submitted by one user, the originator, and subsequently delivers it to one or more users, the message's recipients. The MTS is a distributed system; it is composed of several MTAs (Message Transfer Agents) which cooperate among themselves using an application layer protocol that is known as P1.

An MTA is often linked to some other entities, the MTS users. An MTS user and its MTA can be located in different systems. In this case, the MTS user and the MTA interwork through a standard application layer protocol called P3. In the case where they are collocated, they interwork through a proprietary interface, based on the P3 protocol. Neither ISO nor CCITT standardize interfaces inside a system.

According to the 1984 version of the X.400 recommendations, MTS users are only AUs (Access Units) and UAs (User Agents). AUs are simply gateways to other communication systems, including telex, teletex, facsimile, and physical delivery. Like all gateways, AUs are extremely useful but provide limited functionality. Although they can potentially be used for EDI, AUs are not covered in this paper.

UAs are application processes that interact with the MTS to submit or receive messages on behalf of a single user. UAs are normally grouped into classes that are capable of offering a particular series of services. They interwork with one another through the MTS, using an application layer protocol specific to their class. The way a UA offers its services to its user is not specified in the X.400 standards. Actually, UAs may even provide other services than those which are standardized; for example, they can provide some mechanism to store and retrieve messages locally. In a UA implementation, it may be difficult to separate the code that implements the standard from the code that provides supplementary local functionality.

Until now, only one class of UAs has been standardized by ISO and CCITT, the class of IPM UAs (InterPersonal Messaging UAs). IPM UAs assist users in communicating with other IPM users, achieving a service that is globally referenced as the IPM Service. This service is essentially based on an application layer protocol known as P2, which is performed over the MTS by the UAs. That is, IPM UAs always insert structured data conforming to P2 in messages that they submit to the MTS. To differentiate these messages from all other X.400 messages, communications exchanged among IPM UAs (user messages and notifications) are called IP-messages.

According to X.400-1984, storage and retrieval of messages was always a local matter. There was no specification nor provision in the standard for something analog to a mailbox. However, it was clear that most UAs would provide such a functionality.

There are many situations where the architecture of X.400-1984 is appropriate (for example when a document storage and retrieval server already exists in an open system). However, there are other cases, particularly where PCs are involved, where this architecture is not suitable. This is mainly due to the fact that a UA must be continually available to receive incoming messages. To remove this constraint, ISO and CCITT have included the concept of the MS (Message-Store) in the 1988 version of X.400.

Inserted (optionally) between the MTS and a UA, the MS is a new entity which fits quite nicely in the MHS model, so well in fact that it can be easily incorporated in an 1984 system. Indeed, the MS is linked to the MTS via the P3 protocol, as are the independent UAs. The MS acts as a server for a single UA, with which it is linked by a new protocol, called P7. This protocol is never initiated by the MS. So, the UA which is its client can be switched off when it is not used. Moreover, P7 provides quite a few more services than P3 (namely selective message retrieval).

As the reader may already have noticed, the MS concept makes the X.400 MHS standards more confusing. This is due to the fact that a UA, which is an MS client, is not quite the same thing as an independent UA, although both kinds of UAs may provide the same functionality to an end-user. To get around this problem, the reader may find it useful to consider that an MS is always present (either the MS exists by itself, or it is included in the UA). Of course, a single UA may provide much less functionality, but seeing things that way is useful in many situations.

4.2.2 Public and Private Domains

The PTT administrations in all industrial countries are setting up national X.400 public networks, known in the standard as ADMDs (ADministration Management Domain), that will be interconnected. PTT administrations will also interconnect their ADMDs to their existing communication systems (i.e. telex, facsimile, and physical mail).

PTTs will transport x.400 messages for two kinds of clients: users who dispose of a PRMD (PRivate Management Domain), i.e. an internal electronic mail system; and users who are only using the PTT system. In the first category, users dispose of a computer system or network which runs at least one MTA. Users in the second category use a computer running a UA and possibly an MS, but no MTA, or they have solely a terminal and they rent a UA from the PTT. In technical terms, we can say that the first category of clients have P1 access, while the others have either P3 or P7 access, or a simple terminal access. In any case, these clients will generally be connected to the PTT system by an X.25 link, although other possibilities may exist in some countries.

A PRMD can be seen as the electronic equivalent of a company's internal mail system, but it is more than just that. A PRMD can communicate directly with adjacent PRMDs¹. Indeed, it is technically possible for a company to set up a national or international PRMD (possibly using the X.25 national networks) whose main function would be to interconnect small PRMDs. In this case, the restrictions that apply, if any, are more legal than technical.

The concept of PRMD is interesting for VADS companies, because it allows them to offer their services within the X.400 framework. VADS companies can set up their own PRMD and use the message-store concept to offer mailbox-services in a standard manner. In France, there is already an EDI service that uses this approach. Also, VADS companies may implement a proprietary message-store service and protocol within their PRMD. In doing so, they can open the X.400 world to companies which use proprietary communication solutions. Again, implementations based on this approach are already in existence today.

4.2.3 The Store-and-Forward Concept

X.400 is based on a store-and-forward concept up to the application layer. A message is transferred as a whole from one X.400 node to the next, where it can be stored for several hours if necessary. There is therefore no need to establish an end-to-end session between originator and recipient computers; sessions are set up one by one between adjacent X.400 nodes.

The X.400 network tries to deliver a message to its recipient within a specified time limit. If the message is not delivered (probably because the recipient's computer is not available), the MTS normally returns a non-delivery notification to the sender. This time limit is a function of the message priority; the F.400 series of recommendations, which specify the quality of the message handling service offered by an ADMD, indicates 4 hours for urgent messages, 24 hours for normal messages, and 36 hours for non-urgent ones.

4.2.4 Security of X.400

Users who own their own mailboxes must grant access to their computer to an ADMD, and possibly to several PRMDs, for message transfer. This should represent no serious security threats, for two reasons:

- ADMDs and PRMDs identify themselves through the exchange of passwords;
- the access which is granted is limited to a well-defined protocol which can only perform X.400 services; a remote PRMD therefore cannot directly access the operating system of the host computer, as would be the case with techniques based on remote job entry.

The X.400-1988 recommendations specify a new class of advanced security services that are based mainly on cryptographic techniques. These services, which include message confidentiality and digital signatures, will be invaluable to clarify legal questions within the context of EDI.

5 Standardization Work for EDI/X.400

More and more companies exchanging EDIFACT and other types of EDI messages use or wish to use communication systems based on the X.400 series of recommendations. Indeed, as we mentioned earlier, the universality of this pioneer OSI application layer standard, its world-wide acceptance, its flexibility, as well as its store-and-forward concept, make it a very suitable carrier for a large range of EDI communications.

Unfortunately, the development of EDIFACT and X.400 standards has been done in parallel without coordination between the standardization bodies. As a result, no special user agent class supporting EDI communications was

¹ This is explained in ISO documents but not in CCITT documents, the latter being mainly intended for the PTT administrations.

included in the original design. Current X.400 implementations have been designed for electronic mail. They can handle EDI messages, but they do not recognize them as such, and so they cannot do any automatic processing with them.

Several software vendors as well as some determined users, particularly in Europe, have modified existing X.400 implementations to make them more suitable for EDI. But, in the absence of any reference document or any coordination committee, these companies have developed various systems that are often incompatible with one another, defeating the purpose of using a standard such as X.400. This is particularly the case of implementations that arbitrarily make use of X.400 service elements to carry EDI communication parameters.

To improve this situation, the NIST (National Institute for Standards and Technology) in the United States and the CEC (Commission of the European Communities) in Europe have developed extensions to existing X.400 profiles which explain how the X.400 protocols should be used for EDI. Their guidelines are based on very different principles that reflect the different approaches to EDI communication in the U.S.A and in Europe. The CEC has ensured that its guidelines are compatible with those of the NIST through a simple gateway. On this point, it is important to realize that the CEC could not simply endorse the NIST guidelines, because most European EDI users of X.400 were heading in another direction, and would probably have continued to do so.

5.1 The NIST Guidelines: Making Direct Use of the MTS

Presently, X.400 can be seen as hierarchically structured into two levels: the interpersonal messaging service (IPMS) which defines electronic mail functions, and the message transfer system (MTS), which is a general system for transferring any kind of message.

In 1987, experts of the NIST and ANSI X12 analyzed the communication needs of American EDI users. They estimated that the IPMS was not appropriate for EDI, because the IPMS is a system for the exchange of relatively small messages, generally not confidential, between human users. On the other hand, EDI communication is the exchange of large, confidential messages between companies, or more precisely, between central EDI communication agents. *EDI messages*, also called *transaction sets*, are produced by application processes, translated into standard format, and arranged in *functional groups*, which are then directed to the central EDI communication agent. Then, the communication agent puts functional groups together into *interchanges*, and sends these to their recipients over various communication channels. Linking the EDI communication agent to an X.400 MTA presents no special difficulties. Therefore, the NIST concluded that X.400 should be used at the MTS level for EDI communication.

Since no EDI communications agent has been normalized by the CCITT nor the ISO, there is a subtle problem interfacing such a component directly with the message transfer service. In effect, the 1984 version of X.400 (which is the one in use today) specifies that the content type of an MTS envelope (which indicates the UA class for which the envelope content is intended) be simply an integer value; the problem is to decide on a unique integer value to be used for content types not defined by the CCITT nor the ISO¹. The NIST, having no authority to pick specific integer values for content types, had to use the value zero for EDI, even though this value indicates in fact an undefined content type. This will probably have no serious consequences. Nevertheless, as a result of this choice, the NIST solution has been dubbed *P0* by analogy to the P2 protocol (the only standard content type in use today), although there is no such thing as a P0 protocol. Realizing that it is effectively making use of the P1 protocol and nothing else, some experts prefer to be more precise, and call it *P1/0*.

It is not certain that all current X.400 implementations of the MTS can accept other content types than P2, or have a well defined interface, so it may be difficult for users to interface their EDI communications agent to it. However, an important group of X.400 system developers, united under the banner of the X.400 API Association, are currently working on a series of common interfaces to their systems. Their intention is to make it more easy and more attractive for users and third party software developers to implement communication solutions based on X.400 [12, 22]. Therefore, the work of the API association constitutes a very important complement to the NIST guidelines.

¹The direct use of the MTS for message contents other than content types specifically defined by the standards has been recognised by the CCITT and the ISO; in the 1988 version of X.400, content types can be indicated by object identifiers as well as by integer values.

5.2 The Situation in Europe

EDI communication in Europe is generally based on different principles than in the U.S.A. European users make a minimal use of functional groups; instead of multiplexing EDI messages through central EDI communications agents, they send them directly between final EDI applications. Concretely, this means that they make use of several simple EDI communication agents instead of a complex one. Therefore, European EDI users are looking at the problem of how to use X.400 with a very different point of view from that of the Americans.

It is interesting to note that, in the absence of any guidance, most if not all European pioneer companies that chose to use X.400, decided to use it at the IPMS level. In fact, these users often had very concrete and practical reasons to make such a choice. First, some of them had been using a proprietary electronic mail system as an EDI communication mechanism for some time. Having had a satisfactory experience with it, they found it logical to use X.400 in a similar way. Moreover, essentially for architectural reasons (gateways at the IPMS level, UAs being switched off from time to time inside their company, and so on), it was probably easier for them to migrate to an EDI communication system based on X.400 at the IPMS level than to a system based solely on the MTS.

Other companies decided to use X.400 at the IPMS level because they found it easier to implement an EDI interface that way. In the case of a lack of significant support from X.400 vendors, the idea was to modify an existing X.400 system at the outermost level, making as few changes as possible while maximizing software reuse. For example, the original user interface could be transformed into an EDI communication administrator interface and an application programming interface, while almost everything else would remain unchanged.

Other proponents for the use of X.400 at the IPMS level were the owners and the vendors of personal computers. They benefited from special solutions to get an X.400 access at the IPMS level (along the lines of the message-store concept), or were looking forward to them. Such solutions would not be immediately applicable if X.400 was to be used solely at the MTS level.

Finally, some European EDI users did not see EDI as being a completely automated transfer of structured data between applications. They thought that human intervention in the communication process was tolerable and sometimes even desirable. For them, there was simply no choice to be made.

5.2.1 The TEDIS Guidelines: Using the IPMS

The CEC, which has set up the TEDIS (Trade Electronic Data Interchange Systems) programme to promote and to coordinate the use of EDI in Europe, became alerted to the fact that many European EDI users were implementing X.400 based communication solutions without guidance nor coordination; as a result, they were making different choices for the use of X.400 service elements, such as the subject field, leading to potential incompatibilities between their systems. Another problem was that most implemented solutions were not compatible with the NIST guidelines, making communication between the U.S.A. and Europe very difficult.

During the summer of 1988, the CEC requested proposals for European guidelines on the use of X.400 for EDI; such guidelines would be applicable until an official recommendation is approved by CCITT. In autumn 1988, the CEC organized a meeting with all interested parties, including active users, to determine an official European position. The meeting clearly showed that an overwhelming majority of users were favouring an IPMS based solution. However, it was clear to all participants that it would be very difficult to obtain further agreement on the use of IPMS service elements. Moreover, American delegates, as well as some European users, were concerned that a European solution based on the IPMS would not be compatible with the NIST guidelines. They expressed the wish that Europeans avoid any misuse of IPMS service elements for EDI purposes.

By the end of the meeting, the CEC was able to establish guidelines, thereafter called the TEDIS guidelines [8], which were acceptable to all parties. The use of the IPMS for EDI would be recommended in Europe, but the use of any IPMS (P2) service elements would be discouraged. In this way, EDI communications between Europe and the U.S.A. could take place through a simple gateway. American delegates were therefore satisfied because this was a major improvement on the present situation. The Europeans felt the same because they wanted to use the IPMS mainly for architectural reasons, and generally not for the extra service elements available with it.

The TEDIS guidelines are quite subtle. A confusing fact about them is that they are sometimes dubbed as the *P2 approach*, by analogy to the NIST guidelines which have been dubbed the *P0 approach*. This name is obviously not an ideal choice since the TEDIS guidelines specifically recommend not to take advantage of the services provided by P2. For reasons explained above, it would be more appropriate to speak of the *IPMS approach*.

5.2.2 Demonstrations at CeBit

Only a few months after the meeting convened by the CEC, a demonstration on the theme "OSI and EDI" was held at the CeBit Fair in Hannover. Participants included most if not all major computer and communication software vendors. This was the first occasion to see what kind of X.400 products would be available for EDI in Europe. However, it must be said that this demonstration was organised on very short notice. No strong conclusions should be drawn from it.

The commitment of participants to support EDI in one way or another was very positive. Not surprisingly, all vendors who demonstrated an X.400 solution for EDI came with spin-offs of their original products. Most made minimum changes to their original electronic mail software so that it could automatically handle EDI interchanges. TEDIS guidelines were respected, with one exception: the subject field of the IP-message was used to convey an indication related to the interchange.

The "OSI and EDI" demonstration is to be reconvened at CeBit this year. Participants will probably bring improved versions of the products they demonstrated last year. It will be interesting to see what progress has been made in one year, and whether the TEDIS guidelines are fully respected this time.

5.2.3 Using X.400 for EDI in Europe

Due to the limited demand and also due to the interim nature of the TEDIS guidelines, it is likely that vendors are not ready to do much more than what they showed at CeBit 1989. Interested users will have to negotiate with them for special solutions to their problem, or they will have to write a specific EDI interface themselves (if possible). In that case, they may benefit from the work of the X.400 API Association, although this group clearly gives a higher priority to interfaces at the MTS level than to interfaces at the IPMS level.

Another difficulty that European EDI users will have to face is that European ADMDs are not yet fully interconnected. Since EDI is often used across national borders, they will have to establish PRMD to PRMD direct connections, or to rent the services of a VADS company.

For the next two or three years, using X.400 for EDI will still present some problems. In any case, companies wanting to use EDI must be determined if they intend to succeed.

5.3 New CCITT recommendations

At the end of the 1988 Study Period, the CCITT set up a special Interim Rapporteur Group (IRG) to work on *X.400 support for EDI*.

Exceptionally, participation at IRG meetings was also open to non-CCITT members. As a result there was a large turnout of participants, about 60 persons per meeting, representing not only PTT administrations and computer manufacturers, but also EDI standards organisations (ANSI X.12, UK SITPRO, and United Nations Economic Commission for Europe), VADS providers, and EDI users (in particular, representatives from the EDI users associations EDIFICE and CEFIC). Because of the close collaboration between CCITT and the EDI community, there is good reason to think that the recommendation produced by IRG will be well accepted.

The most important aspects of the recommendation, that have been outlined during the IRG meetings held until now [16,6,7], are listed below:

- ◊ IRG took quite a conservative approach regarding the most fundamental issues. This approach resulted in a standard which will be a significant evolution from the use of X.400 according to current guidelines, but

certainly no revolution. For instance, IRG agreed to consider essentially the store-and-forward exchange of trade data meeting the EDIFACT, ANSI X12, and UN/TDI standards, as they are defined today. However, IRG also agreed to keep the standard open ended where possible to accomodate future information types compatible with the service elements included in the protocols.

- ◇ IRG did consider the possibility of extending the IPMS to support EDI, but it strongly rejected this approach, mainly because EDI requirements were seen as being essentially different from those of interpersonal messaging. Also, most EDI users clearly expressed their preference that the two services be separated. Nevertheless, IRG did notice that there is also much commonality between the two services.
- ◇ IRG designed an EDI Messaging System (EDIMS) which is equivalent to the current IPMS; the use of the MTS for EDI is basically the same as it is for IPM, and there is also an EDI UA and an optional EDI MS in the system. Therefore, the architectural advantages of the IPMS, that were deemed important by European EDI users, have been retained.
- ◇ IRG also attempted to design a protocol which would be as similar as possible to the P2 protocol. At this level, one of the most important contributions of the new protocol is a service element which will convey all essential attributes of an EDI interchange. These typically correspond to the information that can be found in the EDIFACT interchange header today. However, the standard will not give any indication regarding this mapping, so protocol users will have the possibility to send some other EDI content types than just standard interchanges.
- ◇ There will be at most one EDI interchange within a single X.400 EDI-message (the EDI equivalent of an IP-message). It will be placed in the first body part. Additional body parts will be permitted; they will carry information supplementing that of the interchange, for example, engineering drawings or specifications. This is a simple but significant improvement over current solutions. Furthermore, a cross-referencing mechanism will make it possible for the interchange to reference these additional body parts, whether they are part of the same message, or whether they belong to another X.400 message (which may or may not be an EDI-message).
- ◇ An area of the IPM protocol that needed complete reconsideration for EDI was the Receipt Notifications. EDI users did not at all like the way these were used in the IPM service. They preferred to call them Responsibility Notifications, to stress their significance in EDI, and to make it clear that the recipient *must* generate such a notification when it is requested to do so. Another critical question in this area was the interrelation between Responsibility Notifications and the auto-forwarding mechanism of the message-store. In the IPMS, the message-store generates automatically a Non-Receipt Notification when it performs auto-forwarding; EDI users have clearly indicated that such a practice would not be acceptable. The solution that has been retained will provide true end-to-end Responsibility Notifications between the originator and the final recipient.

The NIST and TEDIS guidelines have been produced for the interim period until a CCITT recommendation is available. This will be the case by the end of this year. In practice, products and services will not be available before two or three years. Because the NIST and TEDIS guidelines were defined independently of the CCITT, the new recommendation will not specify how to interwork between the EDIMS and the two current solutions. However, it seems rather likely that the NIST in the U.S.A, and one of its counterparts in Europe, will produce such specifications.

6 Conclusions

The potential benefits of EDI can represent as much as 7% of shipped goods, but for EDI benefits to be effective, companies need to have EDI exchanges with a significant proportion of their trading partners, whatever their location and their computer equipment may be. This remains a distant goal, in particular because international standards are only beginning to be available for EDI. However, for a lot of companies, it is a good idea to start using EDI now. When doing this, care must be taken to ensure that solutions that work today will remain appropriate tomorrow. In particular, it is very important to use international standards whenever they are adequate. Most EDI experts see in EDIFACT the unique international standard for the specification and the coding of commercial documents. More and more of them realize that X.400 will become the basic method for transporting EDI messages. It is true that the new CCITT standard is not ready yet, and therefore products and services implementing it are several years down the road.

On the other hand, there are interim strategies which are applicable in Europe and in the U.S.A. Looking at the present developments, it is quite clear that the CCITT standard will be an evolution of these schemes rather than a revolution. Therefore, it is quite reasonable to claim that today's X.400 based implementations will be closer to future EDI communication standards than anything else.

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