

Enterprise-Level Groupware Choices: Evaluating Lotus Notes and Intranet-Based Solutions

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Abstract. This paper considers collaborative software at the enterprise level, specifically Lotus Notes and alternatives which use Intranet-based (World Wide Web) technologies. We examine the strategic reasons, both short-term and long-term, motivating firms' choices in the decision phase and organizational issues in the implementation phase in three exploratory case studies. We review prior coordination technology literature to show that our focus on the decision faced by senior management of which groupware system to implement is a useful and novel perspective to pursue. We argue that this choice, and its consequences, is of crucial importance to the firm. To understand more fully the nature of the decision, we consider a thematic pair of related issues: Internet standards and interoperability. Why are so-called 'Open Systems' a major factor to some firms and not important to others? Why is the proprietary nature of Lotus Notes a stumbling block to some firms and a strategic advantage to others? We explore enterprise-level groupware expectations and requirements in our case studies to address these interesting questions. The final section focuses on predicting change to understand when an organization might reverse its initial enterprise-wide collaborative strategy.

Key words: Enterprise-level groupware, Lotus Notes, Intranet, World Wide Web, standards, interoperability

1. Introduction

This discussion focuses on collaborative software, or groupware, at the enterprise level. Formal definitions of the term groupware often include the notion of a shared white space for shared editing or doodling, but we will use a simpler definition in our discussion: 'software that helps groups of people communicate electronically' (Goldberg, 1994). The growth in firm-wide groupware, as distinguished from software products confined to a single department, can be attributed to the general trends of increasing cycle time pressures, the globalization of business, leveraging knowledge across place and time, and integrating geographically dispersed teams.

In the 1996 marketplace, there are two major choices for firm-wide groupware. One unstructured choice is to opt for the family of products, offered by various vendors, that support standard Internet Transmission Control Protocol/Internet Protocol (TCP/IP) networking. Such products can accommodate standard Internet electronic mail (Simple Mail Transport Protocol, or SMTP), standard Internet newsfeeds (Network News Transport Protocol, or NNTP) and standard Web con-

nections across internal corporate TCP/IP networks. This choice is a 'Web-based' or an 'Intranet' solution, and it takes advantage of existing network infrastructure (network cards and cables) that most firms already possess. It is also known as an 'open' solution because the products interoperate, using this set of protocols whose specifications are made available to the public by the Internet Engineering Task Force (IETF) and the World Wide Web Consortium (W3C).

The alternative is not a family of products, but rather a single vendor offering, Lotus Notes. Notes can run on standard TCP/IP networks or other networks, such as Novell LANs, that will not interoperate with the Internet without special enhancements. Nevertheless, Notes is a robust client/server product that offers a strong electronic mail interface, good document workflow capabilities, and the beginnings of support for World Wide Web (WWW) Hypertext Markup Language (HTML) document publishing capabilities. In addition, a Lotus Notes server starting with the Domino release that was introduced midyear 1996 can double as a Web server thus blurring the boundaries between the two camps.

The decision is a complex and ill-structured one as it impacts intra- and inter-organizational data sharing. The question of standards is an important one if the firm wishes a seamless integration of its groupware network with the standard Internet networking protocols and a less important one if such interoperability is not deemed essential (or even perceived to be deleterious). We will be examining case studies that cover both extremes.

This paper will discuss the basic requirements for enterprise-wide groupware, touch upon Internet standards and the debate of open versus closed systems, then explore three case studies. Finally, conclusions will be drawn on the advantages and disadvantages of the three firms' approaches to the problem and some speculation will be presented on the short-term evolution on the opposing camps in this debate.

2. Enterprise-wide groupware

2.1. REQUIREMENTS

A list of the features of an ideal enterprise-wide groupware system will naturally vary from firm to firm. However, a core set of features in major vendor offerings includes the following: unstructured information management, transaction security when updating shared resources, electronic mail and messaging, scheduling, group decision support systems, and workflow. Ideally, video and audio conferencing can be included in this list, but in practice corporate bandwidth is usually a constraining factor. A Lotus technical paper also cites support for remote users (telecommuters, customers, or business partners who are sporadically logged on to the network (Lotus, 1996)). In practice, most attention is usually paid to the quality of electronic mail and workflow services. Document revision control is quite important, as is a robust store-and-forward electronic mail system that can reliably deliver large attachments; e.g. Word, Portable Document Format (PDF), or image (GIF or JPEG) files. Workflow and project management considerations require that simple elec-

tronic mail be enhanced with routing slips, automated acknowledgment-on-read tags, and encryption options.

2.2. ENVIRONMENT

The enterprise network environment is a critical factor in choosing a groupware system. It is often quite heterogeneous within the firm which can have fast LANs, employing 100 Megabit per second fiber optic, or slower ones, employing 10 Megabit per second Ethernet cable, as well as provisioning for slower dial-up access, e.g., 28.8K, or 64K ISDN. Another layer of complexity is the multiplicity of connection protocols: IBM SNA (System Network Architecture), TCP/IP, SPX/IPX, and NetBIOS. The harder it is to get the network to communicate cohesively within the firm, the harder it will be to implement Notes and/or Web-based groupware solutions.

2.2.1. *Network trends are in support of enterprise groupware*

It is a cheap proposition to connect a PC to a network; on the order of \$300 (network card \$100; cable \$50; software \$50; hub \$100) plus labor. Computer performance figures continue to improve: in 1994, the PC offered about 6,000 instructions per second per hardware dollar invested; and by 1997 this ratio is projected to pass 10,000 instructions per second per hardware dollar (Goldberg, 1994).

2.3. ENTERPRISE-WIDE GROUPWARE IDEALS

The ideal enterprise-wide groupware would offer (expanded from Goldberg, 1994):

- Efficient protocols. The network protocols chosen should not take up unnecessary bandwidth, and be able to share data effectively to users throughout the firm, including those in remote satellite offices.
- Portable, high-performance implementation. Many firms have heterogeneous desktop equipment. It makes sense that the software should be able to run on various operating systems with a very similar look and feel.
- Effective client interface (GUI) design. The more intuitive the design, the easier it will be for users of all computer skill levels to make use of new applications as they are developed and rolled out.
- Scalability. The groupware should be able to accommodate numerous simultaneous users without a noticeable degradation of performance.
- Distributed management. Administrators should be able to log on to the system from regional centers and fine-tune traffic, route data around broken network components; in general, solve day to day operational issues.
- Interoperability with Legacy Systems. The groupware should be able to access data stored in mainframe databases (such as Oracle, Sybase, or DB2) or in other *ad hoc* development systems such as large Excel or Lotus spreadsheets.

- Distributed Security. The software should have a secure method of entry and a way for regional administrators to track security problems or perform other user maintenance.

2.4. IMPLEMENTATION CHOICES

2.4.1. *Lotus Notes*

Lotus Notes has proven to be a popular commercial choice for firm-wide groupware since its first stable production releases in 1990. It offers private databases on the client desktop (for example, a personal address book) and shared databases on central servers (for example, a Human Resources database). The Notes product comes with a powerful replication engine which copies one server's databases to others throughout the firm, so that remote clients can access the most proximate servers (saving network bandwidth).

2.4.1.1. *Lotus Notes: background*

Software engineer Ray Ozzie worked at Lotus Development Corporation in the early 1980s, developing the Jazz product, and bargained for Lotus financing his venture, Iris Associates, starting in 1984. Iris was the research and development proving ground for what would eventually become Notes. Lotus bought Iris for 1.4M shares in May 1994 and most recently, IBM purchased Lotus in July, 1995 for \$3.5B. A wide spectrum of industries use Notes; here are some major examples:

- Financial services firms, such as Merrill Lynch, Morgan Stanley, JP Morgan, Bank of Montreal, Chase Manhattan Bank, Bankers Trust, and World Bank;
- Consulting firms, such as Arthur Andersen, Andersen Consulting, Coopers and Lybrand, Ernst and Young, McKinsey, Price Waterhouse;
- Publishing firms: Simon and Schuster;
- Manufacturing: General Motors;
- Communications: MCI.

2.4.1.2. *Lotus Notes: architecture*

Lotus implements a proprietary client-server protocol, by which Notes servers store shared databases and Notes clients store private ones. Both the client and server run on multiple platforms, for example, UNIX flavors, Microsoft Windows flavors, and IBM's OS/2. The client graphical user interface (GUI) makes use of Object Linking and Embedding (OLE) to link and embed objects from other applications. The client workspace shows installed database icons and comes equipped with fairly good word processing capabilities. The client view onto a database is one line per document, and standard client operations (cut, copy, paste, etc.) are available on the documents present in a view. On the server side, databases are stored in single files. Notes administrators configure replication of the databases with other Notes servers, and must monitor server performance daily for troubleshooting. Notes 3.x

had slow full-file replication (even when only a few records had been updated) between servers; Notes 4 offers a smarter replication strategy – only updated fields take up bandwidth. Notes servers are configured in a hub and spokes pattern, and during replication, the spokes replicate to the hub in the first phase and the hub replicates back to the spokes in the second phase.

2.4.1.3. *Cost structure*

The cost of Notes ownership consists of setup costs and ongoing costs. Richard Werbin, the former head the Chase Manhattan Bank's Lotus Notes Center of Excellence, reported a fixed cost of \$300 to \$350/user/year of fixed costs, including licensing, end user training, and registering new users (Werbin, 1996) In addition, he gave on-going annual expenses \$600–700/user/year consisting of \$200 for technology, including network costs and \$400 for people expenses, including operations (LAN network support, help desk staff and server administration), and technology (application developers). Thus the total is approximately \$900 to \$950 for a desktop seat annually. A more pessimistic picture is presented by Rowan Snyder, partner and chief technology officer of the Lotus Notes rollout at Coopers & Lybrand, a management consulting and accounting firm. He estimates the costs more broadly at \$1,000–2,000 per user per year for the basic server and client software, network infrastructure, and support but points out that these figures ignore 'application-specific costs, peer support, and the management effort' which balloon the total cost to 'the [\$]5,000 range or more' per user per year (Lownie and Granoff, 1996).

2.4.1.4. *Notes strengths and weaknesses*

The Notes client GUI is a reasonable view on the universe of enterprise-wide Notes content, and clients enjoy full-text searching across documents on the same server, but not across multiple servers.

Application delivery is fairly rapid, but on the flip side Notes developers do not have as rich a set of scripting languages to choose from as do Web developers. The Notes mail is intuitive for the client to use, but awkward to interface to the Internet and its routing schemes are complicated. Notes server data replication again offers convenience to the users (to optimize their views on the data) but poses certain administrative problems in its two-phase replica synchronization as described above. The Notes security model is strong, with Access Control Lists, and public-key encryption built in. Another strength is the fact that Notes' popularity has created a third-party market for Notes consultants, training, and business partners.

Notes 3.x had severe scaling problems; with a database limit of about 2 GB, and view performance problems. Any users in excess of a 50-user limit on a high-end OS/2 server caused the system to creak. Notes 4.x greatly redresses this problem, allowing more than 1,000 active sessions on a similar high-end OS/2 server.

2.4.1.5. *Recent Notes trends*

One of the most important changes of the Notes 4 release is its embrace (albeit a half-hearted one) of Web open standards. For example, Notes 4 makes it easier to configure interfaces to SMTP mail standards using Message Transfer Agents (MTAs) as mentioned. Furthermore, the Internotes Web publisher, a companion product with Notes 4.x, supports Hypertext Transfer Protocol (HTTP) hyperlinks from within a Notes document and it supports a rather primitive dump of a Notes database to a cluster of HTML files viewable by any Web client.

Perhaps the most interesting recent advance has been the Notes client becoming web-aware. Naturally, the Notes browser is feature poor compared to its high-powered WWW competitors such as Netscape, Microsoft, etc. Yet, the Notes Browser following Web hyperlinks offers a masked yet important benefit: the addition of workflow. When a Notes Browser brings in a Web document, it is now a Notes document and can be routed, massaged, or otherwise edited in a normal Notes fashion. Routed Web documents can be sent by proprietary Notes mail and viewed verbatim by the recipient with the caveat that it might not recognize the most recent HTML tags thus leading to a sub-optimal rendering.

2.4.2. *Web-based solutions*

The rapid rise in popularity of HTTP to serve and browse distributed hypermedia documents on the Internet has created an explosive growth in networked programming applications targeted specifically at the Web information-seeker (client) and information-provider (server) audience. In 1996, corporate interest in Intranets, (TCP/IP networks protected from outside intrusion by a firewall), has grown immensely. However, a robust groupware system is difficult to build on an Intranet; the following sections illustrate why.

2.4.2.1. *Web environment and background*

While Lotus Notes is a product, Intranet-based solutions rely on the World Wide Web's open specifications: a loose conglomeration of official standards, de facto standards (e.g., Netscape extensions) and the common network interconnection denominator, TCP/IP.

From the enterprise perspective, the Web offers a convenient and extensible toolkit for application development. Developers can code in a variety of scripting languages and turnaround time is very good. The development cost structure has been estimated to be similar to Notes, about \$600/desktop/year (Werbin, 1996). There is the global Usenet development community backing application efforts. Furthermore, the tools are modular: for example, Perl scripts can query ANSI SQL servers; Java applets can provide standard animation techniques, etc. The HTTP protocol subsumes other important Internet services, such as FTP, Gopher, News (Usenet) and Wais (December and Ginsburg, 1996) and the simple HTML markup language provides a simple mechanism for hypertext publishing. Furthermore, the

HTTP protocol is an open standard; scripts can generate HTML documents on the fly and both servers and clients have been developed for numerous operating systems, for example, many varieties of UNIX, Windows 95, Windows NT, and Macs. Many HTTP servers are freely distributed source code; hence a global development community can participate in their enhancement.

2.4.2.2. *Web architecture*

More information on the components and architecture of the World Wide Web is presented by Bentley et al. in this issue (Bentley et al., 1997). One of the most important points to keep in mind is that the HTTP protocol is inherently stateless: the server keeps no memory of the clients' activities in prior sessions. This complicates the task of implementing groupware on the Web: separate middleware pieces have to be developed to capture client state, since the notion of a strong identity via a single logon, as in the Notes environment, is crucial for security and collaborative work across sessions.

2.4.2.3. *Web cost structure*

It is possible to develop an Intranet document delivery system using shareware or freeware software exclusively on top of an existing network infrastructure. If that infrastructure does not exist, we saw in Section 2.2.1 that it costs about \$300 to add a personal computer to a network. Once the network is in place, there are many possible configurations and price ranges. For example, it is viable to implement a sound, basic Intranet on a Pentium-based server (unit price, approximately \$5000) with the Linux (a PC-UNIX port) Operating System (\$50) running the Apache Web server (no extra cost; bundled with Linux). Free or low cost Web clients are available from major vendors such as Microsoft or Netscape. The cost estimation becomes fuzzier as management requests more features. For example, to provide a secure path between a client and a legacy database, a firm can either choose a lengthy in-house software development initiative of several man-months or purchase a vendor solution which may cost several thousand dollars per Web server and which may have concurrent user limitations. Or, to provide a secure mechanism for electronic commerce, vendors offer premium servers with public-key encryption built-in with unit price in the \$2000 to \$5000 range or greater.

Overall, the marginal cost per additional client is nominal and often already factored into the firm's infrastructure investment. In addition, Web server maintenance is significantly less complex than Notes server maintenance. For a basic Intranet, then, the bulk of the cost is from application development and this is again cheaper than a corresponding Notes effort, since the choice of toolkits and operating system environments is larger and peer group support (Usenet) is broader. The low cost of an Intranet solution to share data between geographically separate firm branches is appealing and can be built on top of a standard mail backbone. This sheds light on the question of how to coordinate the main branch and a satellite branch, as

studied by Rao (1995); a web solution is easy to implement and affords the basic collaborative feature of hypermedia document sharing (not, however, document store and forward).

However, it is quite difficult to estimate costs of an Intranet-based groupware system. There is insufficient data on current projects in this area; since security is not built-in it must be developed or brought in piecemeal. Application development in this gray area may approach the cost, per unit time, of an arbitrary Notes system.

2.4.2.4. *Web strengths and weaknesses*

Some of the current technical weaknesses of the Internet include the fact that HTML is an inadequate document description language; lack of robust HTML authoring tools (early attempts do not impress); poor converters between existing document formats and HTML; lack of persistence between a Web client and a legacy database, and lack of agreement on security standards. Until such time as the twin security problems of user authentication and authorization are solved in a modular manner on the Web, Intranet groupware solutions cannot rebut the objection that Lotus Notes currently is the only robust firm-wide groupware with built-in security.

The chief strength, as we have discussed, is the rapid application development (RAD) afforded by the open and extensible protocols; developers can choose from many powerful toolkits and firms can choose from high-quality development, client, and server offerings at a low price from well-established software vendors such as Microsoft, Sun Microsystems, Silicon Graphics, and others.

2.4.2.5. *Recent trends in Web technology*

Recent software initiatives address some of the weaknesses discussed in Section 2.4.2.4. Vendors are coming to market with middleware products which bind securely a Web client to a relational database. Microsoft and the major UNIX vendors are working on competing specifications for database access; and there is also intense activity to provide efficient mechanisms for secure (encrypted) electronic mail and other transaction activity, such as document store and forward.

Progress has also been made in developing small groupware applications on the Web. For example, Web applications have been written to convert Usenet newsfeeds into a HTML representation, capturing the flow of threads. Netscape's News Browser is one such example. The thread (discussion subject) flow presents the user, in asynchronous mode, past activity information 'so as to give an individual awareness of the activities of other participants integrated with the work object itself' (Dourish and Bellotti, 1992). Similarly, the software product HyperNews, created by Dan LaLiberte, is a hybrid between the Usenet News and the Web where users can respond to articles, or to responses themselves on a Web site. In addition, the scientific software product NCSA Collage allows remote users to share scientific data sets and allows simultaneous data visualization by the participants.

Table I. Notes v. Intranets: key differences (adapted from Ginsburg and Duliba, 1996)

Characteristics	Notes	Intranet
Design philosophy	Proprietary	Open
Security	Very good	Low
Cost, direct	Moderate	Free or cheap
Cost, fully loaded	Low – Moderate	Low
Initial commitment	High	Low
Training cost	Moderate	Low
Features & maturity	Moderate – High	Low
Velocity of feature changes	Low	High
‘Standard’ potential	Low - Moderate	High

2.4.3. Comparison of Notes and Web technologies

Although Lotus Notes, a Vendor product, and the Web-based suite of internal TCP/IP applications that make use of HTTP address the same organizational issues, they can be distinguished in some key attributes, which are shown in Table I.

Consider the last two entries of Table I, ‘Velocity of feature change’ and ‘Standard potential’. The HTTP protocol and the HTML typesetting language are public standards which are constantly undergoing revision. This means that the weaknesses of the components are known and are being addressed at a high velocity with a large pool of participating programmers on Usenet. Contrast this with the scenario where an enterprise is waiting for Lotus to fulfill a software wish list and/or to fix a software bug list; often the firm’s wishes are not in synchrony with Lotus’s priorities in its next release. This follows directly from the fact that Intranets are suites of protocols whereas Notes is a single vendor offering. However, over time, Lotus will lessen the gap on the issue of standards and it slowly moves toward compatibility with the HTTP and mail protocols.

2.4.3.1. Positioning Notes and Web-based solutions in a standard groupware taxonomy

The most common way to categorize groupware systems is along the two dimensions of time and space (Ellis, 1991). Some systems require participants, inconveniently, to all gather in the same space, while others only permit group interaction at the same time. The most flexible groupware systems permit asynchronous interaction among the participants and also permit the participants to be distributed physically. We see examples of distributed, asynchronous software systems in Usenet newsgroups, World Wide Web technology, and Internet Simple Mail Transport Protocol (SMTP) mail. Lotus Notes, which we will discuss at length in this paper, does not offer the shared doodle space that some of the more formal groupware systems have, but it does have replicated (i.e., non-centralized) databases

servicing a distributed user community, store-and-forward mail, and offers some support for multi-author document control. Thus Notes and the Web both fall into the distributed, asynchronous quadrant in the groupware taxonomy.

2.5. BACKGROUND LITERATURE

There is a substantial body of work focusing on Notes or other groupware product implementations at a single firm or in an experimental setting. Orlikowski (1992) examined the impact of implementing Notes on work practices and social interaction in one branch office of a large services organization. After interviewing employees at all management levels, she found that there were two major factors which influenced Notes' adoption: (1) how people perceived their work, and (2) the organization's existing policies, procedures and incentives. A number of factors were found that led to a sub-optimal reception of the new technology: among them, a rushed implementation and insufficient training which caused users to treat Notes as a personal computer productivity tool rather than an enabling technology for collaboration, and a disregard for the intrinsic reward structures and incentives of the firm. Since consultants were loath to accrue non-billable time to learn the software, and since they had no motivation to share information in the peer group, Notes was not put to good use readily.

In a second study, Orlikowski (1995) examined another firm which deployed Notes. In contrast to the previous example, this particular firm already had a prior history of cooperation. The organization was able to apply the cooperative work environment of the old culture to the new technology. She found that groupware increased collaboration, coordination, and communication. Based on this firm's experience, she concluded that one strategy to deploy Notes successfully would be for the firm to undertake some initial organizational changes, then deploy Notes, and follow it up with emerging organizational changes to take advantage of opportunities arising from the software change.

Bowers (1994) reported on a small government agency which deployed groupware. The study highlighted many potential problems that occurred when they implemented groupware, such as conflicts about whether or not to change the business process that groupware supported, disagreement regarding whether to automate part or all of the business process, and debates concerning the sharing and ownership of information. There was such high user resistance to the software that only a few people used it, and it was actually removed in some cases. Bowers concludes his study with some recommendations designed to reduce user resistance, including delineating the anticipated changes while minimizing negative perceptions, recognizing the organizational impact of groupware, and amassing the available resources, both organizational and technical, to increase change. Gorton et al. (1996) investigated Notes as a support for a CASE environment across time zones, and found it to be a good tool for a software development group's organizational memory in a project life cycle.

Our work differs from prior research in the following ways. First, there are differences in the research samples. We examine large installations across many geographical offices, with each organization having thousands of users, compared to a small group of twenty to thirty users (Bowers) or a branch office (Orlikowski, 1992). A large deployment is the result of a key strategic decision by a firm and its success or failure has a profound impact on the firm's productivity and profitability. Because groupware is a product which encourages communication and coordination, we would expect it to have the largest potential impact on organizations which are geographically dispersed. In a small organization or in one branch office, the full benefits of groupware may not be experienced as much as in a physically dispersed organization.

Second, we examine mature Notes' deployments. Orlikowski (1992) began her study immediately prior to implementation of the groupware product at the branch office, and continued the study through the implementation and early use of the system; however, her second study (1995) and Bowers (1994) examine more mature deployments. The organizations in our sample had implemented and used groupware for a few years.

Third, we are interested in the strategic choice of which enterprise-wide groupware system a given organization implements, and why. We interviewed only senior IT management responsible for the decision, not end-users in the trenches who have to wrestle with the decision once it is made. Although the latter is of interest to researchers charting organizational changes in a branch setting (Orlikowski 1992, 1995) it is beyond our primary focus. Taking the firm as the unit of analysis differs from a branch office, where a small IT system can be tested and retracted if insufficient, or an experimental environment. The choice and rollout of a groupware system is a multimillion dollar decision with immense corporate inertia. Since it is not economically viable to test, in parallel, multiple major groupware systems, an organization has to commit to one. Having done so, we explore the rationale and implications of introducing a second, competing system.

Finally, the most important distinction is that we contrast two different deployments: Notes-based and Intranet-based solutions. They each have a number of key differences which we discussed in Section 2.4.3, and which the cases below highlight.

3. Which path to choose? Modeling the decision process

3.1. THE ROLE OF STANDARDS

The question of software choice, de facto standards (which consumers have voted on, in effect, with their purchase decisions) and de jure standards (which are arrived at by a legislative body, for example a standards committee) has interested the Economics and Management of Information Systems (MIS) communities for several decades. However, with the advent of cheap global networking and fast desktop computing, the stakes have never been higher to decide on a proprietary

system (e.g., Notes) which fulfills immediate organizational goals, or opt for an 'open' solution using Internet standards, which might be sub-optimal at the present time but offer more room to grow over time.

Buhl (1995) argues that markets are the most efficient way to drive the evolution of technology, not the creation of anticipatory standards, which are de jure standards set before actual market implementations. However, Lehr (1993) argues that anticipatory standards can help coordinate industry technology choices. Lehr cites examples where an anticipatory standard can help guide the market into efficient incremental steps; he shows theoretically that the participants have less incentive to keep private information as the market proceeds from the baseline anticipatory standard through numerous shocks (as the best direction of the small evolutionary steps becomes clear). Indeed, this is a good model for how the Internet standards move forward. The World Wide Web Consortium, a joint venture of MIT and INRIA, keeps an eye on industry first-mover attempts while keeping a library of reference code to encourage researchers to make their own evolutionary steps. Netscape Communications Corporation and Microsoft, to name two major players, constantly introduce first-mover innovations to gain market share advantages, yet also submit their innovations as request for comment papers to the W3C and to the Internet Engineering Task Force. It appears that Lehr's contentions that anticipatory standards 'reduce collective uncertainty regarding the merits of alternative designs . . .' and ' . . . foster comparative market testing of competing technologies' (Lehr, 1993) are accurate.

Economides and Flyer (1995) and Economides (1996) are concerned about the theoretical underpinnings of technical standards coalitions, such as incentive structure, but in the case of Internet standards, the process is both unusually loose and unusually explicit – a far cry from the ponderous X.25 standards process (Sirbu and Zwimpfer, 1985).

The traditional Information Technology focus on departmental technology choice (Dewan et al., 1995) is relevant to our current discussion because heterogeneous choices at the departmental level can confound a smooth implementation of an Intranet solution (if, for example, unusual network software interferes with TCP/IP) or a Notes solution (if, for example, nonstandard software causes excessive performance degradation on a Notes server replication). Conversely, it is reasonable to posit that the adaptation of a groupware system at the firm level that is fully interoperable with basic Internet protocols will facilitate open solutions at the departmental level for other network computing needs, but this has not yet been tested.

3.2. THE ROLE OF INTEROPERABILITY

Consider a firm facing an implementation choice on a collaborative software system spanning the organization. It is likely that the chosen system will need to interface to outside data sources. Furthermore, those sources are likely to be present on the

Internet. It seems plausible, then, that the internal network (accommodating internal data sharing) should interoperate with the Internet to minimize the friction between the internal and external boundaries. What are some cases when this consideration would be minimized? One scenario is if the firm values its internal information so highly that it is willing to pay a premium for telecommuting employees to dial up to a private network, thus increasing security. Another possibility is that the firm does not trust data arriving from the Internet and contracts with private vendors for most or all of its dedicated data feeds. Note that these situations also point to the firm minimizing the importance of open systems. If a secure private network is desired, the firm may well put its faith into one vendor, standardize its employees on this network and proprietary software which runs on the network, and expect vendors to follow.

4. Empirical evidence: three case studies

We conducted interviews with senior Information Technology (IT) officials at three firms to learn how and why they implemented Notes and to gain post-implementation insight. One of three firms in addition saw a major Intranet implementation subsequent to the Notes implementation. The interviews were conducted in the first and second quarters, 1996. In every case, Notes was implemented as the first option soon after its appearance as a viable product in 1990. We present now excerpts from these discussions, focusing in particular on the environment pre-Notes, the course of Notes implementation, and senior management attitudes toward Notes and Intranet alternatives over the last several years.

4.1. GLOBAL COMMERCIAL BANK (GCB)

GCB is an international commercial banking firm that began to deploy Notes in 1990. The initial investment was low: only \$100,000. The initial planning was led by senior Information Technology (IT) staff and the project was rolled out at mid-level management paying close attention to training in contrast to Orlikowski's 1992 study which saw a rushed deployment.

The initial driving force behind the Notes rollout was the need to present timely information and the pressure to reduce information dissemination costs.

Currently, GCB uses Notes to distribute information, newsletters, and employee handbooks. Client information tracking is another very large and very important application: all contacts with clients are managed through Notes, as are face-to-face meetings, phone meetings, and memos.

Notes also is used for project information tracking in lieu of desktop products such as Microsoft Project. For example, timetables and deliverables are kept in Notes databases. The current architecture of Notes at GCB includes 250 production Notes servers for development, application, and electronic mail. There are about

forty to fifty dedicated Notes developers, and about 20,000 users out of a total of 35,000 desktop computers worldwide.

GCB perceives the strengths of Notes to be a powerful, fast development environment with support for free-form text databases, electronic mail, and security. The support for free-form text allows for that unstructured text to be searched, and is similarly noted in Orlikowski (1995). However, interestingly, Intranet-based search is much more sophisticated and configurable. The Notes search does not span multiple databases, whereas Web agents can be launched to index many Web servers and optionally filter the results. The Notes built-in support for security is particularly strong since they make use of the robust public-key encryption technology. GCB stresses that Notes delivers mature application development tools, centralized information distribution, and timely information delivery – affirming one of the initial goals mentioned above.

On the flip side, GCB considers Notes to be disadvantageous in its licensing costs. Most Internet-based products have little or no licensing cost, although GCB feels that the cost of Internet development and support is approximately the same as Notes development and support. Other minuses of Notes include a 4 GB database limit (in Release 4), and general systemic failures at about a 50,000 document limit.

GCB considers Intranet-based solutions currently to be weak in the areas of security (for example, attacks via viral Internet electronic mail) user authentication, and susceptibility to fraud. This is consistent with our discussion in Section 2.4.2.4, and leads us to believe if the security issue is resolved, the favorable cost structure of an Intranet-based alternative will cause it to be seriously evaluated.

In summary, GCB believes the impact of Notes on the firm has been positive in two categories: improved client tracking (a database is maintained of all contacts, visits, and memos) and teamwork across departmental boundaries is facilitated. The firm declined to provide figures to support or refute the original supposition that Notes would reduce information dissemination costs.

4.2. GLOBAL MANAGEMENT CONSULTING FIRM (GMC)

4.2.1. *GMC demographics and background*

The firm is a multinational business, with offices worldwide in many countries, in the services sector. Prior to the introduction of Notes, the firm was a loosely coupled organization, structured by geographic office. Each office had a large amount of autonomy. There was no coordinated effort to structure knowledge or have an organizational memory across offices. In addition, information technology (IT) was decentralized by office. The firm recognized that it needed to increase communication and coordination among its employees and offices to remain competitive in an industry which is moving to any place any time.

4.2.2. *Notes history and evolution at GMC*

The original decision to use Lotus Notes was made in 1990 by senior IT management. IT management invested in Notes based on their vision of what the product could do for the organization. The business case that they made to senior management centered around three factors: using Notes to reduce support costs, to improve reliability, and to improve the quality of service.

IT management sought to deploy the software throughout the entire firm. To accomplish this objective, two groups of people were targeted to use Notes: (1) senior management, and (2) select key people in several departments who would champion the product within the firm, and who could create a strong grass-roots support. When they implemented a successful database, other employees saw the benefits and wanted to use the technology. This strategy pulled many people in to using the product because the champions would showcase all the latest technological applications that they had developed. Three key applications that were implemented in Notes were employee benefits, human resources, and one business line function.

From 1993 to 1994, Notes' usage rose dramatically. Currently, 100% of the organization uses Notes. People developed their own databases of information that were relevant to their work. Usage increased to such a great extent that the system took a prohibitive amount of time to replicate. Consequently, IT management tempered this explosive growth by implementing a chargeback system, so that the users would monitor themselves about what information was really worthwhile to include in Notes database. The chargeback system eliminated about 30% of the existing databases. Intranet-based firms also sometimes rely on chargeback systems to reduce possibly spurious Internet access by employees to help defray network costs.

4.2.3. *The current uses of Notes: leveraging knowledge*

Notes is used in many ways to leverage knowledge throughout the firm. Specifically, it is used to capture, disseminate, and reuse knowledge. Knowledge is captured when it first enters the organization. There are a few types of knowledge which are captured. The firm collects information from news feeds and from press articles. In addition, the firm captures knowledge when it does primary data collection, such as conducting surveys. Respondents will answer the survey through Notes. Their responses, summary statistics, and sampling information is stored in Notes. If the survey is repeated, the information can be analyzed over time. From the surveys, best practice information is retained, and organized into a taxonomy. Finally, in a more complex manner, when people create knowledge while performing their job, that knowledge is also stored in Notes. For example, one person may forecast technology trends. Another person may have gathered background information in order to make a particular decision. The background research that is used to support

a decision is captured in Notes, and can thus be referenced by others. In summary, Notes is the repository of the firm's knowledge.

Capturing the knowledge is important, but GMC feels the real impact of Notes is that information can be disseminated and shared with appropriate people throughout the firm. This is similar to Orlikowski's (1995) results. She also found that knowledge dissemination was critical in services sector firms, and that groupware was useful for increasing knowledge dissemination and publication. The ability to communicate knowledge in a timely manner throughout the organization is important today, when fast response time makes the difference between retaining customers and losing them. In knowledge creation and sharing, best practice information is retained, and organized into a taxonomy. This knowledge also enhanced work across departments.

Knowledge dissemination, for certain types of information, may be selective. Selective information sharing refers to employees sharing information with only a few people. For example, confidential client information is not shared with anyone else in the firm; it is shared between only the individual employee and the associated client. One database stores sensitive and confidential information that is disseminated only to senior executives. This particular database is used widely in the firm. Important information is included here, but very sensitive information, or strategic advantage information, is not even stored in this database.

A more complex dissemination feature is having knowledge distributed in a particular manner, that is, automating a workflow. There are many firms which use Notes, but have not yet implemented workflow applications. An example of a workflow application is the leasing process. An outside party is responsible for leasing. When a particular work group needs to lease a certain piece of equipment, the work group enters account information in Notes. Each piece of equipment has a work number, and a serial identification number, allowing it to be tracked. The account information triggers the equipment support person.

Finally, the ability to capture and disseminate knowledge allows people to reuse the knowledge and intelligence of others. People can view others' job experiences captured in Notes and use it for their own current job requirements. Because knowledge is stored and can be reused, individual expertise can lead to corporate best practices. For example, if a decision needed to be made whether or not to use a particular fiber optic protocol, the research and background material that is used to support that decision can be stored in Notes. The material can then be reused by junior people. In this manner, individual expertise can lead to corporate best practices. Of course, a system to house organizational memory can be built just as easily using Intranet technology, but GMC thus far has had no cause to evaluate alternatives to Notes.

4.2.4. *The stated benefits of Notes to GMC and an Intranet counterpoint*

Though the firm does not quantify the success of Notes, it has observed a number of advantages of deploying the software. We now paraphrase the key points, according to the GMC CIO, and follow each point with a few salient observations about the uncharted Intranet alternative.

First, Notes allows the firm to bring together a diverse set of knowledge, across geographic regions and time zones. By having employees access this large knowledge base to find relevant information, the firm will have a competitive advantage over its rivals. Because the diverse set of knowledge is centralized, people throughout the organization have access to firm knowledge across all office locations. Information is available anywhere, 100% of the time. Each person is able to access the firm's knowledge and depth of material and methods. Expertise is reused across different projects. Notes allows people to get instant access to the collective knowledge of the organization's best analysis and past experience. Thus, individual intelligence can lead to best practices across the entire firm. An Intranet would produce identical results with its simple client-server model and have less support costs at the network level. However, if security within the firm is important then Notes has access control built-in to its databases.

Second, Notes has decreased the cycle time of work at the firm. For example, preparation time of proposals, presentations, and reports has been dramatically reduced. Proposals written in one part of the world can be accessible to the entire firm immediately. A large knowledge base, together with the ability to decrease the cycle time of work, has given the firm competitive advantage. Precisely these advantages are listed by Intranet supporters: hyperdocuments, with links to other relevant sources of information, assist in creating a large knowledge base. The drawback of the Intranet as it currently stands is that there is no native support for group document control; this is the thrust of Bentley et al.'s BSCW software innovation (1997).

Third, Notes has increased communication and coordination, through its ability to handle scheduling and calendaring. Electronic mail is used by people to communicate on a one-to-one basis. When people need to publish information to a wider audience in the firm, they use Notes' database capability. The CIO did not mention the fact that Notes introduces obstacles at the electronic mail level when an employee wishes to send an attachment to a colleague on the Internet, or vice versa. It is necessary to purchase expensive add-on products ('gateways') to understand standard attachments, such as images, spreadsheets, or documents. It is more efficient to publish a document to a server than broadcast it with electronic mail, as is the case with an Intranet.

Fourth, team productivity rises. Team members can meet anywhere, any time, through Notes. They can meet as virtual workgroups, and use conferencing. More in-depth interviews are in order here, as we saw in studies by Orlikowski (1992)

or Rao (1995) to determine realistically if advanced conferencing features are used, or deemed to be useful, at various levels in the organization.

Finally, Notes has increased revenue through improved response time to business opportunities and improvements in customer service, and has reduced costs for printing, publishing, and disseminating internal information. Again, as with GCB, it is evident that a well-planned Notes rollout has satisfied senior management. The essential feature set that enables collaborative work is stable and the CIO is satisfied that costs are down across the board. Given this satisfaction, there is little incentive to bring in a quite different technology, the Intranet, that has the potential to divide users' loyalties.

4.2.5. *The organizational impact of Notes*

Lotus Notes has changed not only the technological infrastructure of the firm, but it has also changed the organization, and contributed to changing people's attitudes and behaviors toward information. Specifically, people share much more information now than they did before Notes. It is important to note, however, that people do not share information solely because the technology allows them to do so. Rather, the behavior of the people and the culture of the firm has changed to supporting a more open and information sharing environment. Notes is simply a tool; it itself does not cause change. If employees in the firm were not communicating prior to Notes, they will not communicate after Notes. The same points could be made in a firm that implemented an Intranet exclusively.

4.2.5.1. *Key decisions in implementing Notes: strengths of the initial rollout*

Key decisions involved in the rollout included mass distribution, unlimited usage, and standardization. Regarding mass distribution, Notes was initially rolled out to about 20% of the firm. The software is a product which has network externalities associated with it. Network externalities refers to the fact that the value of Notes increases to the installed user base as additional users join the Notes network. Additional users place more information into the collective whole; as with a telephone network, the value to the end-user grows when there are more resources to reach.

Related to mass distribution, unlimited usage was another key factor. IT management encouraged employees to use the system as much as possible, so there were no limits placed on usage. Once the Notes champions had showcased a few successful applications early in the Notes adoption, everyone wanted to use Notes, for everything from news feeds to restaurant lists. Information was not judged on how useful it was; the goal was to get the entire firm to use Notes.

Standardization was a third key decision that the firm made. For example, prior to Notes, there were a few different electronic mail systems. Senior IT management believed that supporting many electronic mail environments could never be as efficient as supporting one electronic mail environment. Therefore, when Notes was implemented, it was decided that it was no longer acceptable to operate more than a

single electronic mail system. When Notes was implemented, the firm standardized on Notes' electronic mail system. Hardware configuration was also standardized and centralized. Note the use of the word 'standardization' here. The Intranet community can attack Notes on this point, since it fails to natively handle Internet attachments, but it is true in 1990 Notes was the only firm-wide solution to allow standardization on a single GUI mail client. Once the look and feel standardization is accomplished, and the necessary investments have been committed to a bevy of Notes electronic mail servers, the high cost of switching away from that architecture is enough to dissuade senior management from considering the more open solution.

4.2.5.2. *Difficulties with the Notes product during or post-implementation*

GMC, even when pressed on this point, could not identify a single difficulty with Notes during its initial rollout or at any time subsequently.

It is unknown what resources GMC has committed currently to track or test Intranet software initiatives. What is evident is the fact that senior IT management is extremely pleased with its Notes implementation. Since we do not know how interested GMC is in exploring the Intranet, we cannot speculate on the possible impact of an apples-to-apples cost comparison of the two technologies (which we believe would have a strong impact at GCB).

4.3. GLOBAL INVESTMENT BANK (GIB)

GIB, unlike GMC or GCB, is quite ambivalent about Notes and the Web. This is due in part to their organizational structure as we shall see.

4.3.1. *Firm demographics*

GIB is a multinational Investment bank, with offices worldwide. Its network is quite complicated with several protocols, hubs in New York and London, and slower connections to the Pacific Rim and to Latin America. On the desktop, clients are running all the major platforms (Macintosh, various UNIX flavors, Windows 3.x, and Windows NT).

GIB has a decentralized development environment. There are numerous internal IT consulting groups and no central charter to adopt certain networking standards or desktop computing standards. Specific business units retain their own IT staff as well, and there is the ongoing problem of coordinating cross-departmental IT projects.

Although a wide latitude is permitted in choosing a groupware vendor, the software must have a full service contract. This rules out certain Web-based solutions, for example unsupported gateway products that link a Sybase database package to a Web GUI front-end application.

4.3.2. *Notes at GIB*

Notes was brought into the bank by one senior IT officer in 1991. It caught on first with the UK Banking Group, for its intuitive electronic mail and document workflow capabilities. Notes adoption spread, subsequently, to New York headquarters and to France where, with strong UK Banking Group advocacy, it gained several more senior IT advocates. Global rollout of Notes on the desktop commenced in midyear 1992, and currently 92% of employee desktops use Notes. The adoption pattern is similar to Orlikowski's 1992 study with a single advocate leading the charge to an extremely rapid deployment. In contrast to Orlikowski's study, GIB had more resources to commit to training especially in the area of Notes usage as a collaborative tool. We saw the same careful treatment of deployment in our discussion of GCB in Section 4.1.

On the other hand, only about 35% of employee desktops have a Web browser. Notes costs are bundled in the desktop common charges, whereas GIB levies an additional \$200/user/year for internal Web access, and \$700/user/year for full Intranet and Internet access, to help defray network costs. This can be taken as an indirect coercive attempt by management to standardize on Notes as the preferred groupware solution. How successful this is depends the value each department places on Web access (either internal or external); since there is more *ad hoc* development and document delivery on the Web than on Notes, there is latitude to justify this additional expense.

4.3.2.1. *Current uses of Notes at GIB*

GIB uses Notes to share convenient databases, for example: classified ads, centralized employee news, and archived suggestion boxes. As with GMC, it feels a strength of Notes is to distribute electronic mail across a common interface and they continue to phase out non-standard third party mail packages. Notes is also used to share extremely sensitive databases with authorized users – e.g. client tracking, a banking application which is very similar to the one we discussed in the GCB case.

4.3.2.2. *Perceived benefits of Notes at GIB*

GIB points to timely knowledge distribution as a key advantage of Notes and an expensive but stable integration with inbound and outbound Internet mail traffic. It is noteworthy that GIB is the first firm to identify explicitly the Internet as an entity worthy of an integration effort. Finally, discussion groups can meet asynchronously to discuss new project plans.

4.3.2.3. *Key decisions in implementing Notes at GIB*

As mentioned, in the early 1990s GIB needed to consolidate non-interoperable mail platforms (e.g., Lotus cc: mail, Microsoft Mail, MacMail, and others) as we saw in the GMC case, Section 4.2.5.1. It also needed a secure platform to transmit internal data.

4.3.3. *GIB Web initiatives*

The decentralized nature of GIB's IT structure makes it possible to do *ad hoc* Web Intranet development as well as the more usual Notes work. For example, scripting languages are used to glue Web front-ends to back-end legacy Databases. The network programming language Java is used to rewrite large legacy C language visualization applications, and various business units develop their own specialized applications; for example a mixed HTML and Adobe Portable Document Format (PDF) search for Emerging Markets Research. We see the power of the Web toolkit gives users incentive to circumvent the de facto Notes development standard as users get more used to the extremely rapid prototyping which is possible in an Intranet.

4.3.4. *Current directions at GIB*

GIB is shedding the traditional conservative IT approach given the rapid evolution of these two products on the Intranet. They are heavily invested in Notes but will also invest in Web projects if the risk/benefits make sense. For example, GIB has implemented a global research bulletin board for internal and external use where economists can post *ad hoc* articles; this system offers a full text search on both plain text and Portable Document Format (PDF) documents. Since the Intranet spans the entire organization as does Notes, the two choices do not necessarily have to compete at that level, but once an application spans the firewall and offers information to the Internet community Notes is no longer a viable option. The ultimate question is: will senior management buy into the notion of supporting two platforms. GIB, seeing no need to ordain one standard will continue, on a case by case basis, on both Notes and Web-based internal collaborative solutions. Their desktop Notes percentage will remain quite high, but over the next few quarters their internal Web browser percentage will steadily rise. The development of a number of high-visibility Web-based groupware applications over the last two years implies substantial erosion in the original notion of Notes as a single groupware answer.

5. Discussion

The element of choice in enterprise-wide groupware systems opens a new dimension in research on coordinating technologies. Previously, the existence of a single robust vendor product, e.g. Notes, was deemed a priori to be a positive development that would be beneficial to the firm if implemented properly. This is the underlying assumption in Orlikowski's 1992 study. Similarly, Gorton's experiment on CASE support (Gorton, 1996) showed Notes to be a suitable tool for capturing a geographically distributed team's project memory. However, choice implies differences between the vendor product, Notes, and the applications built on the open suite of TCP/IP and HTTP protocols, loosely known as Intranet-based solutions. The differences are vast and impact not only the organization in which the

solution is deployed, but also its ability to communicate with business partners on the Internet. Rao (1995) raises the possibility in his study that, given budget constraints of a satellite office, it is possible that no coordination technology is justified; i.e. the features gained do not outweigh the money lost. This is a valid consideration and one of the major building blocks for a Notes to Intranet comparison is indeed missing: a metric to compare network, support, and development costs across the two. Until such a metric exists, firms that have committed to the product that was available earlier (Notes, in 1990, was available fully five years before the first stable Intranets) do not have incentive to change and can fall back on the observation that Intranet solutions do not, as of yet, seamlessly integrate access control and encryption. We noticed this phenomenon with the GCB and GMC studies. However, a firm such as GIB, with its decentralized IT management structure and distributed teams of application expertise, is more likely to discover through *ad hoc* efforts the advantages of rapid application delivery via the Web or the power of a full-text search engine which spans multiple servers. It is instructive to note that the grass-roots efforts to proselytize the Web at GIB are analogous to the grass-roots Notes efforts noted at GMC in Section 4.2.2.

None of the firms we studied make use of the full range of feature sets that are available in either Notes or Web-based solutions. The firms that are heavy Notes users stress robust store-and-forward capabilities, workflow, and project management tools. Discounted or ignored are multimedia conferencing on demand, shared whiteboard editing and doodling, or other high-end groupware features often discussed in the literature such as the successful Notes support of a CASE environment described by Gorton et al. (1996, p. 73). These firms believe that the output of the collaborative process must be guarded highly and is not meant to be interfaced to other entities. Hence, interoperability with the Internet at large, or other firms separated by Internet networks, is not a major issue. However, firms that are ambivalent toward Notes, or favor Intranet solutions, are more likely to place importance on interoperability with standard Internet protocols. These firms will invest in development efforts to provide the transaction security that is already part of Notes. In the long run, firms that use open protocols internally will have less friction in sharing products or findings with strategic partners on the Internet. The firms that protect their data with a proprietary shroud can defend this position as long as the revenues from the client base exceed the penalties incurred by the conversion processes when an interface is needed to open networks and the opportunity costs of bypassing potential partners on the Internet.

However, bear in mind that all profit-making entities must have a satisfactory model of trust before embarking on information sharing ventures with other entities. The strength of an Intranet solution is really only as strong as its ability to leverage information from the internal system seamlessly with Internet data sources. However, there is no current seamless solution because vendors are in disagreement on how to secure the medium satisfactorily. Some, for example Microsoft, posit a model where a firm adds other firms to its list of trusted partners, much like keys on

a key chain. Others, for example Netscape, would have the firm use specialized and expensive servers to transmit encrypted data on a secure channel to a specialized client. While this debate persists, turnkey systems simply do not exist to interface internal (firm-wide) groupware to strategic partners on the Internet or casual (*ad hoc*) information vendors; this in the short-term is in favor of the Notes alternative. Notes advocates can point to superior store-and-forward and workflow functionality on an internal network; we expect to see Web-based internal solutions to gain momentum in the three firms we studied as pioneers make use of new security Internet standards, as they evolve. In other words, standards bodies (the IETF and the W3C) which drive the evolution of protocols on the global Internet also drive the direction of network software products. And, since groupware is quite clearly a network software product, the breadth and depth of the feature set of Intranets are augmented by advances in this arena. We expect the Notes product to conform fully to Internet networking protocols over the next one to two years causing it to continue as a viable choice as a firm-wide groupware system. Of course, it is much easier to justify keeping Notes after it is firmly entrenched than it is to justify purchasing and implementing Notes from ground zero.

To summarize, we have found that firms with a large Notes installation are likely to stress the features after implementation that were attractive a priori such as a strong security model and a server replication feature to accommodate a distributed client base. If the firm is also investigating Intranet based solutions actively, it will discover tools (such as a large-scale and efficient search engine or a global posting system that can span the corporate network boundary) that make the set of Web-based solutions gain at the expense of the Notes installation base. We also see Notes moving toward interoperability with open Internet standards to counterbalance the higher velocity of Intranet software development; this trend can be used as an argument to support both types of groupware solutions until the Intranet-based tools can address their deficient security features. If a feature- and price-attractive solution to the security problems that exist in today's Intranet groupware toolkit comes to light, Notes will be left with the sole advantage of efficient server replication and firms that are Internet-aware in their R&D activities may have sufficient incentive to switch entirely to Web tools to solve the internal coordination problem. Firms that do not care particularly about Internet activities will probably not consider an exodus from Notes until both the security and the replication issues are seamlessly available in a suitable set of vendor products.

6. Future directions

This article suggests in several places that a metric would be useful to facilitate comparison between Notes- and Intranet-based enterprise-wide groupware. The process of quantifying costs and benefits of each approach is quite tricky; firms may vary in their attitudes toward security, toward interoperability with the Internet at large, and their core feature set requirements. Nevertheless, as Intranet offerings

continue to reduce their deficiencies in native access-control support and persistence (state) across client sessions, a basis of comparison would be most useful to senior IT decision-makers and researchers alike.

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