Information Technology for Management

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OXFORD
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YMCA Library Building, Jai Singh Road, New Delhi 110001

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It furthers the University's objective of excellence in research, scholarship,
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Oxford New York
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Argentina Austria Brazil Chile Czech Republic France Greece
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in the UK and in certain other countries.

Published in India
by Oxford University Press

First published 2010

ISBN-13: 978-0-19-806414-5
ISBN-10: 0-19-806414-4

Typeset in Baskerville
by Anvi Composers, New Delhi
Printed in India by Tara Art Printers (P) Ltd, Noida
and published by Oxford University Press
YMCA Library Building, Jai Singh Road, New Delhi 110001

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CHAPTER

1 Information Technology

A market is never saturated with a good product.
But it is very quickly saturated with a bad one.
–Henry Ford

Learning Objectives

After reading this chapter, you should be able to understand:

- the current scenario of IT in business
- the various elements of IT infrastructure
- the relevance of sizing infrastructure for business needs
- and appreciate the current IT trends and their business impacts
- the need for IT audits and IT governance

1.1 Introduction

The expansion of the Internet has been called the most revolutionary development in the history of human communications. It is ubiquitous and is changing politics, economics, and social relations. The borderless nature of

the Internet produces particular needs for global institutions and has opened the door for innovative approaches.

Information technology (IT) provides a significant advantage in a corporation's ability to compete in the growing Internet marketplace. Corporations have adopted technology to increase productivity, reduce costs, drive revenues, offer new capabilities to customers and suppliers, and improve competitive positioning to respond to real-time requirements.

The on-demand, instant action–reaction business environment today requires real-time responsiveness to change, whether it is to meet new demands by customers, changes in the supply chain, or unexpected competitive moves. In order to be able to respond quickly, enterprises must provide their employees with immediate access to accurate and updated information. This greater dependence on information translates into greater dependence on the effectiveness of IT infrastructure as a whole.

Infrastructure is a concept that depends on context. To a city planner (domain/context), infrastructure is transportation and communications systems, water and power lines, and public institutions including schools, post offices, etc. The term has diverse meanings in different fields, but is perhaps most widely understood to refer to roads, airports, and utilities. These various elements may collectively be termed as civil infrastructure, municipal infrastructure, or simply public works, although they may be developed and operated as private-sector or government enterprises.

In other applications, infrastructure may refer to information technology, informal and formal channels of communication, software development tools, political and or social networks. To the chief executive officer (CEO) of an organization, infrastructure might be facilities, security, logistics, power, waste disposal, and large chunks of information technology. A flexible and robust IT infrastructure also plays an important competitive role by enabling employee productivity and globalization, allowing pervasive and secure business communications anywhere and anytime, and finally, by managing operational complexity and providing greater utilization of resource assets.

Over the past decade, as information and computer-based systems have become larger and more complex, the importance of and reliance on IT systems have grown substantially. Information technology has all the hallmarks of an infrastructural technology. Infrastructural technologies offer far more value when shared than when used in isolation. The value of infrastructure sharing has emerged as a business model to increase the bottom line. In fact, its mix of characteristics guarantees particularly rapid communalization. Information

technology is, first of all, a transport mechanism. It carries digital information just as railroads carry goods and power grids carry electricity. And like any transport mechanism, it is far more valuable when shared than when used in isolation.

In recent years, companies have worked hard to reduce the cost of IT infrastructure data centre, networks, databases, and software tools that support businesses. These efforts to consolidate; standardize; and streamline assets, technologies, and processes have delivered major savings. Yet, even the most effective cost-cutting program eventually hits a wall, the complexity of the infrastructure itself.

Large consulting organizations, such as the Gartner Group, perform regular studies on the state of the technical executive. In a 2004 report, surveyed chief information officers (CIOs) agreed that the ability to communicate effectively, strategic thinking, and planning and understanding business processes are critical skills for the CIO position. The switch in information technology's value from a function to control costs and increase productivity to a vehicle to generate revenue, is permanent. Nostalgic yearnings for IT spending levels of the past is a misuse of important time; the business model that once supported lower levels of IT spending no longer exists for many industries and will be less relevant in the future [Stevan 2001].

In the present century, a company's success will be even more driven by the extent to which it can target its products to specialized customer needs. Thus, over time, many companies will evolve to become customer-driven businesses. Market mapping is, therefore, going to be a key organizational capability. While new technologies will be developed to help companies understand customers' needs and to identify their best customers, successful companies will have to do more. They will have to start thinking in reverse, i.e., finding out what their customers want and respond immediately to those needs. They will also have to look at the world through 'new lenses' and develop a learning relationship with each customer. This relationship will be an ongoing connection, which becomes smarter as the company and customer interact with each other. This form of intimacy between a company and a customer can only be built up over time but, if successful, will yield a substantial competitive advantage.

1.1.1 Functional Roles and Responsibilities

Throughout this book, we refer to the chief technology officer as CTO. The CTO's primary responsibility is to contribute to the strategic direction of the

company by identifying the role that specific technologies will play in its future growth. As Sun Tzu said, strategy without tactics is the slowest route to victory and tactics without strategy is the noise before defeat. A CTO is expected to provide a technical strategy that seamlessly segues into the corporate business strategy.

Throughout this book, we refer to the chief information officer as CIO. Just as the chief financial officer (CFO) is a senior person responsible for devising the capital structure best suited to an enterprise's business needs, the CIO is the senior person responsible for making sure that the enterprise's IT infrastructure best supports its business needs. The CIO is the senior-level liaison between the business and technical sides of an enterprise. He/she is the person who helps define and translate business goals and strategies into a system's performance requirements and oversees a portfolio of IT development projects to deliver systems that meet these requirements. The CIO leads the application of IT to internal processes and services. This is a title that is used as a form of shorthand to infer the member of the executive team who has responsibility for all IT functions. There are other members in the IT team who are responsible for carrying out the treadmill of IT functions.

Value delivery meshes with strategic planning and the implementation of an enterprise architecture to support the business mission. The CIO needs tools and methods to identify the most productive investments and then to communicate the value to stakeholders at all levels of the organization.

According to the IT Governance Institute (ITGI), there are four critical questions for value delivery. These are as follows.

1. Are we doing the right things?
2. Are we getting the benefits?
3. Are we getting them done well?
4. Are we doing them the right way?

Many CIOs have had the nagging feeling that the traditional IT risk analysis starts out with what the analyst thinks is the answer. Then the details, weighings, and issues are aligned to show the applications, infrastructure components, and projects that score the highest risk. A comprehensive understanding of risk measures will aid the CIO to take the right decisions.

Four key business requirements (also referred to as Four A framework) have been identified for the success of an organization.

Availability Systems must be up and running. Recovery from failure should be rapid, based on the firm's business requirements.

Access Systems should be sufficiently secure to prevent loss and destruction of data but flexible enough to enable employees to do their job.

Accuracy Information must be timely, complete, and correct when presented to both internal and external users.

Agility Ability to change IT systems to meet new business requirements with requisite speed and reasonable cost.

1.2 Business Value of IT

Information technology can have a significant impact on the quality of services and solutions and the performance of a company. Efficiently and effectively managed IT investments that meet business and mission needs can create new value in revenue generation, build important competitive advantages and barriers to entry, improve productivity and performance, and decrease costs. Similarly, poorly aligned and unmanaged IT investments can sink a company. Concurrent to cutbacks in IT spending and a short-term focus, management within companies is demanding an increase in IT productivity, expanding IT's role from internally focused to customer facing and making IT more relevant to business strategy.

Misalignment between information technology and the strategic intent, inability to establish a common IT architecture, and a highly redundant and undocumented as-is architecture will result in high operations and maintenance costs. Web services and services-oriented development of applications (SODA) will continue to make the business and IT relationship more critical as IT continues to become increasingly more integral to business processes.

Business value is just one output of the collection of processes through which businesses today try to maximize the age-old equation of *profit equals revenue minus expenses.* Most businesses today rely on information technology to realize some of their business value. How do we measure the value of information technology? It is a question that is on everyone's mind, from business managers to board rooms.

The spectacular growth of IT has enormous potential for improving the performance of organizations. However, the huge investment made in IT puts increasing pressure on the management to justify the outlay by quantifying the business value of IT. In today's fast moving competitive business environment,

companies increasingly demand that IT investments demonstrate business value through measurable results.

For many companies, the link between business technology investment and business performance remains elusive.

There is a general global consensus that developments in information technology in recent years have contributed to the emergence of what has been described as the information economy characterized by significant productivity benefits at the macro level. However, there is a critical need to understand the complex relationships between IT investments and business value at more micro levels, as underscored by policy makers, practitioners, and researchers.

Implementing an innovative approach to determine the business value of information technology is an enormous task, but the payoff for the IT organization and the enterprise as a whole is worth the effort.

1.3 Role of Computers in Modern Business

It was not many years ago that the personal computer (PC) was first introduced. The benefits of PCs were obvious but limited because each computer was an island unto itself. Over the years, a great deal of effort has gone into figuring out how to interconnect computer systems. Computers are used to process, store, and exchange information in digital form. Computers have today become the backbone of business processes. The act of computing is built over computing software which runs on top of bare metal computing hardware. A variety of computing and processing software are available for various kinds of applications. Different computer applications generate different kinds of data. It is easy to imagine that the requirements for a network linking a bank's automatic teller machines (ATMs) to its computers are different from those of a network of computers that control air traffic or a car manufacturer's assembly line.

1.4 Infrastructure Management

Management has been defined as assembling the resources to achieve a mutually agreed upon objective. This reflects the two typical management structures American companies now employ: command and control, or collaboration. Based on the classic military structure, this style was popular for most of American corporate history. But now this style has lost popularity. While some environments still operate under this style, many corporations

are revisiting their commitment to such a rigid method of management.

The Five C Model, proposed by Gartner, addresses the performance areas that CEOs, CFOs, and the senior leadership team members expect their CIOs to address. The five C's—clarity, context, competence, commitment, and competition—represent more than a clever memory device. They represent key areas on enterprise balanced scorecards—performance management systems that include forward-looking, predictive metrics in addition to financials.

Collaborative management is a more modern way of handling the art of management. It ensures that all levels of the corporate ladder are actively involved in the execution of a business.

1.5 Elements of IT Infrastructure

The merging of computers and communications has had a profound influence on the way computer systems are organized. Many companies worldwide have invested on substantial number of computers. For example, a company may have separate computers to monitor production, keep track of inventories, and do the payroll. Initially, each of these computers may have worked in isolation from the others, but at some point, management may have decided to connect them in order to be able to extract and correlate information about the entire company.

In a business climate that punishes the inefficient and the slow-moving, enterprises are under pressure to manage their information and infrastructure assets more effectively and efficiently than ever. The information and infrastructure management framework is no longer an adjunct support structure; it is the essential foundation for corporate performance. A company's success in managing its information assets is a function of infrastructure, process, people, and culture, all working in concert. Shrinking business cycles have put many staid, slow-moving organizations into acceleration. Time to market, which was once measured in years, is now measured in weeks. In the intensely competitive, web-fuelled marketplace, today's window could close into tomorrow's missed opportunity. Infrastructure technologies play an important part in bringing markets closer, aiding economic development, aggregating demand, and reducing transaction costs. They also make reduction of communication travel and other costs feasible, consequently creating new forms of corporate activity.

The IT infrastructure is characterized by the 7S model (Figure 1.1). The 7S model identifies the essential IT components to ensure a good IT service.

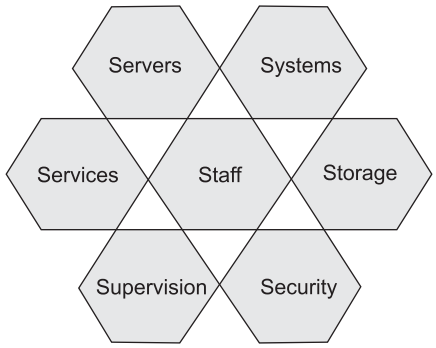


FIGURE 1.1 7S Model

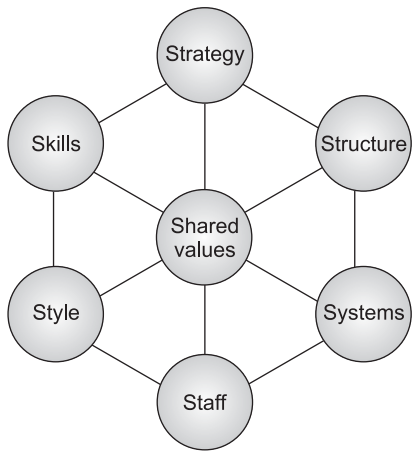


FIGURE 1.2 McKinsey 7S Model

The 7S model includes servers, systems, storage, security, supervision, services, and staff. All the seven components work together to achieve the overall business benefit. This is in line with the 7S model attributed to McKinsey.

The 7S model popularized by McKinsey & Company (Figure 1.2) characterizes a business using a set of seven distinct attributes: strategy, structure (organization and geography), systems (in the sense of both processes and IT systems), staff, style (for example, dynamic versus bureaucratic), skills, and lastly unifying shared values (such as respect for the environment and shareholder value).

1.5.1 Computing Infrastructure

Computing infrastructure is a set of technologies. Computing infrastructure is built on a growing infrastructure of rack-mounted data servers and parallel computing clusters attached to large redundant array of inexpensive disks (RAID) storage systems. Computing infrastructure also encompasses all the associated infrastructure that are required to exploit the available computing power with a good return on investment (ROI). Due to the tremendous strides made by computing technology, machines with enormous computing power are now available. It is well known that today even an entry-level machine has more computing power, in terms of storage, memory, central processing unit (CPU), and so on, than the powerful machines that existed a decade ago. It is, therefore, essential to harness the potential of computing infrastructure and increase the return on investment through suitable optimization of business processes.

1.5.2 Networking Infrastructure

Networking infrastructure is made up of a good number of gadgets built on standards. The interworking of networking infrastructure provides the essential superhighway for the movement of data traffic. A brief overview of some of the essential networking elements are listed below.

Structured Cabling

In the old days, copper wires were the only means of transmitting information. Technically, they are known as unshielded twisted pair (UTP) in comparison to their counterpart which are called shielded twisted pair (STP). The wire pairs are called twisted because they are physically twisted. They do not have a shield, and therefore a high frequency part of the signal can leak out.

A structured cabling system provides a universal platform upon which an overall information system's strategy is built. With a flexible cabling infrastructure, a structured cabling system can support multiple voice, data, video, and multimedia systems regardless of their manufacturer. A well-designed cabling plant may include several independent cabling solutions of different media types, installed at each workstation to support multiple system performance requirements.

Before an enterprise chooses to go for cabling, it needs to understand the purpose for cabling. It is important to have a foresight of business growth as structured cabling will be a long-term commitment. While selecting a structured cabling system, organizations must consider the applications that

may be required to be added in future. Once installed, it is expected to last for many years because unlike the active components it cannot be changed at will. Size of the enterprise, the expansion growth rate expected, transmission speeds, and capacities needed are the key issues.

Structured cabling offers consistency and flexibility, provides support for multi-vendor equipment, simplifies troubleshooting, and provides support for future applications.

Selection of structured cabling components as per their designed performance levels is a complex task. For this, the system integrator or cable installer has to consider key issues such as size of the enterprise, expansion growth rate expected, physical spread, and transmission speeds and capacities needed. It is recommended that one uses modular components that are pre-terminated and tested at the factory prior to shipment, where just connecting the components makes the link go up and running. Continuous growth in the structured cabling industry is directly related to infrastructure investments.

Routers

Routers are network gadgets which direct data packets following Internet protocol (IP) rules from one network to another. Routers are more complex devices. Routers determine the most efficient path to different elements in the Internet complex routing algorithms. Identified path information are stored in routing tables available within the router. Routing tables are lookup tables similar to telephone directories. Routers deal with large routing tables for the global Internet and find appropriate routing addresses on demand.

Router equipment can be classified as core routers and edge routers. Core routers reside in the core of the network. Edge routers have more diversified functions as they reside on the edge of the network and deal with network traffic. Detailed discussion on the various aspects of routers and the associated protocol are discussed later in the book.

Switches

Networks are commonly used to interconnect computers or other devices. Each network generally includes two or more computers, often referred to as nodes or stations, which are coupled together through selected media and various other network devices for relaying, transmitting, repeating, translating, filtering, etc. A network system is a communication system that links two or more computers and peripheral devices, and allows users to access resources on other computers and exchange messages with other users.

Typically, the switch is a computer comprising a collection of components interconnected by a backplane of wires. Switches split large networks into smaller segments, decreasing the number of users sharing the same resources. They allow different nodes of a network to communicate directly with one another in a smooth and efficient manner.

A majority of switches became digital in the 1980s. Vendors and operators saw that, like computers, they could be programmed, making it possible to introduce intelligent services.

Load Balancing and Load Balancers

The world of server load balancing (and network-based load balancing in general) is filled with confusing jargon and inconsistent terminology. Because of the relative youth and the fierce competition of the server load balancing industry, vendors have come up with their own sets of terminology, which makes it difficult to compare one product and technology to another. A load balancer is a device that distributes load among several machines. Load balancing is the process by which inbound IP traffic can be distributed across multiple servers. Load balancing enhances the performance of the servers, leads to their optimal utilization and ensures that no single server is overwhelmed. Server load balancing (SLB) is defined as a process and technology that distributes site traffic among several servers using a network-based device. This device intercepts traffic destined for a site and redirects that traffic to various servers. The load balancing process is completely transparent to the end-user. Load balancers are an integral part of the corporate network which is primarily used for load balancing.

A load balancer performs the following functions.

- Intercepts network-based traffic (such as web traffic) destined for a site.
- Splits the traffic into individual requests and decides which servers receive individual requests.
- Maintains a watch on the available servers, ensuring that they are responding to traffic. If they are not, they are taken out of rotation.
- Provides redundancy by employing more than one unit in a fail-over scenario.
- Offers content-aware distribution by reading uniform resource locator (URL) intercepting cookies, and extensible markup language (XML) parsing.

Load balancing is particularly important for busy networks where it is difficult to predict the number of requests that will be issued to a server. Load balancing allows the service to continue even in the face of server downtime due to server failure or server maintenance. Load balancers are an integral part of today's web infrastructure. They are also complex and under-documented pieces of hardware. The ability for a load balancer to peer into the hypertext transfer protocol (HTTP) headers of incoming connections was once an advanced feature, but now is fairly commonplace. A business overview of load balancers and load balancing is provided in the later chapters.

Direct server return (DSR) is a method of bypassing the load balancer on the outbound connection. This can increase the performance of the load balancer by significantly reducing the amount of traffic running through the device and its packet-rewriting processes.

1.5.3 Storage Infrastructure

Deploying IT, aligning it with the organization's business goals, and creating a scalable architecture is a fundamental yet significant challenge facing today's CIOs. A successful IT backbone is a judicious blend of applications and hardware that create an infrastructure to be used by thousands of users. If we look at the key components of an IT infrastructure, storage is the vital link that secures the data and an enterprise's digital assets reside on a plethora of storage topologies and devices. Information technology infrastructures are stressed because of an avalanche of information, most of it coming from completely new sources and in completely new forms such as image, voice, and video. Since IT budgets have become largely flat, the toughest challenge faced by CIOs is to architect and manage the right storage infrastructure at a reduced budget, which address the data and information growth. Additionally, there are challenges in managing and protecting the data efficiently. Considering the need for content of various forms to be managed effectively, storage has become a big issue because of which organizations need to look at solutions like enterprise content management (ECM) and archiving.

The explosion of data and its management is driving the storage market to glory. New data-intensive applications and access to data from across geographically distributed sites are the key storage driver (refer to Chapter 7 on Storage Infrastructure for more information).

Standards

The Storage Networking Industry Association (SNIA) launched the Storage Management Initiative (SMI) in mid-2002 to create and encourage the universal adoption of an open interface for managing storage networks. The SMI's main aim is to deliver open storage network management interface technology in the form of an SMI Specification (SMI-S). Storage Management Initiative Specification is based on the Common Information Model (CIM) and Web-Based Enterprise Management (WBEM) standards developed by the Distributed Management Task Force (DMTF). Common Information Model is an open standard prescribed for storage vendors by the SNIA to bring uniformity to the storage industry. Storage vendors are beginning to adopt CIM by developing their products according to the standard.

With storage systems getting more complex by the day, it is a challenge for enterprises to manage them. Enterprises need to utilize their storage infrastructure more efficiently by improving storage utilization and performance.

Storage Software

Storage software helps bring down the cost of labour by automating processes that required manual intervention, reducing the dependence on specialists for keeping the corporate data centres up and running. It has become important for enterprises to allocate storage as per the priority of the data, and then replicate it as per the monetary tag attached to it, on the basis of data priority.

1.5.4 Security Infrastructure

Electronic security measures in today's corporate world are limited to anti-virus measures and firewalls (Figure 1.3). But the rise in security incidents and attacks on well-known websites have led to increased awareness of various aspects of information and infrastructure security.

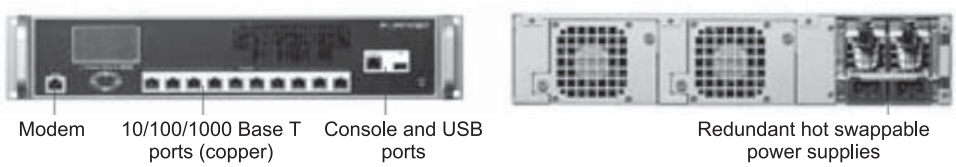


FIGURE 1.3 Firewall

The integration of physical, logical, network security, and security standards in order to provide a reliable security framework is viewed as security

infrastructure. The prime driver for enterprise security is (Internet) connectivity. The other driver for security is globalization. The third driver for increased security awareness is the security regulators. The emphasis on security arises from various aspects of change in the business environment. With business models evolving and competition on the rise, there is a need for greater emphasis on the information and physical security of IT infrastructure. Some of the common security appliances include firewall, intruder detection systems, and intruder prevention systems from different vendors and different makes.

Security can be best achieved by ensuring multiple layers of security and not depending on a single measure. This principle is very evident here.

The controls for physical and environmental security are defined in the following three areas.

1. Security of the premise
2. Security of the equipment
3. Secure behaviour

1.6 Internetworks

One way to categorize the different types of computer network designs is by their scope or scale. For historical reasons, the networking industry refers to nearly every type of design as some kind of area network.

The networking protocol used in most modern computer networks is called Ethernet. Networks connected through Ethernet are called Ethernet networks. Information in an Ethernet network is exchanged in a packet format. The packet provides grouping of the information for transmission that includes the header, the data, and the trailer.

1.6.1 Local Area Network (LAN)

Interconnection allows users to exchange information (data) with other network members. It also allows resource sharing of expensive equipment such as file servers and high-quality graphics printers, or access to more powerful computers for tasks too complicated for the local computer to process. The network commonly used to accomplish this interconnection is called a local area network (LAN). A LAN connects network devices over a relatively short distance. Today, local area networking is a shared access technology. This means that all of the devices attached to the LAN share a communication medium. In addition to operating in a limited space, LANs are also typically

owned, controlled, and managed by a single person or organization. Various aspects of LAN are dealt in Chapter 4.

1.6.2 Metropolitan Area Network (MAN)

A metropolitan area network (MAN) is a class of network which serves a role similar to an Internet service provider (ISP), but for corporate users with large LANs. Metropolitan area networks connect multiple geographically-nearby LANs to one another at high speeds. Its geographic scope falls between a wide area network (WAN) and LAN. A MAN typically covers an area of between 5 km and 50 km diameter. The MAN, its communications links and equipment are generally owned by either a consortium of users or by a single network provider who sells the service to the users. Due to the emergence of new services, the requirements for MANs have increased and diversified.

1.6.3 Wide Area Network (WAN)

A WAN is a geographically dispersed collection of LANs. A WAN spans a large geographic area such as a state, province, or country. The world's most popular WAN is the Internet. A network device called router connects LANs to a WAN. Wide area networks generally utilize different and more expensive networking equipment than LANs do. Wide area networks are composed of long-haul networks. Long-haul networks provide transmission services over long distances, typically over hundreds of kilometres.

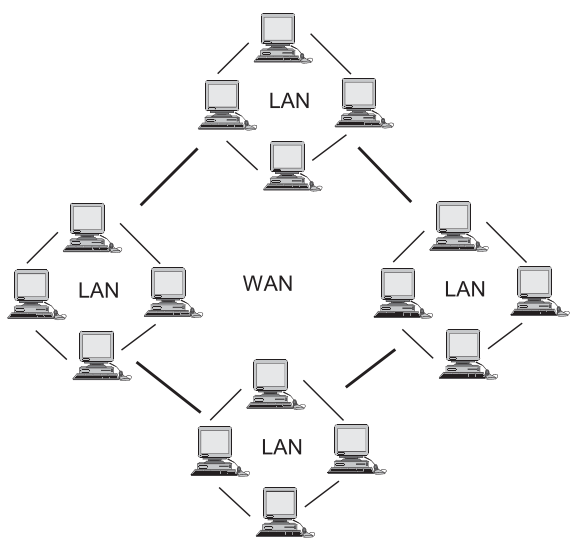


FIGURE 1.4 Wide Area Network

Wide area networks are used to connect LANs and other types of networks together, so that users and computers in one location can communicate with users and computers in other locations. Wide area networks (Figure 1.4) are typically utilized by organizations operating out of multiple office locations that require a secure, flexible, and cost-effective means for their employees to communicate and share information across a central computer network.

A major factor impacting WAN design and performance is a requirement that they lease communications circuits from telephone companies or other communications carriers. Transmission rates are typically 2 Mbps, 34 Mbps, 45 Mbps, 155 Mbps, 625 Mbps (or sometimes considerably more).

Indian Institute of Information Technology, Bangalore (IIT-B) is building a wireless local area network (WLAN) in its campus to give its students and faculty the ability to perform better research and collaboration in an anytime-anywhere environment. Going unwired has been a dream of IIIT-B from the very beginning. It moved to a new campus in 2003, which is an Intel-approved wireless local loop (WLL) site. Intel is funding the entire wireless initiative of the institute as part of its vision to spread mobile computing with Centrino technology. Wireless computing is accessible across the campus.

1.6.4 Wireless Network

Wireless is the new buzzword among networking and software vendors. The wireless communication revolution is bringing fundamental changes to data networking, telecommunication, and is making integrated networks a reality. The wireless phenomenon is reshaping enterprise connectivity worldwide. By freeing the user from the cord, personal communications networks, WLANs, mobile radio networks, and cellular systems harbour the promise of fully distributed mobile computing and communications, anytime, anywhere (refer to Figures 1.5 and 1.6).

1.6.5 Ad Hoc Networks

Since the inception of wireless networking there have been two types of wireless networks: the infrastructure network, including some LANs and the ad hoc network. Ad hoc networks are created on the fly and for one-time or temporary use. Ad hoc networks are generally closed in so that they do not connect to the Internet and are typically created between participants. They are self organizing, self healing, distributed networks which most often employ wireless transmission techniques.

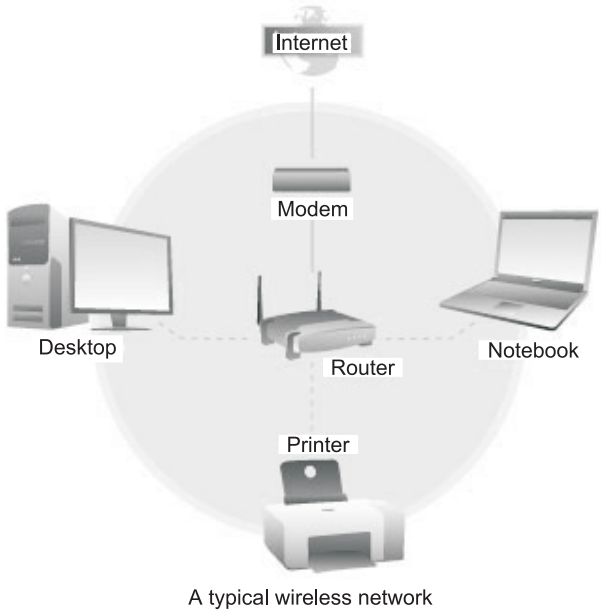


FIGURE 1.5 Wireless Deployment

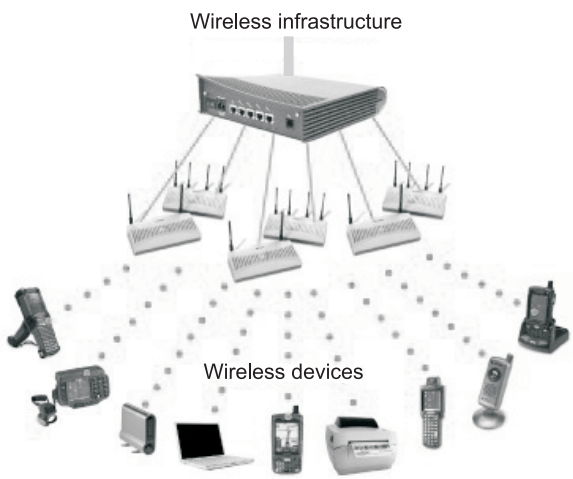


FIGURE 1.6 Current Wireless Network

A mobile ad hoc network (MANET) is an autonomous collection of mobile users that communicate over relatively bandwidth-constrained wireless links.

1.6.6 Mobile Networks

Mobile computing represents a new paradigm that aims to provide continuous network connectivity to users, regardless of their location. A wide spectrum of portable, personalized computing devices ranging from laptop computers to hand-held personal digital assistants, are currently being used. Their explosive growth has sparked considerable interest in providing continuous network coverage to such mobile hosts (MHs), regardless of their location. Such hosts cannot depend on traditional forms of network connectivity and routing because their location, and hence the route to reach them, cannot be deduced from their network address.

To facilitate continuous network coverage for mobile hosts, a static network augmented with mobile support stations (MSSs) have emerged that are each capable of directly communicating with MHs within a limited geographical area cell, usually via a low-bandwidth wireless medium. The requirement of continuous coverage has opened up the market for wireless services. Wireless data services represent a significant revenue growth opportunity to carriers worldwide.

1.6.7 Optical Networks

Forecasting demand for telecommunications services and equipment has been a challenge with respect to optical networks. Telecommunication networks based on optical communication have been constantly evolving for the last decade following the changing industry landscape as shaped by the market conditions, technological innovations, and regulatory decisions. As networks face increasing bandwidth demand, network providers have started moving towards a different solution based on the principles of optics. The interconnection networks based on optical principles are called optical networks. The recent surge in bandwidth demand, driven by fast-growing video-on-demand (VOD) services and emerging applications, such as network gaming, peer-to-peer downloading, etc. has revitalized the optical communication industry.

Current optical networks are expected to support the increasing network load by employing advanced transmission wavelength division multiplexing (WDM), switching optical switches and cross-connects (XC) and routing technologies. After more than 20 years of active research, passive optical network (PON) based broadband optical access systems are finally seeing widescale deployments in Asia and North America.

Optical networks began with WDM, which arose to provide additional capacity on existing fibres. Optical networks are high-capacity telecom-

munications networks based on optical technologies and components that provide routing, grooming, and restoration at the wavelength level as well as wavelength-based services. The cornerstone of an optical network is the advanced optical technologies that perform the necessary all-optical functions.

An all-optical network (AON) is a network that uses light wave communication exclusively within the network. More precisely, in an AON all network-to-network interfaces are based on optical transmission, all user-to-network interfaces use optical transmission on the network side of the interface, and all switching and routing within AON network nodes is performed optically.

Wavelength division multiplexing and dense wave length division multiplexing (DWDM) have emerged to augment the capabilities of optical networks. They increase the capacity of optical networks by increasing the number of wavelengths, or colours of light that can be transmitted down a fibre optic path.

The evolution to the optical layer in telecommunications networks will occur in stages in different markets because of the traffic types and capacity demands.

Optical networks, based on the emergence of the optical layer in transport networks, provide higher capacity and reduced costs for new applications such as the Internet, video and multimedia interaction, and advanced digital services.

One of the great revenue-producing aspects of optical networks is the ability to resell bandwidth rather than fibre. By maximizing the capacity available on fibre, service providers can improve revenue by selling wavelengths, regardless of the data rate required.

Optical networks can be divided into multiple groups based on their functionalities and architecture. They are discussed below.

Passive optical network A passive optical network (PON) is a point-to-multipoint architecture for delivering last-mile connectivity without any active components in the distribution network. It is a single, shared optical fibre that uses inexpensive optical splitters to divide the single fibre into separate strands feeding individual subscribers. Passive optical networks are passive because other than at the central office (CO) and subscriber endpoints, there are no active electronics within the access network.

Ethernet passive optical network Ethernet passive optical network (EPON) is a passive optical network based on the Ethernet standard. It allows the users to utilize the economies-of-scale of Ethernet and provides simple,

easy-to-manage connectivity to Ethernet-based IP equipment, both at the customer premises and at the central office.

Gigabit passive optical network Gigabit-capable passive optical network (GPON) is currently one of the fastest access technologies to attract market interest. It has received a lot of attention since the International Telecommunication Union (ITU) introduced the ITU-TG.984 recommendation in 2003. A GPON solution is an integral part of a full service broadband architecture, which is designed to meet the needs of fixed mobile convergence (FMC) and next generation networks (NGN) across residential and enterprise service offerings. A key characteristic is the 2.5 Gbps downstream data rate and the 1.25 Gbps upstream data rate. Gigabit passive optical network operates in a very similar fashion to gigabit Ethernet passive optical network (GEPON) when supporting Ethernet as its primary transport protocol.

1.7 IT Systems

Information is one of the most important resources for managers. It adds to the knowledge a person has about an entity of interest. For information to be useful to managers, it must possess certain attributes, which include accuracy, timeliness, relevance, and completeness.

The successful development and implementation of business information systems requires an integrated approach which includes the seamless design of both the business processes and the information systems supporting the business processes. Therefore, several frameworks and modelling methods have been developed for an integrated modelling of the entire enterprise with respect to both organizational and information systems aspects.

Information systems and processes are very important parts of our due diligence assessment of a company—yet the jargon is often more difficult to understand than many foreign languages. An information system is a set of interrelated components working together to provide useful information as needed by problem solvers and decision-makers. The five major components of an information system include hardware, software, people, data, and procedures. In other words, information systems are the software and hardware systems with a set of formal procedures that support, data-intensive applications for human consumption.

Information systems are classified into groups based on functionalities. The major types of information systems that serve the needs of different levels

of managers in an organization includes transaction processing, office automation, management information, decision support, and executive support. Some of the prominent information system groups are management information systems (MIS), expert systems (ES), geographical information systems (GIS), health information systems (HIS), hospital management system (HMS), etc.

1.7.1 Management Information Systems

Management information system (MIS) is the term given to the discipline focused on the integration of computer systems to meet the aims and objectives of an organization. The components of an MIS include a hardware which is used for input/output process and storage of data, software used to process data and also to instruct the hardware component, database which is the location in the system where all the organization data will be automated, and procedures which are a set of documents that explain the structure of that MIS.

Management information systems are generally used by medium and larger-scale organizations. They help the manager to access relevant, accurate, up-to-date information.

1.7.2 Expert Systems

Expert systems are computer programs that are derived from a branch of computer science research called artificial intelligence (AI). Often, the term expert systems is reserved for programs whose knowledge base contains the knowledge used by human experts, in contrast to the knowledge gathered from textbooks or non-experts. Every expert system consists of two principal parts: the knowledge base and the reasoning or inference engine.

One of the most powerful attributes of expert systems is the ability to reason and explain the reasoning. Since the system remembers its logical chain of reasoning, a user may ask for an explanation of a recommendation and the system will display the factors it considered in providing a particular recommendation.

1.7.3 Geographic Information Systems

Geographic information systems (GIS) have become an increasingly important means for analysing and understanding geography. Geographic information system concepts and technologies help us collect and organize geographical data and understand their spatial relationships. A geographic information system can be viewed as a data-management system that permits access to and manipulation of spatial data and visual portrayal of data and

analyses results. Geographic information system concepts and technologies arise from a wide variety of fields and GIS has become a generic term referring to all automated systems used primarily for the management of maps and geographic data. The development of GIS has relied on innovations made in many disciplines including geography, civil engineering, photogrammetry, remote sensing, surveying, geodesy, statistics, computer science, operations research, demography, and many other branches of engineering and natural and social sciences.

Various definitions have been offered that reinforce the major dimensions of GIS. Elements of a GIS include data and information technology (ie., computers, software, and networks) to support it. Spatial data include any data that has a geographic location.

A data model is a set of rules to identify and symbolize features of the real world, called entities, into digitally and logically represented spatial objects consisting of the attributes and geometry.

There are two basic categories of data involved, namely

1. Spatial data
2. Attribute data

Spatial data include the locations of features, such as the latitude/longitude of dams, gauging stations, etc. Spatial data are often represented as objects, such as points, lines, and polygons, which are used to represent the differing types of features. The spatial data are characterized as having a vector structure composed of features represented as points, lines, and polygons. Other GIS spatial data are handled as images or rasters, having simple row and column formats. Geographic information system functions for spatial data capture include the numerous technologies for data capture as well as the many ways for conversion of source data into GIS-compatible formats.

Attribute data include numerical and character-type data that characterize the resource. Geographic data are characterized by a series of attribute and behavioural values that define their spatial (location), graphical, textual, and numeric dimensions. Attribute data are handled in relational database software composed of records and fields, and the power of the relational model is applied to these data. Geographic information system databases incorporate two distinct branches, the spatial database and the associated attribute database.

1.7.4 Health Information Systems

Hospitals are the key institutions in providing relief against sickness and disease. Effectiveness of a health institution—hospital or nursing home—depends on its goals and objectives, its strategic location, soundness of its operations, and efficiency of its management systems. Hospital information system (HIS) is one of the most promising applications of information technology in the health care sector. The aim of HIS is to use a network of computers to collect, process, and retrieve patient care and administrative information from various departments for all hospital activities to satisfy the functional requirement of the users. It also helps as a decision support system for the hospital authorities for developing comprehensive health care policies.

The next system that most hospitals are looking to deploy is picture archiving and communication system (PACS). It is a filmless and computerized method of communicating and storing medical image data such as computed radiographic, digital radiographic, computed tomographic, ultrasound, fluoroscopic, magnetic resonance, and other special X-ray images. This is a system that is used to capture, store, distribute, and display medical images. Electronic images and reports are transmitted digitally via PACS, eliminating the need to manually file, retrieve, or transport film jackets. A PACS consists of image and data acquisition, storage, display stations integrated with various digital networks.

A PACS comprises four principal components of imaging, namely computed tomography (CT) and magnetic resonance imaging (MRI), a network for the transmission of patient information, workstations for interpreting and reviewing images, and long-term and short-term archives for retrieving images and reports. It has the ability to deliver timely access to images, interpretations, and related data. Typically, a PACS network consists of a central server which stores a database containing the images. This server is connected to one or more clients via a LAN or a WAN which provides and/or utilizes the images. Client workstations can use local peripherals for scanning image films into the system, printing image films from the system and interactive display of digital images. Picture archiving and communication systems workstations offer means of manipulating the images. The medical images are stored in an independent format. The most common format for image storage is digital imaging and communications in medicine (DICOM). For example, Samsung Medical Center, an 1100-bed general teaching hospital, started a four-phase PACS implementation plan in 1994. The medical centre had over 4,000

outpatient clinic visits per day and performed about 340,000 examinations per year. The PACS in Samsung provides support for primary and clinical diagnosis, conference, slide making, generation of teaching materials, and printing hard copies for referring physicians.

Health care in India is just beginning to realize the importance of integrated, configurable systems. Hospitals in India are in various stages of implementing HIS. The driver is return on investment (ROI), and in the long run, benefits are realized from the bottom line and quality of care delivered to patients.

1.8 Management

Strong IT leadership and a relationship of trust between business and IT executives are prerequisites to successfully exploit technology. A clear understanding of IT enables better management. Improving information management practices is a key focus for many organizations, across both the public and private sectors. Effective information management is not an easy job. There are many systems built on different technologies with different mandates and different protocols integration requirement, a huge range of business needs to meet, and complex organizational (and cultural) issues to address. Information Technology Infrastructure Library (ITIL) provides a management framework to address the management needs of information technology.

1.8.1 Service Management

A service offering is a defined entry in the enterprise service catalogue. It is a measurable and specific offering of the IT organization to external clients. It should be seen as a logical application programming interface (API) of the service provider; everything behind it (in theory) may be opaque to the service consumer. Service offerings are of two major types: orderable service and hosting service.

1.8.2 Data Management

Data is the lifeblood of an organization and a valuable enterprise asset. It provides the foundation on which critical and everyday business decisions are based. It is, therefore, essential that decision-makers can access and depend on quality data to operate confidently in a high-performance environment.

Data management has become increasingly important as businesses face compliance consequent to modern legislation, such as Basel II and

the Sarbanes–Oxley Act, which regulate how organizations must deal with particular types of data. The data management dilemma that all organizations around the world face today are the regulatory requirements that cause data growth and longer retention periods. Data management experts stress that data life cycle management (DLM) is not simply a product, but a comprehensive approach to managing organizational data, involving procedures and practices as well as applications.

Data management is essentially the process of managing data as a resource that is valuable to an organization or business. Key elements of data management includes specification of data formats (metadata), data access protocols (transport), and data transformation rules (mapping). A good data management solution would provide all these capabilities in an easy-to-use single product package. The data management platform coupled with its process and methodology provides auditing, tracking, and controlling mechanisms to manage the data effectively. A detailed discussion on data life cycle is presented in the later chapters.

1.8.3 Disaster Management

Disasters come in many forms. Natural disasters kill one million people around the world each decade, and leave millions more homeless. Natural disasters may include earthquakes, floods and flash floods, landslides and mud flows, wildland fires, winter storms, and others. Technological disasters include house and building fires, hazardous materials, terrorism, and nuclear power plant emergencies.

The mission of an effective disaster communications strategy is to provide timely and accurate information in all the following four phases of emergency management.

1. *Mitigation*, which is to promote implementation of strategies, technologies, and actions that will reduce the loss of lives, business, and property.
2. *Preparedness*, which is to communicate preparedness messages that encourage and educate business in anticipation of disaster events.
3. *Response*, which is to provide to the appropriate notification, warning, evacuation, and situation reports on an ongoing disaster.
4. *Recovery*, which is to provide business units affected by a disaster with information to recover from the business data loss and the time taken to bring the business functions to operational readiness.

1.8.4 Remote Infrastructure Management

Over the past few years, the infrastructure outsourcing industry has witnessed substantive shifts. Key drivers behind these shifts include enterprise customers that seek to enhance service and performance levels while exploring innovative delivery models to reduce costs, technology that has improved infrastructure efficiency, and management and maturing offshore capabilities. Businesses today face a considerable challenge to effectively optimize their IT infrastructure and related operations and deliver ever-improving service levels to meet and exceed the expectations of their business users without compromising on quality and security. More and more companies are turning towards infrastructure management service (IMS) as the answer to this need. Infrastructure management as a service has resulted in the genesis of remote infrastructure management services (RIMS).

Remote infrastructure management services comprise day-to-day management of IT infrastructure needs of an organization from a remote location. Remote infrastructure management services consist of remote monitoring and managing the infrastructure components and taking proactive steps and remedial actions across the IT landscape. Remote infrastructure management (RIM) capabilities are bounded with service level agreements (SLA) with penalties on downtimes. These value propositions appeal to two distinct demands of enterprise customers: cost reduction and optimization that leads to transformation.

Networking infrastructure has emerged as a key differentiator to drive RIMS. Since infrastructure management is a critical issue and even minutes of downtime can cripple a client's business, the network has emerged as a crucial element of an IT vendor's business strategy. The entire network must, therefore, be resilient. Business resilience refers to the operational and technological readiness that allows IT service providers to operate their networks efficiently. Business-resilient networks help businesses respond quickly to opportunities and react appropriately to unplanned events.

The study conducted by McKinsey & Company highlights that the $524 billion infrastructure management services (IMS) industry— that manages an enterprise's core IT systems, including hardware, software, connectivity and people could become as important as business process outsourcing (BPO) industries that have dominated the rise of offshoring in the last decade.

Increasingly, enterprises worldwide have been waking up to the challenges involved in ensuring the availability and the predictability of their networks

and devices. The rigorous processes and operations combined with the critical nature of business makes it imperative for the vendors to specialize in RIMS service delivery. A detailed discussion on remote infrastructure management is presented in the later chapters.

1.8.5 Measures and Metrics

It is arguably the number one rule of business—if one cannot measure it, one cannot improve it. Or as many a CIO has had to learn the hard way, if one cannot measure it, one cannot communicate its value. Applying manufacturing-style metrics to the global delivery of IT application development and maintenance does more than streamline and reduce cost. It provides organizations with a clear path to IT productivity to help them achieve higher levels of performance.

> In April 2008, Forrester published the report 'The Five Essential Metrics for Managing IT'. This has become one of the IT industry's most popular documents in terms of readership and reader feedback. Principal Analyst Craig Symons lays out five IT metrics that are extremely relevant to IT's business stakeholders: investment alignment to business strategy, business value of IT investments, IT budget balance, service-level excellence, and operational excellence.

Chief information officers frequently ask what IT should measure and report to business executives. The key to success is choosing a small number of metrics that are relevant to the business and have the maximum impact on business outcomes. A beginning step in the development of an IT performance management program is the identification of information technology's role as an enabler of both the strategic and operational requirements of the business. As understood and promoted by the ITIL framework and information technology service management (ITSM) in general, the primary accomplishment of IT should be the effective alignment of services with the current and future needs of the business and its customers.

Information technology metrics are hardly new but the understanding of how to learn from and leverage them is steadily evolving, and their importance is growing as corporations weave IT into virtually all of their activities. Information technology measures must have context to have meaning; the appropriate context is derived by deciding which investments in measurement will actually provide business value. Effective service level agreements (SLAs) are extremely important to assure effective operations. Information technology projects, deployments, operations and maintenance, and other IT

exercises are measured through the planned and executed SLAs. The metrics used to measure and manage performance to SLA commitments are the heart of a successful agreement and are a critical long-term success factor. Lack of experience in the use and implementation of performance metrics causes problems for many organizations as they attempt to formulate their SLA strategies and select and set the metrics needed to support those strategies. Among the most salient differences between performance measurement and integrated performance management is the ability to develop and apply measures that determine the causal factors of performance.

Now, yet another category of metrics is gaining attention, namely metrics that aim to help IT in better justifying itself at a business level. This means fewer bits and bytes and more dollars and cents, which in turn means calculating fully costed ROIs and being able to associate measurable gains in revenues or market share.

Leading organizations apply metrics and use them to continually boost the quality of their output, increase the predictability of that output and improve their overall efficiency. The proactive use of metrics is increasingly important as organizations adhere to industry standards for measuring quality such as Six Sigma and Capability Maturity Model for Software. The importance of metrics will only increase as IT departments strive to organize and manage themselves as in-house service providers.

Return on Investment

The return on investment(ROI) for corporate information technology investments has been the subject of considerable research in the last decade. When capital to invest is scarce, new e-business and IT projects must show a good ROI in order to be funded. One conceptual definition of ROI is that it is a project's net output (cost savings and/or new revenue that results from a project less the total project costs), divided by the project's total inputs (total costs), and expressed as a percentage. The inputs are all of the project costs such as hardware, software, programmers' time, external consultants, and training. Therefore, if a project has an ROI of 100 per cent, from this definition the cash benefits out of the project will be twice as great as the original investment.

Return on investment was defined in the introduction as

$$\text{ROI} = \frac{\text{Project outputs} - \text{Project inputs}}{\text{Project inputs}} \times 100\% \tag{1.1}$$

where the project outputs are all of the benefits of the project quantified in terms of cost savings and revenue generation, and the project inputs are all of the costs of the project.

Return on investment is an important component of the IT investment decisions made in many large companies. Full life cycle ROI analysis translates into better information to make better decisions, which in turn should impact the returns for the total corporate IT portfolio of investments.

The method of calculating ROI for an e-business or IT project is in principle no different from the method for calculating ROI for a new manufacturing plant, marketing plan, or research and development project. However, e-business and IT projects can be incredibly complex, so that estimates and generalities that are good enough for a manufacturing project can potentially destroy an IT project if any element goes wrong. Building the ROI model on sound assumptions and developing a risk-management strategy can, therefore, significantly impact the actual ROI realized for IT projects.

Profitability Index

Profitability index identifies the relationship of investment to payoff of a proposed project. It is the ratio of the present value of a project's cash flows to the initial investment. Profitability index is also known as profit investment ratio, abbreviated to PI and value investment ratio (VIR). Profitability index is a good tool for ranking projects because it allows you to clearly identify the amount of value created per unit of investment.

$$\text{Profitability index} = \frac{\text{Net present value}}{\text{Investment}} \tag{1.2}$$

1.9 Standards, Audit, and Governance

Technology leadership is as important for the managing executives of a large Fortune 500 company as it is for the new entrepreneur. Whether you are a technology person who has learned the business side, or a business person who has learned the technology side, a technology map gets generated as a brain map. A technology map is a mental map of how technology works and how the different components of the systems in a company fit together. The map gives the reader a good understanding of how technology interacts and fits together. The map demonstrates the layering effect of IT.

The IT system, so understood, needs to be audited based on some common criteria called best practices or standards periodically, in order to find the dynamic interplay of IT systems. A clear understanding of national and international standards are required to capture the big picture in order to fine-tune the governance mechanisms.

1.9.1 Standards

There is an old joke in the technology industry about standards—'the wonderful thing about standards is that there are so many to choose from'. A standard, literally, is an approved way of accomplishing a technical goal that is published by a standards body such as the Institute of Electrical and Electronics Engineers (IEEE), International Organization for Standardization (ISO), the World Wide Web Consortium (W3C), and several others. Old or young, a standards organization is usually needed to broker negotiations for shared standards so that businesses can capitalize on interrelationships.

International Committee for Information Technology Standards (INCITS) is a US-based standardization organization in the field of information and communications technologies (ICT), encompassing storage, processing, transfer, display, management, organization, and retrieval of information. As such, INCITS also serves as American National Standards Institute (ANSI) Technical Advisory Group (TAG) for ISO/IEC Joint Technical Committee 1 (JTC1). Joint Technical Committee 1 is responsible for international standardization in the field of information technology.

Competing standards are often not interoperable. One cannot have a network card talking (transferring data) at gigabit Ethernet speeds while the hub port is talking (transferring data) at fast Ethernet speeds (100). They must match, or the network does not work. Information technology products are useless unless they interface with other IT products. So IT products must comply to standards providing the essential compliance and interoperability. Hence, the products and services sold by IT vendors have a relationship with the standards published by standards bodies.

Although a de facto standard is not a standards body but a standard, it is relevant to explain this term here. If the market commonly has adopted the implementation of a specific company, or a standard specified by an unofficial standards body, then this standard is called a de facto standard. When this kind of a standard exists, it can be very difficult for competitors to enter the market with different directions, including those companies that implement an official standard on the subject. Microsoft is an example of a company whose products are de facto standards. Participation in the standards processes can assist the formulation of company strategy, marketing plans, finance, and development.

The most important benefits of standards are as follows.

- They ensure that equipment from different suppliers can interwork. This benefits the user by enabling competitive procurement.

- They enable equipment supplied by a manufacturer to be used for different applications and in different regions. This increases the market size and reduces costs due to economies of scale. This benefits both the suppliers and the consumers.
- They provide the means to deal with a changeable environment. Today, businesses must do more with fewer resources in changeable conditions and environments. It is difficult to keep up to date, to understand the complex technologies, to be a specialist in all system parts, and to respond effectively to changes, because of the speed at which change takes place.

1.9.2 Audit

In most companies, key operational processes are managed by information technology systems. An IT organization, with well-defined internal controls, enables companies to identify and manage their IT-related risks. Ability to manage and contain such risks is critical to ensuring compliance with regulations and mandates such as Sarbanes–Oxley Act (SOX), Gramm–Leach–Bliley Act (GLBA), and Health Insurance Portability and Accountability Act (HIPAA). Moreover, companies leveraging outsourced services that impact their own control environment rely on SAS 70 service auditor reports to gain an understanding of the IT processes of their service providers.

Auditing, in general, is formally described as 'the independent examination of records and other information in order to form an opinion on the integrity of a system of controls and recommend control improvements to limit risks'. Information technology auditing is a branch of general auditing concerned with governance (control) of information and communications technologies (computers). Information technology auditors primarily study computer systems and networks from the point of view of examining the effectiveness of their technical and procedural controls to minimize risks. All audits are performed in relation to certain risks identified by the auditor which he/she believes are important. The specific controls that are actually embedded in or associated with IT systems and processes are then assessed to determine whether they adequately address the risks. Most organizations regularly test the internal controls within their IT organization to ensure secure and continuous operation of their entire information system's infrastructure.

1.9.3 Governance

Governance essentially means systems of control. Information security managers develop, implement, and operate information security control systems

for ICT governance. Information technology governance is a framework for the leadership, organizational structures and business processes, standards and compliance to these standards, which ensure that the organization's IT supports and enables the achievement of its strategies and objectives. It is a critical component of corporate governance. Essentially, governance addresses proper management of organizations. Information technology governance takes these concepts one step lower and applies them to the IT group. Information technology governance is the key to integrating people, processes, technology, and information necessary to achieve business goals according to International Business Machines (IBM).

Perhaps the best definition can be found in the executive summary of control objectives for information and related technology (COBIT), which identifies IT governance as a structure of relationships and processes to direct and control the enterprise in order to achieve the enterprise's goals by adding value while balancing risk versus return over IT and its processes. The COBIT framework is comprised of 34 high-level control objectives and 318 detailed control objectives that have been designed to help businesses maintain effective control over IT.

The ISO/IEC 38500:2008 provides guiding principles for directors of organizations on the effective, efficient, and acceptable use of IT. It relates to the information and communication services used by an organization. These standards provide a framework for the governance of ICT, comprising a model, principles, and a vocabulary. They also reference other standards and relate to methodologies used for project management and control. This governance framework for IT complements a number of standards, frameworks, and methodologies. It also relates to record keeping, fiduciary duties, and privacy regulatory and legislative requirements and the organization's internal policies covering fraud control, whistle blowing and corporate social responsibility(CSR).

Weill and Ross [2004] recommend the 10 principles of governance as listed below.

1. Actively design governance
2. Know when to redesign
3. Involve senior managers
4. Make choices
5. Clarify the exception-handling process
6. Provide the right incentives

7. Assign ownership and accountability for IT governance
8. Design governance at multiple organizational levels
9. Provide transparency and education
10. Implement common mechanisms across the key assets.

1.10 Current Trends

Aligning information technology with business strategy is essential to meet and beat competition. Information technology is dynamic and changes over time.

1.10.1 Data Centre

The modern corporation runs on data. Data centres house thousands of servers that power applications, provide information, and automate a range of processes. The data centre is a physical place that houses computers, computer networks, critical computing systems, data storage, including backup power supplies, air conditioning, and security applications. Wikipedia defines data centre as a facility used to house computer systems and associated components such as telecommunications and storage systems. It generally includes redundant or backup power supplies, redundant data communications connections, environmental controls (for example, air conditioning, fire suppression), and security devices. According to Gartner forecasts, the total data centre capacity in India will be almost 5.1 square million feet by 2012 growing at a compound annual growth rate (CAGR) of 31 per cent. Captive data centres will grow at a CAGR of 29 per cent and hosted data centres will grow at 33 per cent to reach 2.571 and 2.573 million square feet respectively.

1.10.2 Green Computing

Energy is a major concern especially in developing countries like India where there is a power crisis. Data centre operational costs have also been heavily impacted by the rising costs of energy. Data centres today consume a substantial percentage of generated power for any country. Especially, the cost of energy needed to power and cool the data centre facilities, computer rooms, and data centres.

A National Action Plan on Climate Change (NAPCC) was released by Prime Minister Manmohan Singh. The central ministries were directed to present a detailed blueprint to the Prime Minister's Council on Climate Change on the specific implementation plans they would adopt to mitigate the greenhouse emissions.

Stacking servers ever closer together in rows and rows of racks and making their processors work faster and harder has recreated many of the old cooling problems. Today, the industry finds that for every kilowatt of power it uses to drive a server, another kilowatt is needed to cool it. Businesses are looking to minimize energy waste and reduce the carbon footprint of computing resources.

> Mckinsey's cost curve studies of potential ways to reduce carbon emissions show that the incremental improvement of today's technology and energy consumption patterns cannot have a significant effect and new low carbon technologies will have to be developed [Enkvist et al. 2007].

Green IT efficiently utilizes computing resources reducing carbon footprint based on reduction of energy requirements and decrease in total energy usage.

1.10.3 Grid Computing

Computer facilities are expensive to build and maintain, so being able to share cycles across the globe represents a more effective way to utilize IT resources. Grid computing enables the creation of a single IT infrastructure that can be shared by multiple business processes. The basic idea of grid computing is to create a grid computing infrastructure to harness the power of remote high-end computers, databases, and other computing resources owned by various people across the globe through the Net. Grids are intrinsically distributed and heterogeneous but must be viewed by the user as a virtual environment with uniform access to resources. Grid computing extends the web services concept by providing task and resource management functions across heterogeneous computing environments [Franc 2003, Lucio 2005]. Compute grids can be deployed at a local level or encompass computing facilities around the nation.

1.10.4 Virtualization

Virtualization is one of the IT buzzwords being thrown around the industry more and more lately. Virtualization technology is a way of making a physical computer function as if it were two or more computers. Each non-physical or virtualized computer is provided with the same basic architecture as that of a generic physical computer. There is an increasing recognition of virtualization as a tool that helps in better utilization of server hardware, reduces floor-space requirements, lowers power and cooling costs, and improves productivity of personnel. Virtualization today is such an exciting topic because people realize

that through virtualization they can consolidate and get more out of their infrastructure.

Virtualization provides the benefits necessary to give IT organizations the ability to save costs on hardware and increase the efficiency of server deployments, provisioning, and management. Virtualization also enables physical hardware independence, which gives IT the flexibility and freedom of not being locked into a single vendor's hardware solution. Virtualization allows an operator to control a guest operating system's use of CPU, memory, storage, and other resources, so that each guest receives only the resources that it needs. This distribution eliminates the danger of a single runaway process consuming all the available memory or CPU. It also helps IT staff to satisfy service-level requirements for specific applications.

1.10.5 Server Consolidation

Consolidation allows companies to improve overall business processing through the following three primary IT objectives.

1. A higher and more consistent level of service
2. Greater efficiency and control over operations
3. The flexibility to respond to constantly changing business requirements

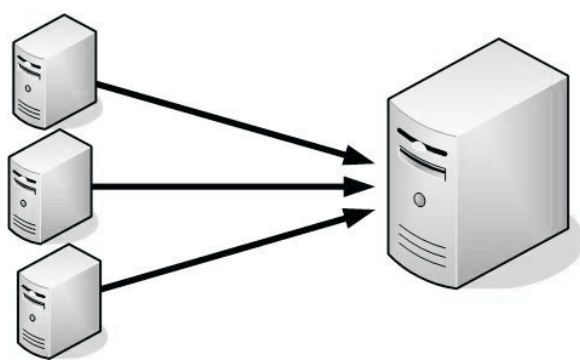


FIGURE 1.7 Server Consolidation

Server consolidation (Figure 1.7) is becoming an increasingly popular technique to manage and utilize systems. Server consolidation is an approach to efficient usage of computer server resources in order to reduce the total number of servers or server locations that an organization requires. The practice developed in response to the problem of server sprawl, a situation in

which multiple, under-utilized servers take up more space and consume more resources than can be justified by their workload. Although consolidation can substantially increase the efficient use of server resources, it may also result in complex configurations of data, applications, and servers that can be confusing for the average user to contend with.

There are a number of steps an organization could take after successfully executing a server consolidation strategy. One of them is to orchestrate workloads to make maximum use of physical server capacity, reduce power consumption, reduce administrative and operational expenses, and create an environment which can assure that each and every workload can meet service-level objectives. Orchestration is a process of identifying the need for a virtual spin for a virtual server. Information technology coordinates resource allocation among different infrastructure components such as switch provisioning, Internet protocol (IP) addressing, domain name servers (DNS), and active directory services (ADS).

1.10.6 Storage Consolidation

During the past few years, customers have focused on day-to-day business and and have created storage islands interns of dedicated storage. As these storage islands have expanded to more significant capacity levels, total storage utilization across the enterprise and the inability to share data between applications have become inhibitors to further growth.

The proliferation of data throughout every facet of industry, combined with an increasing demand for secure access from a variety of devices, make data storage a critical component of every business strategy and organization. As the cost of storage management and maintenance continues to skyrocket, the business is under increasing pressure to streamline storage management and maximize investments in the current business practices.

Consolidating the storage systems, platforms, and applications can help the organization ease manageability and improve capacity utilization factors. Storage consolidation, also called storage convergence, is a method of centralizing data storage among multiple servers. The objective of storage consolidation is to facilitate data backup and archiving for all subscribers in an enterprise, while minimizing the time required to access and store data. By creating large storage pools accessible by many servers, IT asset utilization is increased and operating costs are reduced.

Storage consolidation provides a common platform to allocate and manage growing demands for data storage and helps reduce administrative effort

by establishing a single management console. The formation of centralized storage pools that can be managed as a whole and shared across applications and servers improves storage utilization and efficiency.

1.10.7 IT Practices in Banks

Core banking solutions (CBS) have been around in banking circles for quite some time now. Today, the situation is such that an increasing number of banks are recognizing the need for a strategic transformation of their day-to-day operations. Core banking solutions implementation is the first step towards transformation and automation of all of a bank's business processes. Core banking solutions have become a part of basic hygiene for a bank's operation. Today, if a bank does not have a CBS in place, the ecosystem solutions, such as anywhere banking, Internet banking, etc. become a huge challenge for operations. The CBS solution forms the primary IT environment for any bank today. This has become an integral part of business rather than being a support function. Thereby IT, and in turn CBS, becomes a business driver rather than a back-office operation.

By integrating all the varied and disparate legacy systems and self-contained services, a CBS provides a bank with a solid, flexible, and scalable foundation on which other systems can be easily built and harmonized into a robust scalable banking solution. The focus of many banks is now on business agility as a key differentiator in their attempt to gain a competitive edge. With business agility, banks achieve improved operational efficiency, enhanced customer service experience, a proactive approach towards risk, and most importantly, a drastic reduction in operating costs.

Meanwhile, the largest opportunity at the moment is for the Regional Rural Bank (RRB). According to a mandate by the Reserve bank of India (RBI), all commercial and RRBs are supposed to implement CBS by March 2010. As per RBI guidelines, the CBS in RRBs should be geared towards better management control and monitoring, wider range of services offered and enhanced level of customer satisfaction. Adoption of CBS would lead to uniformity in work environment, more informed decision-making, centralized processing and better MIS and reporting and improved regulatory compliance.

The centralized funds management system (CFMS) initiative provides for a centralized viewing of balance positions of the account holders across different accounts maintained at various locations of the RBI. The electronic clearing service (ECS) and electronic funds transfer (EFT) are also being enhanced in terms of security by means of implementation of public key

infrastructure (PKI) and digital signatures using the facilities offered by the certifying authority as per the guidelines of the RBI. Modernization of clearing and settlement through MICR-based cheque clearing, popularizing electronic clearing services and integration of RBI-EFT scheme with funds transfer schemes of banks, introduction of centralized funds management system are significant milestones.

SUMMARY

In this chapter we discussed the basic IT components, networks, and the types of resources networks can share. Computer networks are groups of computers connected together by some type of media (the physical connection among the devices on a network) to allow them to communicate and share information. Servers are large, powerful computers that provide services to clients. Clients are smaller desktop computers that users use to access network services. The physical connection between the computers on a network is referred to as the media. Client/server architectural network is an arrangement used on LAN that makes use of distributed intelligence to treat both the server and the individual workstations as intelligent, programmable devices, thus exploiting the full computing power of each. The client and server machines work together to accomplish the processing of the application being used. Local area networks are small networks usually contained in one office or building. They have high speed, low error rates, and they are inexpensive. Metropolitan area networks are larger networks that consist of individual LANs to interconnect large campus-type environments such as organizations spread over a city. Wide area networks can cover an entire organization's enterprise network.

Information technology managers have to understand IT more effectively to make it dance to their tunes. The chapter outlined the basic need for IT infrastructure and the various components that go with it. An overview of current trends in the field of IT has been discussed to enable the reader to get a feel of it. The topics discussed include data centre, grid computing, cloud computing, virtualization, server consolidation, and storage consolidation. This chapter is also the foundation chapter for the successive chapters.

Key Terms

Cloud computing It is the term used for anything that involves delivering hosted services over the Internet.

Data centre It is a well-equipped computer facility designed for continuous use by several users.

Ethernet passive optical network It is an optical network built on Ethernet technology.

Gigabit passive optical network It is a network built on optical technology.

Grid computing It harnesses unused processing cycles of all computers in a network.

Local area network It is an internal network of computers.

Metropolitan area network It is a network spread over a large geographic area.

Passive optical network It is a network built on optical technology.

Virtualization It is a technique for hiding physical characteristics of computing resources.

Wide area network It is a network of networks spread over geography.

Review Questions

1.1 What is IT infrastructure and what is it composed of?

1.2 Discuss the four key business requirements for the success of a business organization.

1.3 Discuss the business value of information technology.

1.4 Briefly discuss the various elements of networking infrastructure.

1.5 Justify the statement 'structured cabling is a capital investment'.

1.6 Briefly discuss the various aspects of a networking switch and its types.

1.7 How is optical network different from wired network? Differentiate between PON, EPON, and GPON.

1.8 Briefly explain the concept of remote infrastructure management identifying the business value of RIM.

1.9 Differentiate IT audit and IT governance.

1.10 Discuss and differentiate grid computing and cloud computing and identify their business values.

Projects

1.11 Visit an organization which has implemented virtualization of IT assets. Study the business impact of virtualization of infrastructure in the organization outlining the pre- and post-business benefits including ROI spread over a period of three years.

1.12 Prepare a short business report on green initiatives, need for going green and its business impact on bottom line.

1.13 Discuss the technical and management plans which enabled ABC Unlimited to carry out the migration with no detectable disruptions. Note: AS/400 is a mid range server. Refer to the business case given below

Run-through Business Case

From his office on the sixth floor in New York, ABC Unlimited's state-of-the-art global headquarters, CIO Nayak watched the traffic loom away. ABC Unlimited is perhaps not a familiar name for the average Indian customer. It is a retail chain establishment with multiple outlets spread across various sectors of the USA and the UK. As Nayak sipped his morning coffee, he glanced at the internal memo from his boss, ABC Unlimited's CEO, David. The subject read 'Costs must come down'. The message from David was succinct, clear, and immediate. 'Our product offerings are clear and our balance sheet is strong.' David indicated that in order to sustain profitability 'We must lower our costs and deliver a premium service. The challenge to cut costs is never-ending, and our task is to work together to get them down year over year.' The message was crystal clear and echoed across the organization. Like many of his competitors, David hoped to move his company up the value chain. At ABC Unlimited, the plan was to accomplish this goal by providing clients with innovative, integrated services that would impact and even redefine their core way of doing business. David was clear that in order to survive he would have to change the way the company approached its customers. To do so, he wanted to differentiate the service offerings with unique propositions that would tie the customers with ABC Unlimited. In order to do this, he wanted to remove the silos of information spread across the organization and centralize it.

New York based ABC Unlimited was founded in 1991 by an Indian named Pooja as a venture capital attempt with an initial investment of about 1 million dollars. (Venture capital can be defined as equity or equity-linked investments in young, privately held companies, where the investor is a financial intermediary and is typically active as a director, advisor, or even manager of the firm). In 1994, one of Hong Kong's largest trading company acquired a 45 per cent share in the company. As a retail group, ABC Unlimited developed most of its systems in-house. John, who started his career in IT in 1998 right after his graduation, joined ABC Unlimited as a programmer and wrote the first integrated online billing system for ABC Unlimited called 'centralview', a program which was later sold to other retail outlets. John and his team of systems developers were responsible for writing the code for most of ABC's proprietary applications including accounting systems, personnel systems, logistics, and supply chain systems apart from a host of internal applications. The department started with less than 20 developers and by late 2003 had grown into a team of 120 members.

ABC Unlimited had earlier taken a decision to decentralize the operations across all the outlets. Each outlet had hardware and a copy of the appropriate software running in their hardware to take care of the business. However, of late the organization found it very difficult to get a consolidated view of the business due to multiple data sources and multiple reports. Based on the demand from the developers and answerable to the board of directors, David wanted to have a comprehensive consolidated view of the reports on demand and had sent an internal note to Nayak on the possibilities of centralizing the data. He also added that the centralization would considerably reduce the overheads on IT infrastructure and help the organization overcome the IT resource crunch.

Nayak was supposed to meet David with a plan of action on the cost benefit advantage apart from a plan to set up a data centre. The company needed to aggregate their data at a data centre to a new headquarters building several miles away. As identified, the IT costs at the new location including human resource (HR) cost, were slightly lesser than the current pay levels spread across the various outlets. Nayak believed that the move to the new location will also have

a direct impact on the HR management issues. Apart from the location-specific competitive advantages, on the whole the new location had an extensive fibre-optic network infrastructure in place, with a fast growing cohort of IT professionals. Several large multinationals such as IBM, Cisco, and Dell have established their presence in the selected location. This, Nayak believed would result in rapid support delivery. He also understood that the new location was well secured from a seismic zone chart. He also understood that the new location was an emerging IT hub with a good residential support at an affordable cost.

Apart from the challenge of moving headquarters personnel, there was a need to move the existing servers and IT infrastructure which supported the warehouse operations and retail sales. While the warehouse only functioned six days a week, allowing one day to move an AS/400 and bring up new ISP links, many of the stores were open 24 hours a day and any significant downtime would quickly find its way to the bottom line. From the data processing viewpoint, the move included a large uninterruptible power supply (UPS), an AS/400, multiple application servers, and directory servers and with PCs. The network consisted of approximately 75 stores connected through ISPs to three routers at the data centre running a common LAN shared by headquarters (HQ) staff, the data centre, and the warehouse.

John, by now the head of IT operations, was asked to evaluate the configuration and dependency options of the IT infrastructure and identify a suitable systems migration plan. Needless to say, the prospect of shutting everything down on a Friday night, running backups on every server, dismantling all data servers and HQ employee systems, reconfiguring all warehouse systems which were not moving, and having everything up and running for the

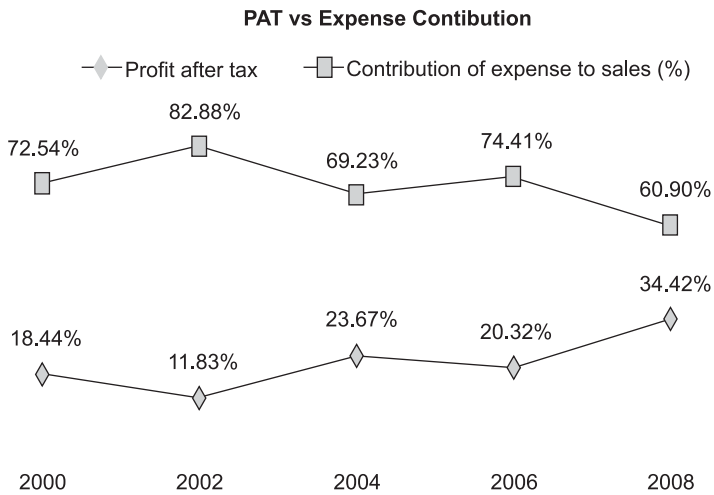
ABC Unlimited					
Particulars	**Year 2000**	**Year 2002**	**Year 2004**	**Year 2006**	**Year 2008**
Assets					
Cash and cash equivalents	49	95	249	539	953
Marketable securities	29	59	129	359	569
Loaned securities	37	76	169	335	359
Finance receivables net	109	462	861	1698	2968
Other receivables net	28	94	195	299	495
Inventories	79	386	756	1269	3496
Net property	98	248	445	699	1245
Defered income tax	104	126	327	692	1022
Other asset	58	88	166	226	333
Total assets	**591**	**1634**	**3297**	**6116**	**11503**
Liabilities and stockholder's equity					
Payables	95	292	393	596	1056
Accured liabilities and deferred revenues	35	183	377	825	1265
Debt	109	349	589	1615	2566
Liabilities of discontinued/held for sale operation	24	89	28	35	60
Total liabilities	**263**	**913**	**1387**	**3071**	**4947**
Stockholder's equity					
Capital stock (including in excess of par value of stock)	146	368	479	1096	1596
Accumulated and other income/(Loss)	137	285	1182	936	3395
Treasury stock	0	0	0	359	496
Retained earnings/(accumulated deficit)	45	68	249	654	1069
Total stockholder's equity	**328**	**721**	**1910**	**3045**	**6556**
Total liabilities and stockholder's equity	**591**	**1634**	**3297**	**6116**	**11503**

Balance Sheet (Figure in USD)(In Millions)

Statement of Income

ABC Unlimited					
Particulars	**Year 2000**	**Year 2002**	**Year 2004**	**Year 2006**	**Year 2008**
Sales and revenues	987	2985	6045	10284	15875
Total revenues	**987**	**2985**	**6045**	**10284**	**15875**
Cost and expenses					
Selling, administrative and other expenses	**429**	**1487**	**2945**	**5955**	**7744**
IT expenses	189	809	995	1200	1395
Interest expense	98	178	245	497	529
Total expense	**716**	**2474**	**4185**	**7652**	**9668**
Income/(loss) before income taxes	271	511	1860	2632	6207
Provision for income tax	89	158	429	542	743
Net income/(loss)	**182**	**353**	**1431**	**2090**	**5464**
Profit after tax %	**18.44%**	**11.83%**	**23.67%**	**20.32%**	**34.42%**
Contribution of expense to sales (%)	**72.54%**	**82.88%**	**69.23%**	**74.41%**	**60.90%**

Statement of Income (Figure in USD)(In Millions)



Expense Contribution

warehouse to begin operations at 6:00 a.m. on Monday caused the MIS manager to pass many sleepless nights.

Rather than even attempting to pick everything up and hope that it would all work when deposited in the new location, ABC Unlimited, worked up a network and data migration plan which would allow the move to occur in phases, allowing the MIS staff to concentrate on one critical factor at a time and minimize the danger of excessive downtime at any time during the move.

The data centre move took place on schedule and with no detectable disruption of retail support services.

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