Chapter 2

Information Systems Infrastructure

Learning Objectives

- To be acquainted with the technological as well as human and organizational capabilities of information systems
- To appreciate the need of building flexible and robust IS architecture
- To understand the role of business process reengineering in designing IS infrastructure
- To be able to distinguish different architectures such as file server computing, client-server computing and Internet computing
- To understand the role of data centre and network resources in enterprise-wide business applications

In the spring of 2001, Ashish Mitra, CIO of a leading Indian petro-chemical enterprise, was entrusted upon the daunting task of preparing a blue-print on information systems infrastructure (ISI) for his company. The company has 5 oil refinery plants and over 300 sales distribution centers apart from the corporate office and R&D centers. The top management of the company has accepted the recommendations of the consultant to restructure the company around strategic business units (SBU) and e-enable the entire enterprise using state-of-the-art IT, such as ERP, SCM and the World Wide Web. Although the company's financial performance has been excellent, the management visualizes new threats due to changing environment around the globe and wishes to adopt best business practices while exploiting the power of IT. The existing information systems were mainly home grown and were not standardized across business units. One of the first challenges encountered by Ashish Mitra was to understand what ISI is all about. In fact ISI means different things to different people. Several researchers view it as a collection of technological resources that provide the foundation for computer-based application systems. Others view ISI as a combination of technological and other resources such as processes, organizational structure, and people (Star and Bowker 1995). Based on the published literature, the working definition of ISI is derived *'as a base of shared technological, human, and organizational capabilities that provide the foundation for computer-based business application systems in the form of services to a range of users'.*

Evolution of Business Processes, Organizational Structure, and IT Architecture

Information systems infrastructure comprises:
- business processes
- organizational structure
- IT architecture
- people
- management control

The co-evolution of information technology architecture, business processes, and organizational structure over the past 40 years has indeed dramatically influenced the concept of enterprises. IT is no longer simply a tool to support back-office transactions; it has become a strategic business component, enabling the reengineering of business processes, redesigning of the organizational structure, and redefinition of markets and industries. Just as IT has radically altered how the relationship between firms is viewed, it also challenges the notion of relationship within them.

As companies install sophisticated information and communication technologies with the potential to link everyone within the firm to a common source of organizational knowledge and a fully distributed network of relationships, the rigid walls around organizational layers and functions begin to disappear. As IT becomes the major platform upon which a company is organized and business is conducted, the organization can no longer delegate the responsibility of IT to its operating managers and IT professionals.

Strategies and policies that guide the development and deployment of IT within the organization must be defined, enforced, and continuously reviewed as part of an ongoing process of developing and monitoring business strategy. Also the organization must understand that IT architecture is only one of the many components of IS infrastructure. The other components of ISI are business processes, organizational structure and culture, people, and management controls. The organization must recognize the interrelationship between all these components while designing and implementing IS infrastructure.

Information Systems Architecture

The rapid development of IS infrastructure is attributed to the evolution of informations systems architecture technology over the decades from mainframe, to client–server computing, and finally to modern-day component-based Internet computing.

The IS architecture has evolved from the mainframe era to the client–server and distributed component (Internet) era as shown in Figure 1.

Mainframe Era (1960s to 1970s) The IS architecture in the mainframe era was based on centralized computing and data processing using proprietary hardware and software technology. The entire software is installed in the central host computer. Users interact with the host through a terminal that captures key strokes and sends that information

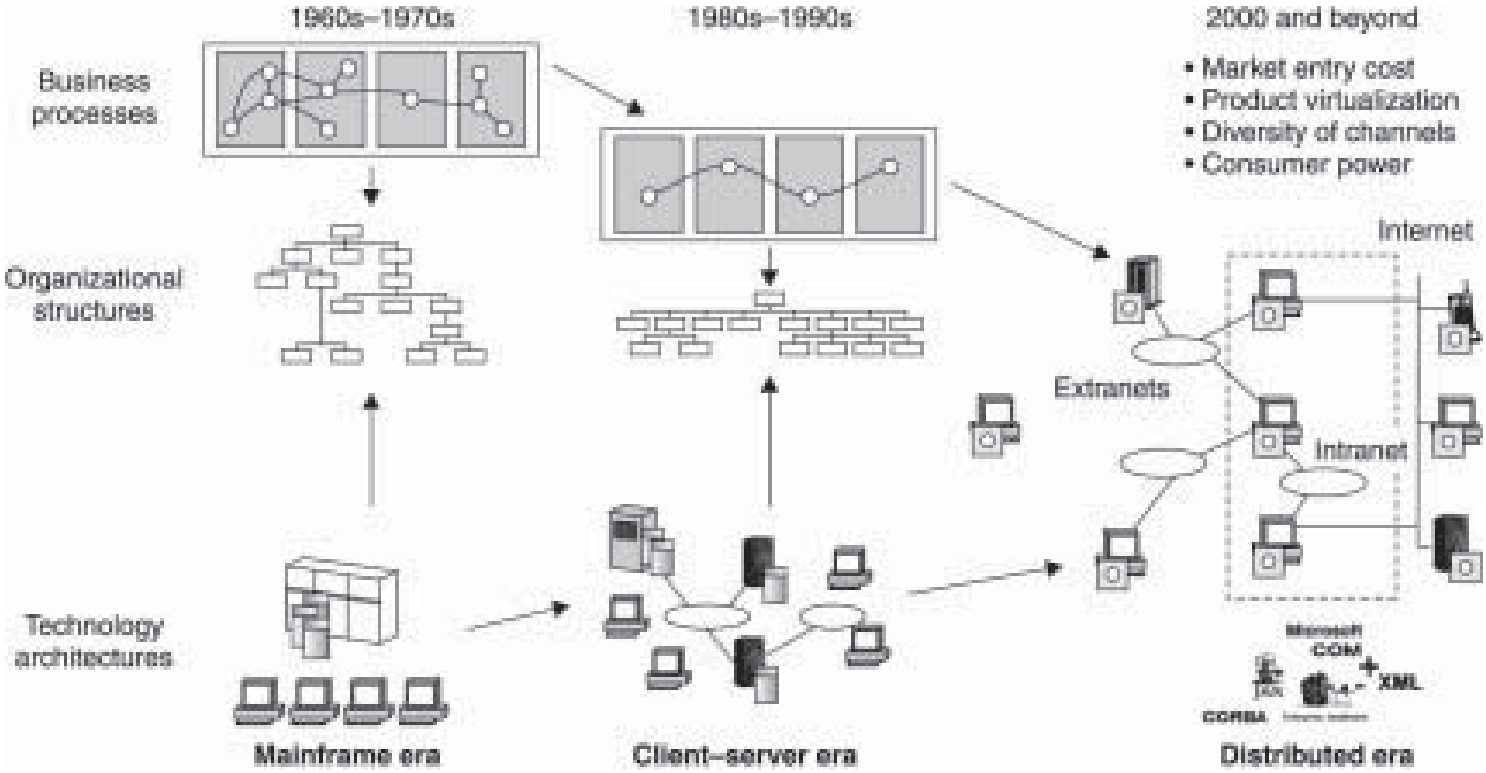


Figure 2.1 The evolution of business process, organizational structure, and IT architecture

to the host. The mainframe software architectures are not tied to a hardware platform.

User interaction can be done using PCs and UNIX workstations. A limitation of mainframe software architectures is that they do not easily support graphical user interfaces (GUI) such as icons in windows or access to multiple databases from geographically dispersed sites. However, in the early 80s the advent of PCs and local area networks gave birth to the *file sharing architecture*.

The original PC networks were based on file sharing architectures, where the server downloads files from the shared location to the desktop environment. The requested user job is then run (including logic and data) in the desktop environment. File sharing architectures work if shared usage is low, update contention is low, and the volume of data to be transferred is small.

Given such constrained local information processing capability and limited direct interaction between users and data, the mainframe era was characterized by a focus on data processing. The impact of IT on management in this era was limited to automation of back-office applications. The organizational structure (hierarchical) and business applications (functional) were not affected by IT. The use of IT was confined to the IT specialist.

Client–Server Era (1980s to 1990s) The client–server architecture may be defined as an organization of computer applications on a network in which one computer (the client) can request for a process or data from another computer (the server) attached to the network. The term is a functional, not physical, description. In other words, the two computers may alternate their roles as 'client' and 'server'. *Binding* is the process whereby the association between the client and the server occurs. Binding may be dynamic, which means that the client may find the appropriate server through the network directory service if the server is registered. The typical client–server model divides an application into server-side and client-side components. Client–server applications typically distribute the components of an application so that the database would reside on the server, the user interface would reside on the client, and the business logic would reside on either of them.

To access and use the server-side application, a client computer (e.g., a desktop PC) should have the associated client application installed on it. The client application usually employed is a non-standard and proprietary interface—that is, the 'look and feel' of the interface and its navigational features are unique to that particular application and seldom resemble the other programs that a worker is used to. Users need to be specially trained to operate the software.

Upgrading the server-side application usually requires upgrading the client software also. Clients may be 'thin' or 'fat', depending on how much of the software is running on the client. Factors affecting the right client weight include the speed and reliability of the network, the degree of security required, and cost (thin client machines are cheaper). Thin clients require less remote support to maintain software because more of the software resides on the server. If the network is slow (e.g., phone lines) then a fat client is appropriate because less data is transferred though each transaction.

By catching data on the remote machine and having the client software to provide the access, the impact of unreliable networks (e.g., remote sites) can be minimized. The client–server architecture can include two or more layers. A two-layer system has a 'fat' client connected to a database server via a network. The three-layer model has a 'thinner' client connected to an application server that is connected to a database server.

In a *two-tier client–server architecture* (Figure 2.2), the user interface and the business logic part of the application software are stored locally on the client computer (PC) while the back-end part, the data warehouse,

resides on the network server. In a *three-tier client–server architecture* (Figure 2.3), the user interface resides on client computer and the business logic and database software are loaded onto two different logical servers. The three-tier client–server architecture improves on the two-tier client–server architecture in two ways:

First, and perhaps most importantly, it makes the application less fragile by further insulating the client from changes in the rest of the application. Also, because the executable components are more fine-grained, it allows more flexibility in the deployment of an application. The user interface layer communicates only with the business rules layer, never directly with the database layer. The business rule layer, in turn, communicates with the user interface on one side and the database access layers on the other.

Thus, changes in the database access layer will not affect the user interface layer because they are insulated from each other. This

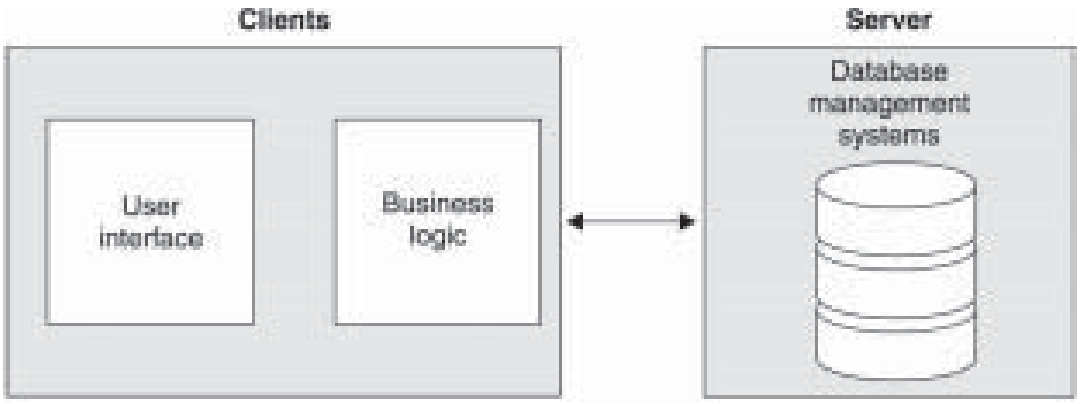


Figure 2.2 Two-tier client–server architecture

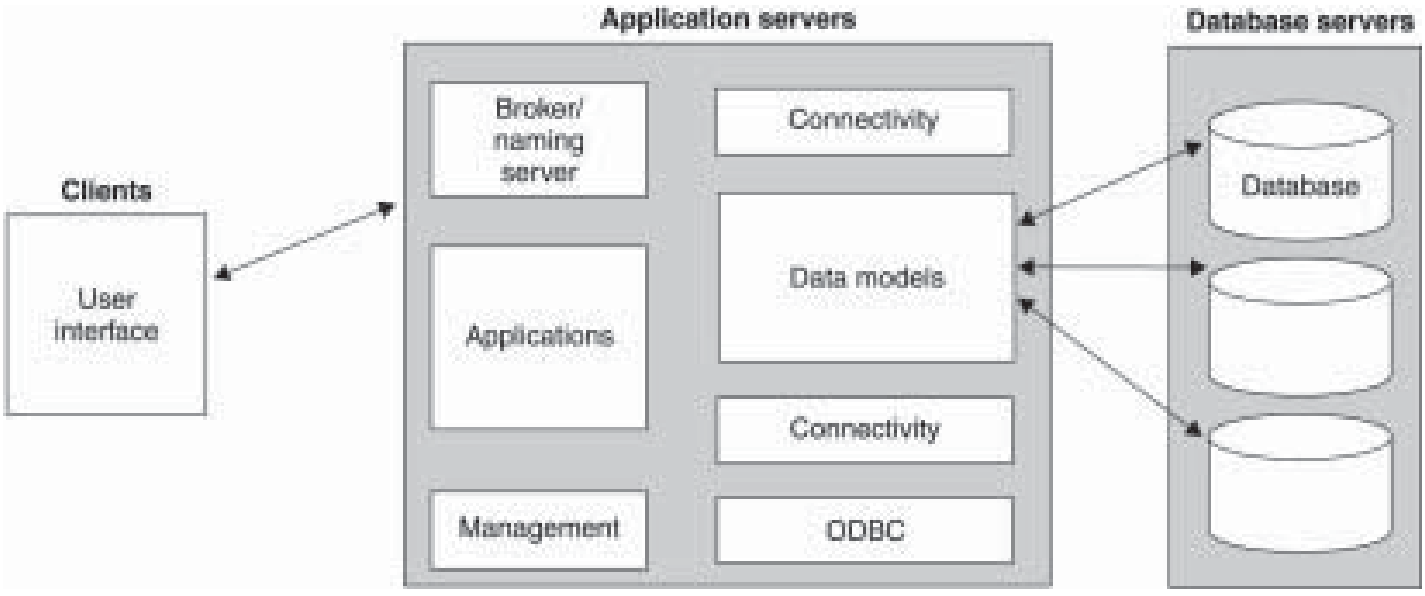


Figure 2.3 Three-tier client–server architecture

architecture enables changes to be made in the application with less likelihood of affecting the client component.

Web-based Client–Server Most of the enterprise application software such as SAP R/3, PeopleSoft, Oracle, Baan, I2 technology, SIBEL, etc. have been developed using client–server technology and are now translating to Web-based computing. In this case the application software resides entirely on a network server and the client computer only needs a standard browser. The browser is a 'thin client' unlike the 'fat client' of client–server computing.

The browser provides a window to the server-based applications. To upgrade or modify application software, customers need to make changes only on server-based applications rather than upgrading hundreds or thousands of copies on individual PCs. The benefit of Web-based computing is that users do not have to learn to navigate multiple interfaces and the cost and administrative burden of keeping each desktop in the firm updated are reduced because fewer applications need to be stored and maintained. Web-centric applications also allow larger number of clients to be served simultaneously.

The Web-based applications may be categorized as Internet-enabled applications and Web-native applications. Since these applications were originally built for the client–server environment and then subsequently redesigned to run over the Internet, it requires a very high network band-width to run. Technologies such as CITRIX may be deployed to reduce the network bandwidth for these applications.

Client–server architecture is supposed to be independent of hardware, operating systems, and database systems platform, and hence it invokes an open system view. Therefore, it enables tremendous flexibility in designing IS infrastructure. Finally, client–server computing fundamentally changes how people interact with each other and with the technology itself. Most of the enterprise application systems such as SAP R/3, Peoplesoft, BaaN, Oracle, etc. are based on client–server architecture and its implementation affects the organization's business processes, structure, and people.

These applications enforce the manag ement to reengineer their business processes as well as restructure the organization. Rigid hierarchical management control and standardized operating procedure are to be replaced with streamlined, integrated, and synchronized operations and controls. The centralized authority systems and functional hierarchical reporting and incentives must be replaced by a more

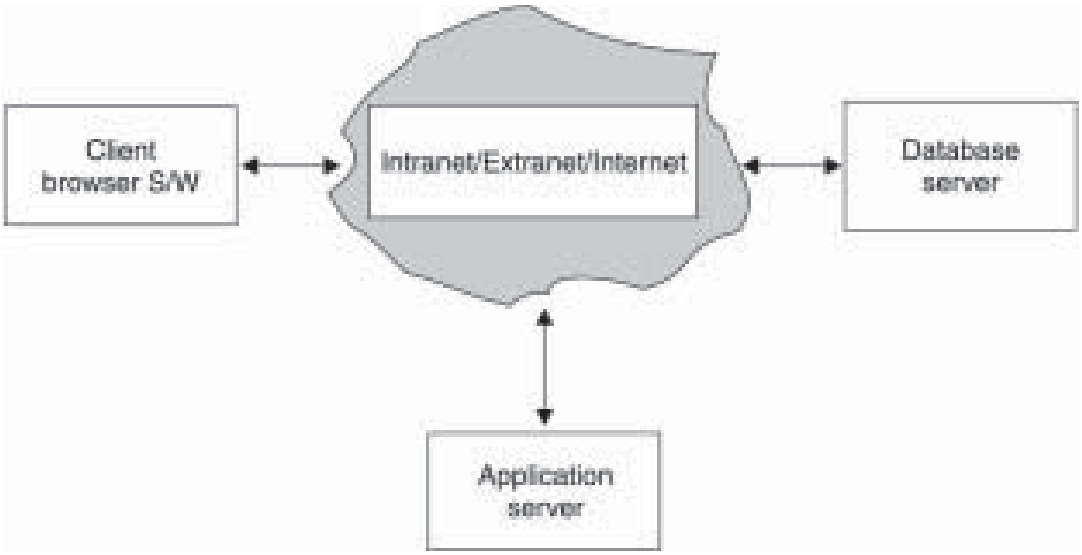


Figure 2.4 Web computing architecture

collaborative organizational design. This calls for the need of cross-functional teams of business users and IT professionals with the help of external consultants for designing IS infrastructure.

Distributed Component Era (2000 and Beyond) The next generation technology is the emergence of distributed component architecture, which promises to be the most significant shift in corporate computing environment since the move from monolithic enterprise systems. In particular, the shift towards componentized, packaged applications—large-scale suites that combine component-based software with highly integrated functionality—heralds a new era in the design, implementation, maintenance, and upgrade of corporate information systems.

These new application suites promise highly configurable application systems that match the distributed functionality of real-world business processes more closely than any previous architecture did. It is these real-world applications of componentization that make this new technology especially germane to the dynamic, fast growing companies. This architecture takes the concept of muti-tier client–server to its natural conclusion. Instead of differentiating between business logic and data access, the distributed component system model simply exposes all functionality of the application as objects, each of which can use any of the services provided by other objects in the system, or even objects in the other system.

The architecture can also blur the distinction between the 'client' and the 'server' because the client components can also create objects that play server-like roles. However, business components are distinct

from GUI components such as drag-and-drop buttons, boxes, and images. They are also distinct from utility components that are used to provide system and infrastructure services such as database connectivity and event service components.

In contrast, business components encapsulate business characteristics such as business logic, business process, business rules, and information. Thus far, most component reuse has centered on reuse of technical components, especially user interface components. The power of business components, which provides the capability to make real inroads into better productivity, resides in the business knowledge that goes into developing those components. This knowledge is embodied in the component models that are used to architect and specify the business components. A *component* may be defined as a language-neutral, independently implemented package of software services, delivered in an encapsulated and replaceable container and accessed via one or more published interface. While a component may have the ability to modify a database, it should not be expected to maintain state information. Component is not platform-constrained nor is it application bound. Presently only IFS and JD Edwards products are based on component technology; however, all major vendors such as Baan, SAP, and Oracle are expected to componentize their products in future.

The deployment of enterprise application systems such as ERP, CRM, and SCM would require a well-designed enterprise-wide communication network. The following factors need to be considered while designing the enterprise-wide corporate network.

Data Center Network

The connectivity amongst application servers, database servers, and all other computing and communication hardware is the heart of the network and has to be fully tail-proof in all respects. The servers should be having RAID storage with hot swappable replacement. It has to have dual power supply. Servers must have multiple and redundant high-speed network interface cards. Since all clients from LANs, CANs, MANs, and WANs would connect and request to the application server, which in turn would fetch data from or save data to the database server, the traffic between application servers and database servers would be much higher than that between clients and application servers.

Therefore, these connectivities are to be logically isolated by way of subnet and activation of the layer-3 routing capability of modern

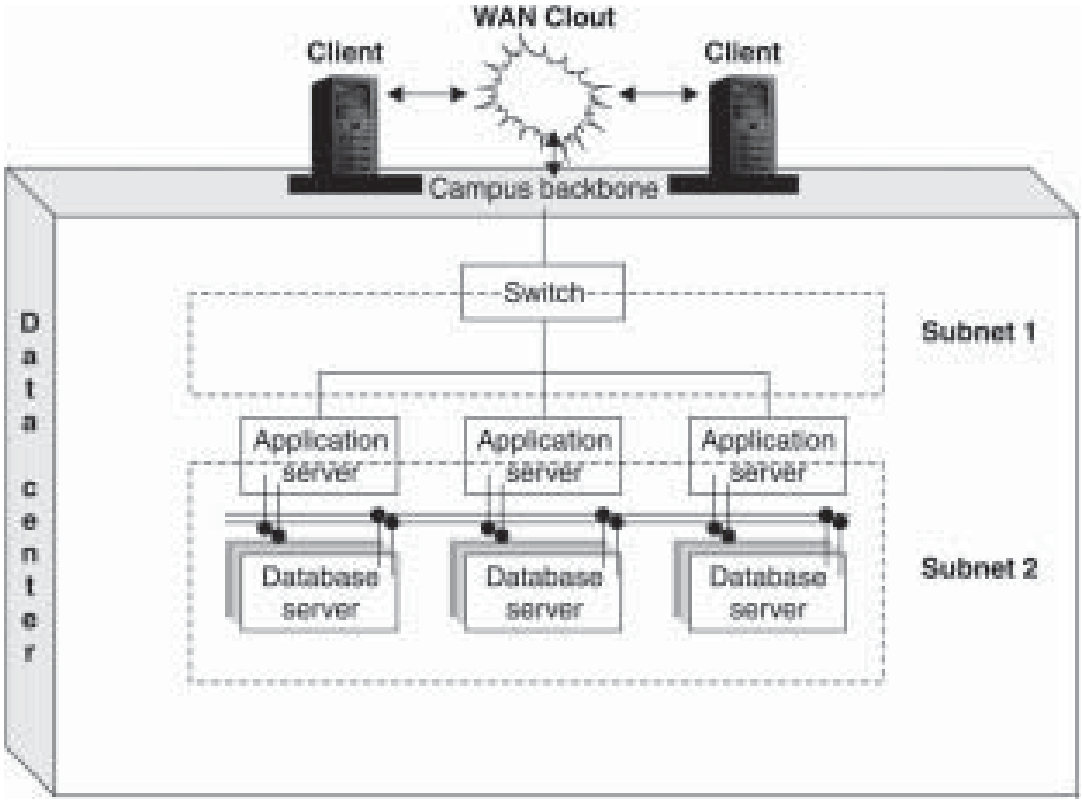


Figure 2.5 Schematic of data center network

switches. Chassis switches with high back-plane capacity and port redundancy are to be deployed in the data center. All cable plants are to be structured which will connect the data center items including servers. Network devices are to be software configurable and should be scalable and flexible. Stable, surge-free power supply is another requirement with UPS backup. UPS should be so chosen to provide backup time not less than the specified one. It should also offer true DC and ripple-free supply after inverting.

All equipment of data center should be placed close by and in the same room since it will eliminate even the minimum chances of data loss. Any high-speed network, for example, Fast Ethernet, Gigabit Ethernet, and the latest 10 Gigabit Ethernet should only be considered for building data center network. Conforming to all the points mentioned above would ensure high uptime, maximum redundancy, and high traffic in the network.

Network Connectivity

The corporate network should be such that it offers flexible, scalable, and reliable connectivity to all locations and all users. Unless uniform business logic/business standards are enforced in all locations to all users

through enterprise application systems and unless cent percent critical information of all business/decision units are captured, the purpose of enterprise systems is defeated. The database will remain incomplete, and thereby decision support systems (DSS) will also be very weak.

Bandwidth Requirement

Bandwidth is the major consideration in any network. The issue is most critical in case of wide area network. As we move from data center to local area, local area to campus area, campus area to metropolitan area, and finally wide area, available bandwidth decreases. For example, there is lightning speed of operations (teraflops) inside processors, and 100 Mbps to 10 Gbps speed in LAN and CAN, but the speed in MAN and WAN is limited to a maximum of 2 Mpbs. So identifying the applications and calculating the bandwidth are pre-requisite for WAN operations. To calculate the bandwidth for each location, one has to establish (a) average bandwidth requirement of each type of transaction and allied services like query, commit, roll back, report and print, (b) the total number of users currently making on-line transactions, and (c) latency, response time, and congestion loss. All combined will give the total bandwidth requirement of the location. For higher offices/locations, the aggregate of bandwidth requirements of self and other locations converging there are to be calculated. For data center, the highest bandwidth would be required.

Communication Protocol

The undoubted choice is TCP/IP over LAN's & WAN's. Older protocols like IPX/SPX are to be eliminated since working with these protocols results in performance degradation. Novell Netware, which was earlier working with these protocols, has facilitated pure TCP/IP suite.

Network Management

Even if a network is properly designed and implemented, its success cannot be sustained for long without proper network management systems (NMS). The following issues should be looked into for greater details.

The most important thing in NMS is adoption of policy-based management. There should be a clear-cut organizational policy for bandwidth management, backup and recovery management, maintenance management, contingent management, and quality of services (QoS).

A decision has to be taken to identify or post an officer in each location who will coordinate with divisional coordinators, regional coordinators, and finally the corporate coordinator for day-to-day and long-term network planning.

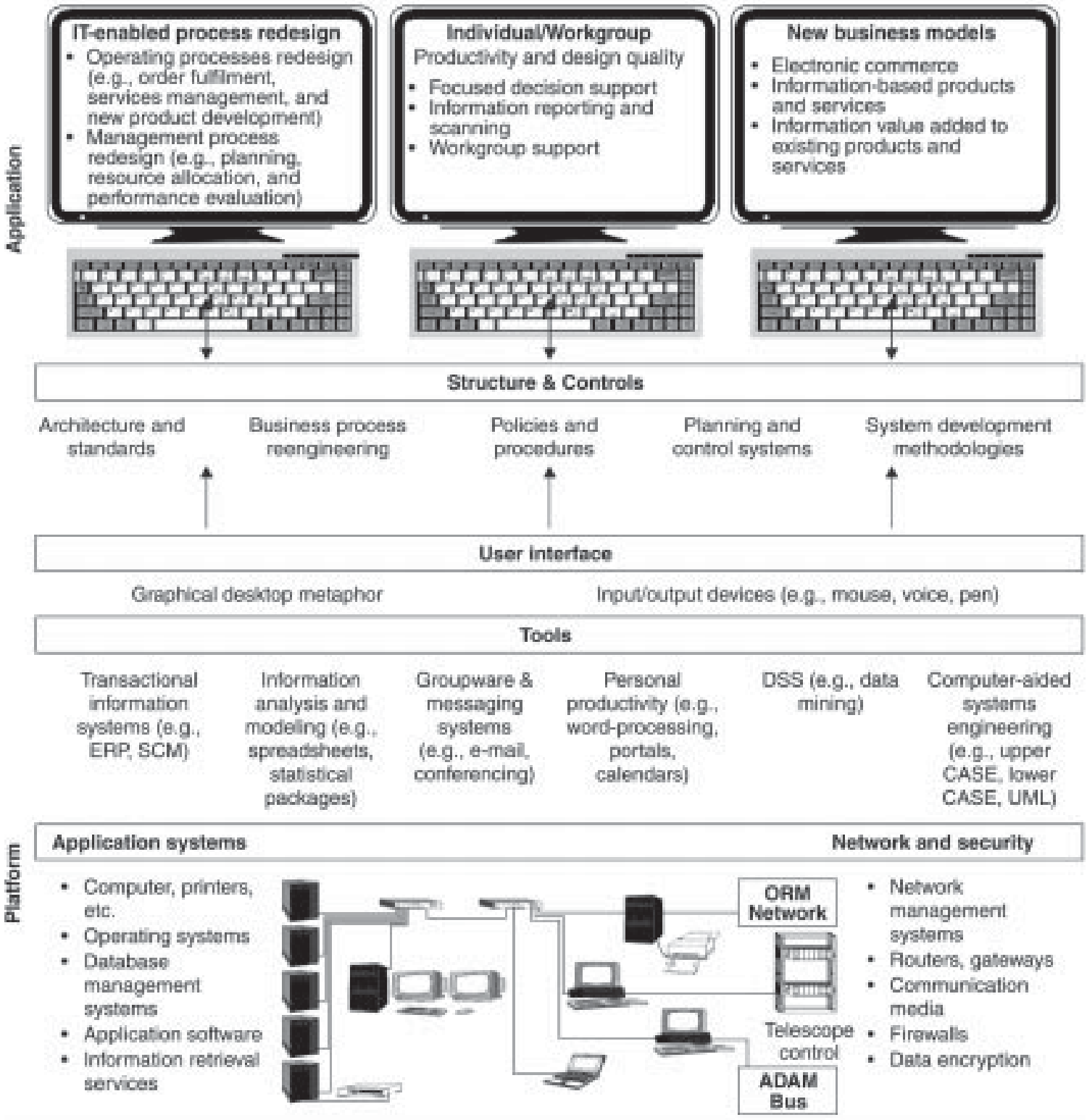
In a heterogeneous environment where there is every chance of multi-point failure, good network management tools are pre-requisite for tackling management-related issues. The software should be able to detect the faults and take corrective actions automatically with due logging of facts. If it cannot rectify the errors, it should generate systems alarm depending on the severity of the problem. The software should also facilitate remote configuration of the server machines, client machines, and communication devices.

The NMS software must also have the facility of automatic software deployment so that one version of any software can be installed in the remote client's PC without actually travelling to the place.

Network Security

The next vital issue is security of the network. The security threat may come from internal sources or the external world. The threat could be purely out of ignorance or completely intentional. The potential threat might come from virus attack, computer hackers, and intruders. The need to protect tangible (applications, networks, servers) and intangible (processes, intellectual property, competitive intelligence) assets of the enterprise leads to a whole gamut of security solutions. Therefore, the protection has to be taken care of both in design and management of network.

The above study identifies three factors underlying ISI: IT capabilities, human capabilities, and organizational capabilities. *IT capabilities* refers to the capabilities of IT including computing architecture, network design, and security architecture. Technological capabilities are provided in a form of reliable services and are usually coordinated by the IT department. IT components are increasingly being made available as commodities in the marketplace. *Human capabilities* refers to the ability of information management personnel to develop and maintain business applications and to understand business functionality. Information management personnel include both IT and non-IT staff. *Organizational capabilities* refers to the ability of an organization to manage and coordinate its members. These are done through processes, procedures, policy, training, leadership, etc.



Source: L. Applegate, *Managing in an information Age* (Boston: Harvard Business School Publishing, 1995)

Figure 2.6 IS infrastructure

In conclusion, it is appropriate to view ISI as a multidimensional construct and assume each dimension as equally important. However, due to rapid technological advancement, the IT aspects are getting simplified, posing more challenges to human and organizational capabilities.

By now ISI is somewhat well understood but the major task of preparing blueprint on ISI for a company is still unresolved. What kind of information would be needed for the same. Will it require a cross function team to carry out needs analysis? What methodology has to be used to carry out ISI requirements analysis? What should be the characteristics of ISI? Is business process redesign a part of ISI task?

Summary

In a competitive global environment, organizations need to build a flexible and robust information systems infrastructure (ISI). However ISI should not be looked at only from the technological perspective, but it should also include human as well as organizational capabilities. There has been a rapid development in ISI over last 30 years. The IS architecture has evolved from mainframe computing to client–server computing and now component-based Internet computing.

The mainframe computing architecture was based on centralized computing resources which were built using proprietary systems. The client–server computing architecture enables distributed computing using network systems. The emerging component architecture is based on Internet computing. The deployment of client–server and component-based enterprise systems put pressure on network resources such as server, bandwidth, security, and data centre.

Key Terms

Information systems infrastructure A base of shared technological, human, and organizational capabilities that provide the foundation for computer-based business application systems in the form of services to a range of users.

Mainframe computing Computing based on centralized computing and data processing using proprietary hardware and software technology where users interact with a central host computer through a terminal.

Two-tier client–server computing A method of client–server computing where the user interface and the business logic systems of application software are stored locally on the client computer and the back-end system, i.e., the database, resides on the network server.

Three-tier client–server computing A method of client–server computing where the user interface resides on client computer and business logic and database systems are loaded on two different logical network servers.

Component architecture Assembling parts of an application based on an object-oriented programming language—essential hardware, software, personnel, and documentation components of a system, their responsibilities, their relationships, and their interfaces.

Data center A data center is a centralized repository for storage, management, and dissemination of data and information organized around a particular area or body of knowledge such as the business applications of an organization.

Network management A set of activities and duties that provide high-quality, reliable communication among a group of networked computer users—resource planning, network design, providing user assistance and training, reconfiguration of the network, and troubleshooting and remedying network problems.

References

Star, S.L. and Bowker, G.C., 'Work and Infrastructure', *Communication of the ACM* (38), p. 41, 1995.

Weill, P. and Vitale, M., 'What IT infrastructure capabilities are needed to implement e-business models?', *MIS Quarterly Executive*, Vol. 1:1, pp. 17–34, 2002.

Broadbent, M., Weill, P. and Clair, D., 'The implications of information technology infrastructure for business process redesign', *MIS Quarterly*, Vol. 23, pp. 159–1.

Concept Review Questions

1. What are the drawbacks of mainframe computing architecture?
2. Explain the difference between file server and client–server computing architecture?
3. What are the advantages of 3-tier client–server computing over 2-tier client–server computing?
4. How is distributed component architecture different from Web-enabling client–server architecture?
5. What are the technological and managerial functions of data centre in ISI?
6. How is BPR related to ISI?

Critical Thinking Exercises

1. The Electrolux Group is the world's largest producer of appliances and equipment for kitchen, cleaning and outdoor use, such as refrigerators, cookers, washing machines, chainsaws, lawn mowers and garden tractors. The Electrolux India is in the process of implementing e-business system (PeopleSoft software) across its supply chain management as shown in the following figure. The telecommunication bandwidth is not adequate to run the e-business application systems. Suggest an appropriate computing architecture such as client–server, network computing, or server computing as shown in the following table. Also justify your suggestions.

Computing architecture	Client–server computing	Network computing	Server-based computing
Client hardware	Fat client	Fat client	Thin or fat
Application systems architecture	2 or 3-tier client–server	Component	Main frame, 2- or 3-tier client–server or component
User interface	Windows	Java	Windows or Java

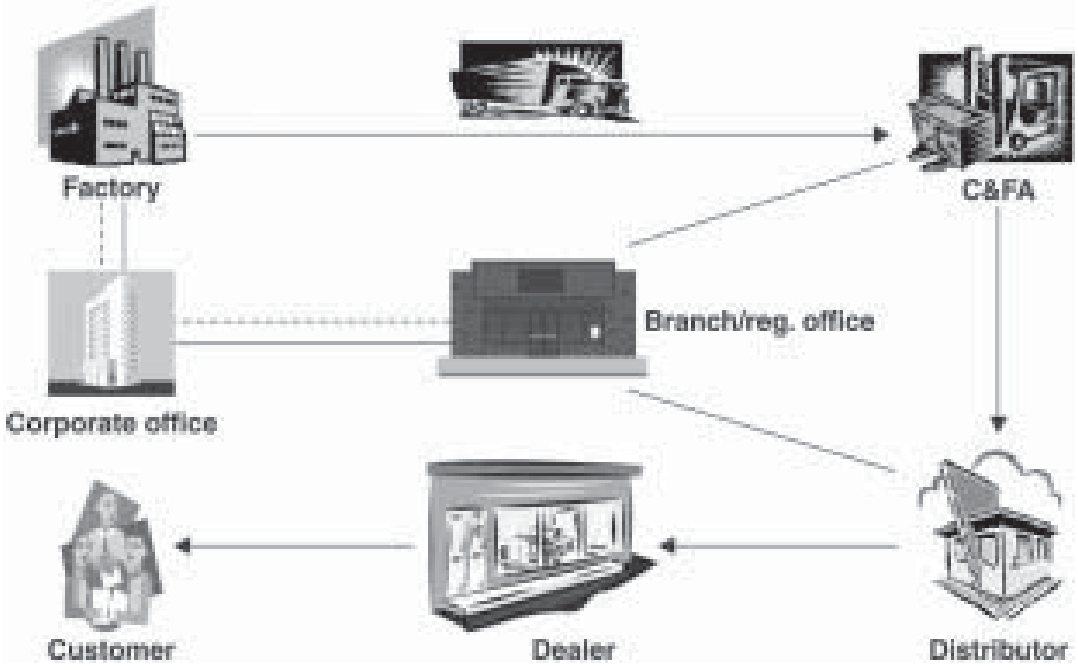


Figure: E-business architecture at Electrolux India

Project Work

1. National Thermal Power Corporation Limited (NTPC) is the largest thermal power generating company of India with the annual power generating capacity over 21000 MW. NTPC has about 23 power-generating project units scattered all over the country and wish to implement Web-based state-of-the-art packaged integrated information systems (IIS) to fulfil the following business objectives:
   - To optimize asset, service, and customer business processes across the enterprise for the highest return on capital and human assets
   - To improve productivity of its manpower, plant equipment, finances and spare parts inventory
   - To improve customer services while reducing service delivery costs

   However in order to achieve the above business objectives, the proposed IIS will include business process reengineering, cultural change, and organizational restructuring, such as creation of strategic business units.

   Your group is supposed to prepare a blueprint of the design of IIS infrastructure as per the above requirements of NTPC.
2. IRCON International Ltd is a leading construction company with an annual turn over of Rs 8002 million. It has got the corporate office in New Delhi, four regional offices and over 20 project sites including four overseas. Most of these sites are in remote locations and keep shifting as the work progresses. Its major business functions include project management, assets management, finance & accounts, contract management, procurement and human resource management. The company wishes to implement an integrated information system using packaged solutions such as ERP. The following objectives are expected to be achieved from the proposed systems.

- To ensure the accuracy, completeness and consistency of business transactions
- To integrate the operations of the various business processes across the functions
- To ensure transparent decision making based on information
- To establish world-class business processes and best practices

Your group is required to design various architecture options for IS infrastructure for the IRCON keeping in view the characteristics of its project sites.

3. Select any company and study its ISI with respect to its effectiveness, flexibility, openness, security, and future relevance due to advancement of technology. The study has to be carried out using primary as well as secondary data.

Case Study

Information Systems in New Holland Inc.

New Holland Inc. brings Ford technology to Indian soil, to meet the demands of the traditional farmer and rural markets, along with another modern tool—knowledge management. 'Thinking global, acting local,' goes the mission statement of New Holland tractors, like most other international companies which wish to make a mark in the country's local market. But unlike the other manufacturing industries, the challenge here is much greater.

The product may offer world class technology, but it has to find a place in the highly traditional rural market of India. The farmer here cannot be swayed by hi-tech gimmicks—he means business. Unless he is assured of significant returns in income and productivity, he will not easily part with his money. 'Being the latest is not necessarily an advantage for us because agriculture all over the world is still a very traditional industry,' admits T.L. Palani Kumar, Managing Director, New Holland Tractors.

The company, which manufactures Ford tractors worldwide and boasts of a global market share of 20%, came to the country in 1996 with ambitious plans. Along with the mammoth task of establishing a tractor unit, it also wanted to create a self-contained knowledge base through information systems. 'We did not have the luxury of first putting our project in place, letting the company become operational and then look at the management of information. We were clear that a knowledge base was also important and had to be created along with the project. This was an ambitious move because there is so much to be done in setting up a business—making a plant, creating the supply chain and putting the best practices in everything that you do,' says Palani Kumar.

In order to meet the expectations of increasingly demanding customers in growing markets, and to fully accomplish the company's mission 'to be a customer-driven organization, flexible, agile and innovative', New Holland's strategy is based on the following four points:

- Customer orientation
- Global product excellence—emphasizing quality on a worldwide basis
- Global organization
- Strategic development in new areas, new markets

New Holland is divided into three business divisions: agricultural division, construction machinery division, and financial services division.

Power of Knowledge The idea behind creating such a knowledge-oriented culture in the company was obviously to understand the real needs of the

consumer through information from dealers and suppliers. There was a need to create product-related databases that were relevant specifically to the Indian farmers. The company was also seeking a complete customer database which has much more detailed information compared to a traditional invoice. This would enable the company to provide much better service.

'The fact is that rural marketing even in the West is logistically a nightmare. So, when you have to deliver a service to the farmer in a large country like India, it is even more difficult because practically every region has its own specialized farm practices,' says Palani Kumar.

Gradually, New Holland went on to create an entire set of databases including ones that contained information about business associates, employees, customers, and so on. Based on the knowledge base it created, the company had to devise a structure and focus for its operations. The emphasis was on having a flat organization, where the process of decision making was decentralized. For this, it was important to have total connectivity, which would allow people in any location to share information on a day-to-day basis. At present there are four locations in and around Delhi—the corporate office, spare parts center, training farm and factory, including the research and design center. Each of these has its own local area network, which allows access to information from the database. Palani Kumar says, 'This has promoted a culture which allows the company to follow the best business practices while setting up the supply chain.'

Driving with IT IT was identified as the major business driver right from the start. The IT plan had to be in conformity with the broad marketing and business goals. Apart from using knowledge management, information systems at New Holland had to put the best business practices in place. Integration of all the operations was essential to create an environment for growth.

Although the network systems had to be in tune with worldwide operations, the decision to go for ERP software at the project stage itself was taken entirely by the local management. An investment of Rs 11 crore was planned for Baan ERP and Lotus Notes groupware. Rajesh Kharbanda, Chief of Information Systems, New Holland, says, 'For selecting the suitable ERP package, a team of users from different areas was formed and the objective was to select a package suitable for the manufacturing business.' SAP, Baan, and Oracle were the main packages that went through evaluation. Besides going through detailed presentation of these vendors, the team visited various sites where these solutions were being used.

Baan's advantages were:

- Baan was oriented towards a manufacturing environment and had more functionality.
- With limited time for understanding and implementation, simplicity was an essential prerequisite and Baan was found qualified in this regard.
- After inclusion of implementation costs and consultation fees, Baan was found comparatively more cost effective.
- The parent company had a legacy of a variety of systems and Baan was one of them. Although selected locally after evaluation, the decision was also supported by the parent company.

The ERP project began in October 1997 with basic modules such as sales and purchase, inventory, finance, and manufacturing. It went live in the beginning of this year, and at present, there are 75 licensed users of Baan. The number is likely to increase to 125 in the next two years. It runs on RS/6000 F50 model Unix servers from IBM, which have been divided into database–server and client–server architecture. They work together in a cluster mode, which means one can take up the job of the other in case of any failure.

Both systems have about 1 GB memory each and 50 GB storage space. Besides the ERP servers, there are two NT servers for each location. One of them is used for running network services and the other is used for Notes. They have been segregated to avoid overloading. Each location runs on

a switched ethernet-based LAN, which rests on fiber optics cables.

In Partnership Following its decision to focus on IT from the beginning itself, New Holland worked out a strategy to optimize on resources. Instead of devoting a number of employees in software development, the company has decided to outsource the task. The strength of the IT department is maintained at about seven people who act as a bridge with the technology partners. Internal support is available for some amount of customization, but the moment this grows beyond capacity, it is offloaded to the technology partners.

For instance, if one person is dedicated to Notes, he can at best monitor the applications and ensure that it is fully exploited. But developing more applications would require long man hours, which one person cannot provide.

Kharbanda explains, 'With rapidly changing technology, in-house maintenance becomes difficult. Developing in-house skills and providing regular training to keep abreast with the change is also not easy.' By developing long-term partnership with experts in every area, one can save a lot of time and minimize the internal expenses. Moreover, it guards you against the turnover of employees, which is a perpetual problem in the IT industry.

Although IT services, at present, is a relatively new concept, more and more companies will gradually realize their benefits, believes Kharbanda. 'People need the maturity to accept it,' he adds. The two main partners of New Holland are IBM and Sonata Software for Lotus Notes and again IBM for ERP. While selecting the right consultant, the other available options such as PriceWaterhouse and Arthur Andersen were ruled out due to lack of experience. When the company went for Baan, it was a fairly new package and these companies did not have implementation experience.

IBM, on the other hand, had already done two projects, including an in-house one. Kharbanda explains, 'For an ERP, you need a right mix of management and technical experience, and IBM had both.' It not only provided a cost advantage, but also proved the one-stop shop for all hardware requirements. Their role is to develop applications according to requirements, manage the network and assist in other activities involved with facility management. The company is talking to other partners who can be stationed in-house for managing the plant network and take care of day-to-day administration. The in-house team also meets regularly to solve the problems that crop up from time to time.

Grouping Efficiency While the business processes are based on Baan, Lotus Notes is being used for basic information sharing. The company is consciously promoting the culture of using information in the most effective way. 'We started using groupware across all locations to be able to conduct virtual meetings,' says Kharbanda. The company wants to exploit the entire groupware suite of Lotus Notes for its day-to-day functions. It is presently using e-mails, discussion database, and workflow applications. It has developed and installed about 12 groupware applications designed for specific operations. For instance, a product-related database application has been devised to solve problems that crop up while designing products. The company wants to extend the workflow systems in three main areas and administrative procedures are being developed within these areas, namely:

- manufacturing,
- supply chain with dealers and suppliers, and
- office automation for administrative functions like travel bookings, purchases, and personnel management. For instance, when a new employee joins, all the formalities are taken care of by the workflow management system.

According to Kharbanda, this year the company has been busy streamlining its ERP applications, but next year, the emphasis will be on groupware. Kharbanda says, 'This set-up offers tremendous support to allow people in different locations to work as a team.' Besides the local area network for each location, the company is also connected to

all its twenty three locations worldwide through a WAN, which was being managed by IBM and has now been sold to AT&T. This total connectivity promotes the information-sharing culture that forms the basis of this company. It allows them to respond to market needs in a much better manner.

Value-added Products Although the entire business and IT plan has been designed to cater to the Indian agriculture industry, localization was brought in only gradually. The first product was launched mainly to introduce the technology and to inform the farmers that Ford is back in the country, so the scope of localization was very limited only to 10–15%. But it increased to about 60% with the second product. While the 70 HP tractor was priced at Rs 5.75 lakh, the 50 HP came at Rs 3.8 lakh. When the company talks of keeping the product affordable and relevant to the Indian market, one wonders whether the poor farmer can really afford this price. Palani Kumar says, 'The price of products may be higher than competitors, but the additional features justify the costs. Although the Indian customer is quite conscious of price, we want to make him conscious of the value-added services of our product.'

The fact that the company decided to set up an R&D center in the country even when it had 12 centers around the world does indicate that the company is well aware and focussed on the local needs. The design department has incorporated various features specifically for India. For instance, water-proof tractors had to be developed keeping in mind the style of rice cultivation here. Palani Kumar says, 'In India, we had to remove some sophisticated parts because they are not required here. Moreover, maintenance would be such a problem because you depend mainly on the roadside mechanic.' The design department, which is working on CADDS 5 software based on Sun Workstations is now planning to shift to Parametric Technology.

Towards a New Era From a small make-shift arrangement in a corner of the office to a fully-equipped development center, the company has come a long way. Ranging from infrastructure bottlenecks to cultural changes, it has encountered and solved a number of implementation hurdles. And adaptation is the key word. 'The biggest problem of implementing any technology is with the human interface. No technology can be utilized up to its optimum level if the people are not ready for it. The companies that are very old and have many senior people usually face a problem in adapting to new technology,' says Palani Kumar.

Being a start-up, adaptation to the latest business practices was not too difficult. As the company moves up on the maturity curve, people's knowledge and understanding of the applications would also improve. Its future plans include data mining, data warehousing, and further optimization of the present infrastructure. Although it has made an ambitious beginning, New Holland now has to live up to the challenges ahead. It has to cut across the monopoly of existing tractor makers to create room for its niche product. With knowledge management and information systems as foundation, New Holland is certainly going ahead to usher in a new era in Indian farming.

1. Draw the sketch diagram depicting IS architecture for the case company.
2. What are the management challenges the case company faced while implementing enterprise systems?
3. Assuming the company decides to extend its ERP to cover the employee portal, customer relationship and supply chain management over Internet, what would be the new challenges and the possible solution architecture?