

Infrastructural Technologies to Enable Electronic Commerce

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Summary

We discuss some frequently neglected issues relating to corporate communication infrastructures. The perception of services like e-mail as infrastructural -- and thus less interesting -- lies at the heart of corporate ignorance regarding their strategic capabilities. This may cause major problems in the near future, when inadequate communication infrastructures may hamper the successful uptake of strategically vital applications. Finally, we make some suggestions as to how this misconception can be corrected.

Keywords: *E-mail, communication infrastructure, adoption, implementation.*

1 Introduction and Motivation

The view that corporate IT architectures to support electronic commerce (EC) should be based on business processes and organisational requirements, rather than driven by technological developments, is now widely accepted. Unfortunately, however, the fact that such architectures are comprised of both the actual application plus a supporting communication infrastructure is typically ignored. In almost all cases, business processes and organisational requirements only refer to an application (e.g. Electronic Data Interchange, EDI), or maybe even just an application area (e.g. EC), whilst meaningful requirements for the underlying infrastructure are not normally defined. The consequence of this is that companies run the risk of eventually being stranded with a communication infrastructure which is incapable of supporting the range of applications in place.

Electronic Commerce is enabled by a number of technologies including e.g. EFT (Electronic Funds Transfer) and EDI, which themselves use services provided by e.g. electronic mail, which in turn relies on the underlying transport network (see Figure 1).

Companies wishing to introduce a new application need to identify carefully the additional requirements this application imposes on the communication infrastructure, and make sure that they can be adequately dealt with. It is important to note that this holds for all infrastructure levels. Thus far, it appears that such requirements are not normally defined. This observation (as well as most others reported in here) is based on a case study we conducted into the introduction, diffusion and utilisation of e-mail systems in large, internationally operating corporations.

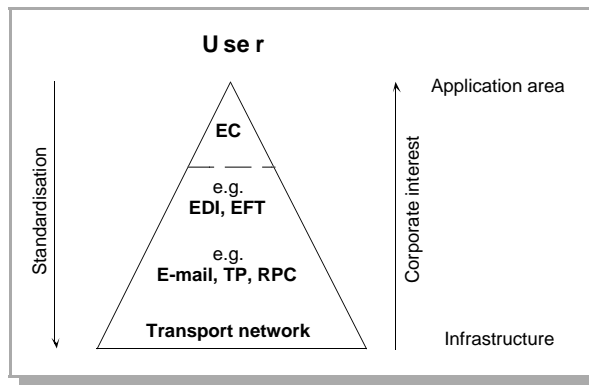


Figure 1: The infrastructure hierarchy

If standards-based EDI services are to be used (as opposed to the proprietary systems still widely employed today), X.400-compliant e-mail systems are typically the underlying carrier of choice (this holds at least for Europe). Thus, a suitable implementation of the e-mail system is a crucial contributor to the successful uptake of EDI. This holds particularly as markets, and thus business relations, become increasingly global, thereby making standards-based solutions a sine-qua-non. It appears from our studies, however, that for most large corporate users e-mail has until very recently served as little else than a convenient means for interpersonal communication (Jakobs et al 1996). Whilst this finding provides as an explanation for the absence of detailed technical requirements on the services -- the specifications of today's e-mail systems provide for ample functionality for this comparably simple application -- it is interesting to look at the reasons behind this phenomenon. It might reasonably be expected that after years of service utilisation, at least large, global organisations would have moved beyond this simple use, and employ e-mail in a more sophisticated way. In particular, it is reasonable to assume that the crucial role of e-mail as an enabling technology for EC applications would have been realised. How can it be that even technically advanced organisations, operating on an international scale (and thus being prime customers of sophisticated communication services), and after long years of usage, still have not realised -- let alone exploited -- the full potential of e-mail? This situation is all the more surprising if we consider that over the last ten years, four crucial business trends have resulted in a dramatically increased need for seamless global communication:

- **Internationalisation**
Moving into new markets requires adaptation to the respective dominant local system (as e.g. X.400 in Europe and the Internet in the US).
- **Integration**
Companies are merging or acquired, with a very high likelihood of resulting completely heterogeneous information technology (IT) and communication environments.
- **Cooperation**
The degree of cooperation even between possible competitors is increasing, again yielding the need for reliably working inter-company communication services.

- **‘Virtualisation’**

Virtual enterprises, i.e. temporary joint ventures of different departments or companies to achieve a certain, rather short-term goal are becoming increasingly popular.

It might be thought that for the business community each of these trends alone would justify an urgent need for globally working communication services, enabling seamless communication both internally between different groups or departments and externally with business partners and customers. One of the major recent developments in the IT sector does indeed reflect these trends: the move from proprietary e-mail systems -- almost exclusively employed until about the early eighties -- towards ‘open’ systems -- i.e. TCP/IP or OSI-based communication networks in general, and e-mail services in particular. In fact, these observations make the situation even more baffling: if organisations have realised the importance of open, standards based communication, why is its potential still not fully exploited?

In order to shed more light on this puzzling situation, we examined the current state of e-mail exploitation in organisations, and the underlying typical history and development of corporate e-mail systems. The degree of e-mail usage, the sophistication of mail-enabled applications in use, and corporations’ judgements regarding the strategic importance of e-mail provided valuable insight as to why no more detailed requirements are available.

We argue in this paper the case for greater corporate appreciation of infrastructure technologies. Approaching the issue from the perspective of innovation and diffusion theory, Section two will first outline the typical development of a major component of a corporate communication infrastructure -- e-mail. Section three will provide a brief outline of the survey methodology. Subsequently, the notion of ‘infrastructural’ and ‘business relevant’ technologies, respectively, will be introduced in Section four. Based on these observations we will explain (in Section five) how and why the corporate perception of a service as being ‘infrastructural’ has severely hampered its development and limited its usefulness and usability. Finally, in Section six, we will discuss what can be done to improve this situation.

2 Methodology -- A Brief Outline

The principle investigative technique employed was a survey of corporate IT users. The goal of the survey was to compile a number of qualitative studies, rather than to yield statistically significant data. The reason for this choice was that the accessibility of the prospective respondents was deemed far too low to hold the prospect of obtaining more than a (comparably small) number of case studies.

The chosen approach has a number of consequences for the investigation, and the subsequent data analysis. For one, given the small sample size, and the qualitative goal of the research, there was little scope for any statistical analysis of the data. Moreover, the sampling strategy could be made extremely simple; the sample frame was established by large, international members of international messaging associations. It was assumed that large companies are more likely to be interested in messaging-related issues, as they have an urgent need of seamless global information interchange than e.g. companies operating only within a national or

even local environment. It was also felt that membership in such associations expresses a higher than average degree of interest in the subject. The individual prospective interviewees were senior members of corporate IT divisions, and almost all of them were responsible for the respective corporate e-mail system. These were considered the most reasonable criteria since they guaranteed adequate technical and organisational knowledge on the part of the respondents.

The nature of the information sought (as discussed above) had a major impact on the design of the questionnaire. Thankfully, by and large it made life easier. For example, the ordering of questions was not that much an issue. Whilst obviously a certain logical structure was necessary (e.g. to avoid switching back and forth between subjects), it did not really matter whether or not questions were answered in the same order they were put. Moreover, the fact that no statistical analysis had to be done rendered subsequent coding unnecessary. Rather, the underlying guiding principle of the questionnaire was to convey as little bias as possible, as it was felt that unanticipated answers were most likely to occur. Taken together, these characteristics suggested the use of open-ended questions.

There appears to be a general agreement in the literature that open questions should be used sparsely (Hoinville 1989). The disadvantages of both open and closed questions can be summarised as follows (adapted from (Oppenheim 1992)):

Open questions	Closed questions
Time-consuming	Loss of spontaneous response
Costly of interviewer time	Bias in answer categories
Potentially unreliable coding	Sometimes too crude
Responding requires more effort	May irritate respondent

Table 1: Disadvantages of Open and Closed Questions

In this case, the relevant disadvantages associated with open questions boil down to 'time consuming'. Whilst this is an issue, and was in fact commented on negatively by some respondents, it was felt that this was outweighed by the benefit of obtaining unbiased information. Accordingly, only open questions were put in the questionnaires.

The questionnaire was made up of four parts, entitled 'general background', 'e-mail', 'directory', and 'standardisation'; the numbers of questions per part were three, twenty, fourteen and twelve, respectively. The relevant topics addressed included:

- general expectations of, and experiences with electronic messaging services,
- introduction strategies,
- envisaged or planned future developments,
- functional shortcomings of the systems used, if any, and how they were overcome, if at all,

Identical questionnaires were both mailed and used as the basis for the face-to-face interviews. This enabled a common analysis of the obtained information.

The nature of the topics to be discussed and the characteristics of the interviewees (i.e. typically very knowledgeable but extremely busy IT-professionals and managers) lent themselves to conducting only a comparatively small number of in-depth interviews. Semi-structured depth interviews were employed, i.e. a catalogue of open ended questions served as a guideline through the interviews. In-depth interviews allow a discussion to run more freely, and to address issues that rise spontaneously, or to omit topics that may be irrelevant in particular cases. This part of the survey comprised ten face-to-face interviews with representatives of companies from very different sectors, including (but not limited to) finance, information brokering, transport, and petro-chemicals, all headquartered in London and its vicinity.

Doing face-to-face interviews is a costly exercise in terms of both time and money. Therefore, and true to the motto 'practice what you preach' they were complemented by questionnaires being distributed via e-mail to corporate representatives. As for the face-to-face interviews, e-mail was used to establish the initial contact. A total of twenty responses from corporate representatives were received, representing a response rate of 4 %.

3 The Typical Pattern of Introduction and Diffusion of E-Mail

The results of the survey study suggest that large, international enterprises do not normally make top-down, strategic decisions about messaging services from the very outset of their introduction. Typically, we found that decisions were initially made at departmental or site level. The result of this was that the IT environments in the case study organisations, particularly (but not only) messaging systems, were generally very heterogeneous.

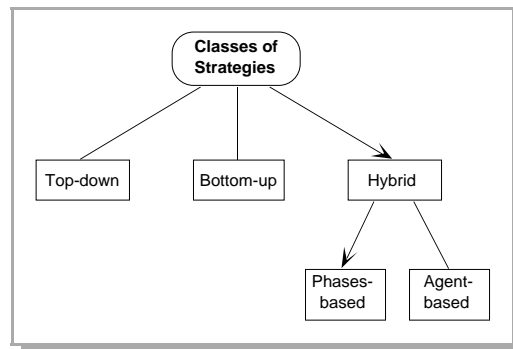


Figure 2: Classes of Introduction Strategies

Figure 2 shows the different development paths identified in the case studies. Only rarely was there evidence of a top-down strategy being followed throughout adoption and development (Jakobs et al 1996). The survey shows that it were either the smaller organisations, or particularly those that were 'born' into the Information Age which adopted this approach, often initiated by a top executive. In fact, in most cases a hybrid strategy could be observed, with a distributed and largely uncontrolled bottom-up phase eventually being succeeded by a centrally-led top-down phase. No examples of a pure bottom-up strategy were found, a fact that may most likely be attributed to the massive technical incompatibilities this

approach is bound to produce, and which can only be overcome through centrally coordinated counter measures

The prevailing adoption and diffusion patterns found are characterised by a bottom-up adoption and top-down development. Four different stages of the overall implementation and diffusion process may be identified: (1) introduction, (2) interconnection, (3) interoperation, and (4) integration:

(1) Introduction. In classical bottom-up fashion, a group of employees obtain a messaging tool. This happens, for instance, to fulfil a specific work requirement, or bundled in with other software. The new service soon becomes popular. Slowly, mainly by word of mouth, information about benefits provided spread throughout the department.

The number of users increases steadily, though still within the department or site, rather than at the organisational level. However, at the same time very similar developments take place at many sites, resulting in an extremely heterogeneous environment. The conditions potentially now exist to justify the pursuit of a top-down strategy to e-mail service development. In technical terms, this stage may be characterised by a variety of local systems, partly interconnected through point-to-point gateways.

(2) Interconnection. Users now recognise the need for interconnection as they experience the problems of the incompatibilities between the patchwork of systems adopted at different sites. In some cases, there are more than ten different mail systems within one single organisation. The degradation of organisation-wide communication quality is severe and often costly and frustrating for users. Thus, the case for following a central, top-down development strategy as a solution to these problems is now very strong. Attempts to institute a top-down development strategy begin: a central entity takes over and tries to integrate the different services with management backing. At the end of this stage the typical environment comprises of a (still considerable) number of local systems interconnected via a backbone.

(3) Interoperation. This stage, which many of the case study organisations are currently pursuing, is a continuation of the top-down development strategy, and is characterised by the introduction of a uniform local e-mail environment (e.g. MS-Mail or cc:Mail), interconnected through a messaging backbone (typically an X.400-based system or the Internet), which also offers access to the respective other e-mail world (i.e. the Internet or X.400). Completion of this step means that a (more or less) homogeneous service will be available for most, if not all, users, and that the number of different gateways will be minimised.

(4) Integration. Whilst thus far the single stages occurred virtually sequential over time, this stage seems to overlap in part with the previous ones, in that mail-enabled applications are used over a still rather heterogeneous underlying e-mail infrastructure. However, the major characteristic of this stage, which makes it stand out from the others and, indeed, defines it, is the integration of e-mail into strategic processes and its recognition as a strategic corporate tool. Thus far, only three of the case study organisations (i.e. less than one out of four) have partly progressed to this stage, in that they consider e-mail as being mission critical, as a strategic tool in its own right, and as an enabler of strategic applications (after more than ten years of usage!).

Thus far, the fourth phase has been reached only by very few companies; most are still stuck in phases (2) or (3). E-mail has almost exclusively been used for interpersonal communication in most companies (apart from maybe scheduling and calendaring, which have been around for a while). Only recently have more sophisticated uses of the service got off the ground (including predominantly EDI/EC), and early adopter companies have been looking closely at other e-mail enabled applications for some time. A more detailed discussion of the single phases can be found in (Jakobs et al 1996).

4 The Two Categories of Technology

A remarkably indifferent attitude regarding corporate e-mail has been demonstrated by most companies. This comes as some surprise especially since a massive body of literature exists on the diffusion and management of innovations, providing guidelines on how to introduce, utilise and manage corporate IT, as well as the organisational changes potentially induced by IT systems (Hammer and Champy 1993, Martin 1994).

Large organisations deploy technology in very different contexts for very different purposes. This holds particularly for information technology. IT artifacts can be found on plant floors, in R&D labs, and on secretaries' desktops; the different purposes they serve include production automation, number-crunching, and accountancy. Despite these different application areas, at a very general level IT artifacts may be categorised either 'business relevant' or 'infrastructural'. A car manufacturer's robot may serve as a representative of the former, a secretary's fax machine as a typical example of the latter. In particular, a company's communication system (e.g. the internal telephone network, or the corporate e-mail system) is in many cases considered as being infrastructural technology.

In terms of innovation theory, the major distinction between the two categories is their different degree of exposure to context-specific requirements. Business relevant systems are very much shaped by the particular environment within which they are deployed. In contrast, infrastructural technology will not vary too much between contexts. Likewise, we can observe that typically business relevant systems are useful only for users within a certain context. That is, an EDI system for, say, invoice processing may be useful only for people within the accounting department, whereas the underlying infrastructural e-mail system can be put to good use by many other users in different departments as well.

A further characteristic of infrastructural systems is the fact that they are not, or only to a very small extent, integrated into business processes within most companies. Figure 3 attempts to illustrate the distinction between 'infrastructural' and 'business relevant' (IT) technologies. Figure 3a shows how an organisation's IT infrastructure and its business relevant applications operating on top of it are typically separated; in most cases they have been developed independently. Yet, the infrastructure should be transparent for the application and the user by offering both the functionality and the performance necessary to make distributed or remote applications appear to be installed locally. It should also extend across organisational boundaries. This situation is shown in Figure 3b.

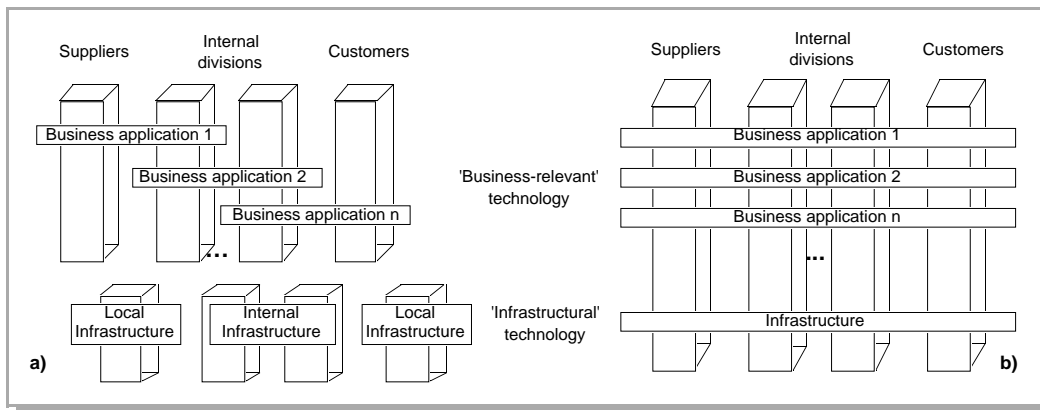


Figure 3: 'Business relevant' and 'infrastructural' technology

(based on (Benjamin & Levinson 1993))

a) Typical situation today - separation of, and mismatch between, infrastructure and applications

b) Ideal situation - integration of common infrastructure and applications

5 Obstacles to an Optimal Deployment of E-Mail

Which technological systems are actually considered as 'business relevant' by a company very much depends on the respective organisation's commercial interests. Accordingly, this will vary between companies; a car manufacturer, for example, may look to robots or systems for Computer Integrated Manufacturing (CIM), a publisher may be interested in Desktop Publishing equipment, and an innovative bottling line might attract a brewer. In particular, a system considered by one company as being 'business relevant' may well have 'infrastructural' status for another, a phenomenon that may, for example, be observed in the case of e-mail where perceptions regarding its business value differ between firms.

For each company technologies that relate to its core business -- and its core competence -- will naturally attract most interest, particularly if they hold the prospect of a quantifiable return on investment.

Very specific requirements and processes are most likely to be found primarily in the areas of a company's core business interests. These, in turn, stand in the way of a straightforward installation of a system. It is here where long-standing, time-honoured traditions characterise the environment, and where technical systems as well as production and business processes have been designed to optimally meet the demands of their specific environment. A new business relevant system to be implemented here will have to be customised to a similar degree as have been the other artifacts in this environment. In contrast, infrastructural technologies are far less context sensitive -- the telephone network and interpersonal mail systems, for example, are roughly equally useful for all users, irrespective of their specific technical and organisational environments. Thus, their implementation will only occasionally be influenced by environmental particularities.

The case studies have also shown that only those few companies which consider e-mail as a strategic tool, i.e. as 'business relevant', are prepared to implement a system that really meets their needs. This situation is highlighted by the

representative of one of these companies, who remarked that his organisation frequently had to build its own innovator level tools to achieve the desired functionality because of inadequate products. In contrast, the case studies also revealed that where an e-mail system has not been considered as 'business relevant', it typically was a matter of buying it off-the-shelf.

The need in particular to quantify the corporate benefits to be gained in several cases hampered attempts to upgrade corporate e-mail systems, which are widely considered as part of the 'infrastructure'. Firms invest where they perceive they will get benefit. However, their perceptions are not necessarily based on rational calculation. In the context of incomplete information -- which must be assumed here - we see that decisions are shaped by other factors -- 'fashion trends' and media hype play a role too (Williams 1997). Accordingly, new fancy applications are likely to receive more interest than 'boring' infrastructure technologies. Thus, investments in this area are hard to justify as they will yield largely indirect or intangible benefits. Indeed, most companies represented in the case studies adopted a very reactive approach towards infrastructural systems. That is, although at some stage infrastructural technology may well have been enhanced to meet identified new requirements, in a vast majority of cases this only happened once the situation had become intolerable (e.g. through an unacceptable percentage of lost messages).

Another central dilemma is associated with the organisational implementation of IT today, and concerns the relationship between the central and the local. On the one hand, the vision of the strategic application of IT advanced, for example, by proponents of Business Process Re-engineering (Hammer and Champy 1993), implies a centrally planned, top-down design and implementation of systems coupled to a radical transformation of organisational practice. Our case studies have shown that this approach has not normally been applied to infrastructural systems such as e-mail. On the other hand, research into IT implementations has revealed the importance of bottom-up strategies allied to local individual and collective learning processes in which technical potential is explored and fitted to the specific current and emerging requirements of groups of organisational end-user (Procter et al 1996). This approach could indeed be observed in most of the case study companies. However, we have also seen that such a heterogeneous approach remains problematic in relation to distributed IT systems, which exhibit strong network externalities, i.e. where the value for each user of being on the network increases with every new player joining the network. For example, if different local systems are incompatible, this will limit the benefits available from using the system.

Thus, two kinds of barriers to successful implementation are particularly important for distributed IT systems such as electronic messaging services. The one most commonly recognised is at the technical level of interoperability, where differences between various proprietary solutions or different generations of technology may mean that systems cannot interoperate or that some functions cannot be shared. Considerable corporate resources are required to overcome the almost purely technical problems. This leaves little, if any resources to take a more strategic view and to fully exploit e-mail's potential, which is well beyond interpersonal communication. That is, solving 'tactical', day-to-day problems takes precedence over long term, 'strategic' thinking.

Another, potentially even more significant barrier in terms of the cost and effort needed to overcome it arises from the commitment of end-users to their own

locally-chosen systems -- which may represent a substantial investment made by large numbers of people to learning how to use a system and to apply its functionality to their working activities. This may result, for example, in a reluctance on the part of some end-users to comply with the imposition of organisation-wide, standardised services. Eventually, this may even lead to a whole system being unused.

6 Final Remarks and Conclusions

The vast majority of companies in our investigation share a common past in terms of e-mail implementation. They typically experienced a distributed user-led bottom-up approach resulting in a variety of different messaging systems, that at some point had to be integrated through a centrally designed and implemented backbone network. This happened around the mid to late eighties. From then on, e-mail implementation has been under corporate control and management, and further developments have been directed by central IT or IS divisions.

The dilemma between centralised, top-down and distributed, bottom-up strategies for system implementation is perhaps unavoidable in the attempts within very large, multi-divisional organisations to employ new and evolving technologies. For instance, departments and other sub-units are positioning themselves closer to their information resources in an attempt to circumvent a central IS division. As a result departments hope to minimise coordination costs between supplier (central IS division) and user (themselves) of IT. Moreover, with IT increasingly being perceived as easy to use even for non-specialists, and with hardware prices dropping steadily, inclination will rise on the side of departmental managers to have their own staff design and develop tailor-made applications. One reported consequence of this development is a shift in the primary function of the central IT division from systems design and development to systems integration, and from the role of developer to that of advisor (Clark 1992). This is precisely what could be observed in our case study companies, where integration of heterogeneous e-mail systems had been the major task of the central IT departments.

Indeed, characteristics of the recent trend of end-user computing to a considerable degree resemble the situation that arose during the first phase of the e-mail introduction process. Whilst this approach is perfectly valid on the purely local scale, it does not take into account company-wide implications, which may indeed not be foreseeable at all at the time of implementation. In consequence, problems in terms of incompatibility and heterogeneity are likely to occur eventually at the corporate level. If and when this happens, central IT will be called upon for systems integration (Dodson 1996). Even if this were the accepted major task for a central IT department, early planning, issuing of guidelines, and requiring use of standardised components from the early stages on, which would only marginally interfere with the single departments' freedom of choice, could help avoid a lot of problems later. Against this background, insights gained especially from studies of introduction strategies of interactive services (such as e-mail) -- and the subsequent development -- may attain additional relevance.

While extra problems at the corporate level are likely to surface through the various forms of end-user computing, measures to limit experimentation with new technical alternatives to centralised functions would act as a barrier to innovation by reducing the scope for individual and organisational learning. This is, for instance,

one of the reasons why large bureaucracies in public administration and financial services were much slower than e.g. manufacturing organisations in successfully adopting distributed computing (Adler 1991). Management responses to end-user computing have been characterised variously as 'monopolist', 'laissez-faire' and 'managed free economy' (Gerrity and Rockart 1986). The evidence of our case studies points to the apparent domination of laissez-faire strategies for e-mail service adoption which, as we have seen, leads to major problems once organisations are forced to grasp the nettle of interoperability and system incompatibilities.

Of the alternatives, a better strategy than the monopolist approach of suppressing locally-generated innovation, might be to develop policies that cater for it, and allow it to be fostered within a more overarching strategy. An example might be the agent-based strategy identified in the case studies, where seemingly local innovations were pushed and, in fact, guided through a central entity. This approach was considered highly successful by those in charge (Jakobs and Lenssen 1994). Similar strategies involving 'change agents' are also known from the literature (Rogers 1995).

In some way, the corporate assessment of e-mail as an infrastructural technology, and the distributed bottom-up approach are mutually dependent, and both further extended the implementation process. Low priority due to its perceived infrastructural nature at least contributed to the lack of central involvement and guidance, which in turn fostered the emergence of an extremely heterogeneous environment comprising of incompatible messaging islands. Likewise, the surprising lack of more sophisticated functional requirements can be attributed to the apparent domination of laissez-faire strategies for e-mail service adoption which, as we have seen, leads to major problems once organisations are forced to do something about interoperability, incompatibilities, and system integration.

However, more specific requirements are likely to surface once a hitherto infrastructural system or service has been 'elevated' to 'business relevant' status. As leading edge users have at last recognised e-mail's strategic potential -- and are acting accordingly -- it may be expected that this is going to happen on a wider basis not too far from now. Once this has happened, e-mail too needs to be integrated into the technical and organisational environment, with its potentially very specific characteristics and requirements. Such problems could be minimised by an early and gradual integration.

Our findings also suggest that, irrespective of a company's core business, it appears that the perceived strategic importance of an IT system is the yardstick by which a company's willingness to start its own coordinated development activities has to be measured -- i.e. whether it is classified as business relevant or 'infrastructural'. Accordingly, a specific e-mail strategy requires the recognition of e-mail as a strategic service in the first place. Neglecting the crucial role of an adequate infrastructure has in many cases already led to an environment suffering from the fact that investment in infrastructure technology has been given low priority (Benjamin and Levinson 1993). Particularly in the field of electronic commerce, companies should try and avoid making the same mistakes again.

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