MANAGEMENT INFORMATION SYSTEM

Chapter Two: IT Infrastructure, Platforms and Emerging Technologies

Learning Objectives

At the end of the chapter the learner shall be able to;

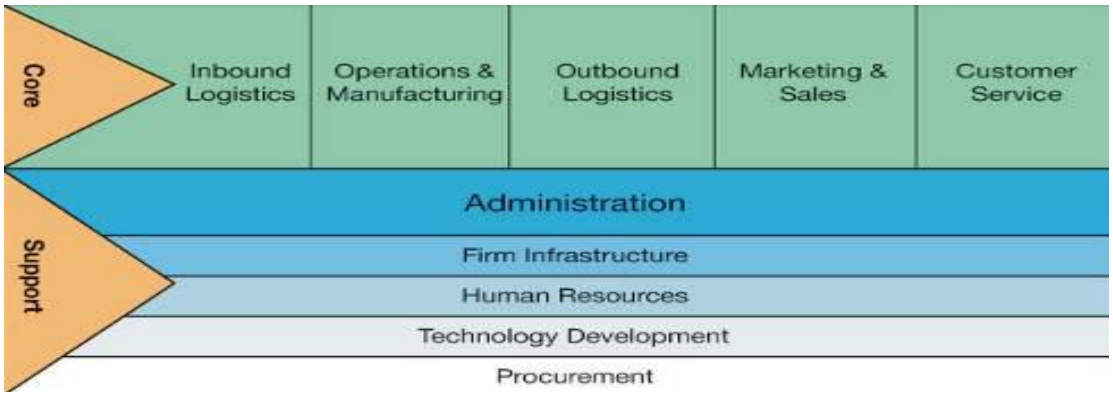
i. Define IT infrastructure and describe the components and levels of IT infrastructure.
ii. Identify and describe the stages of IT infrastructure evolution.
iii. Identify and describe the technology drivers of IT infrastructure evolution.
iv. Assess contemporary computer hardware platform trends.
v. Assess contemporary software platform trends.
vi. Evaluate the challenges of managing IT infrastructure and management solutions.

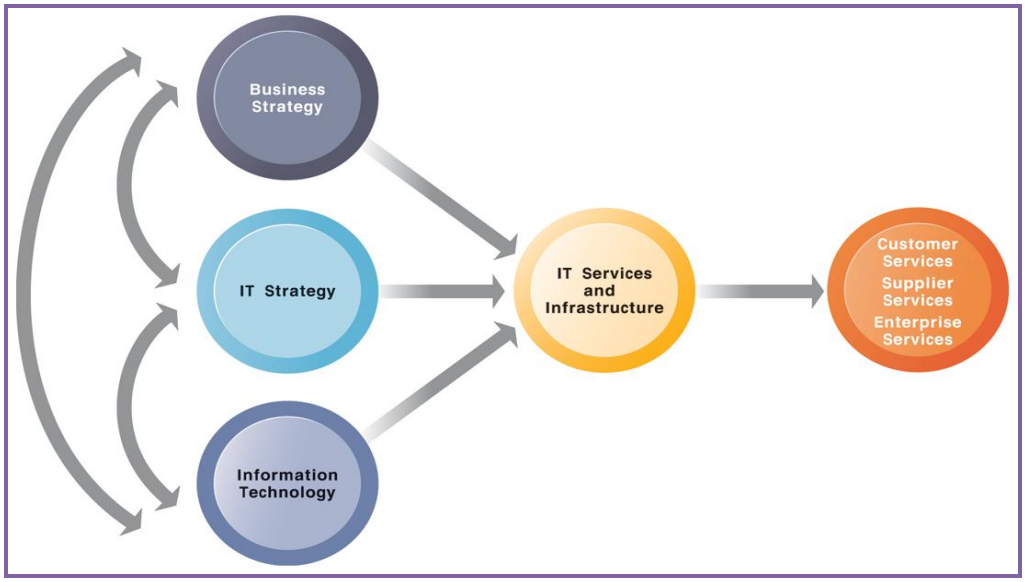
2.1 Defining I.T. Infrastructure

- Information technology infrastructure is the shared technology resources that provide the platform for the firms/ organization's specific information systems application.
- A set of firm wide services budgeted by management and comprises both human and technical capabilities
  The firm-wide services includes;
  a) Computing platforms used to provide computing services that connect employees, customers and suppliers into a coherent digital environment, including large mainframes, desktop and laptop computers, and personal digital assistants (PDA) and internet appliances.
  b) Telecommunications services that provide data, voice, and video connectivity to employees, customers, and suppliers
  c) Data management services that store and manage corporate data and provide capabilities for analyzing the data.
  d) Physical facilities management services that develop and manage the physical installations required for computing, telecommunications, and data management services.
  e) IT management services that plan and develop the infrastructure, coordinate with the business units for IT services, manage accounting for the IT expenditure, and provide project management services.
  f) IT standards services that provide the firm and its business units with policies that determine which information technology will be used, when, and how.
  g) IT education services that provide training in system use to employees and offer managers training in how to plan for and manage IT investments.
  h) IT research and development services that provide the firm with research on potential future IT projects and investments that could help the firm differentiate itself in the marketplace.

The Need for an IS Infrastructure

The infrastructure includes investment in hardware, software, and services such as consulting, education and training, that are shared across the entire organization or across entire business units in an organization. Investment in infrastructure account for between 25% - 35% of the information technology expenditure in large organizations. An organization's IT infrastructure provides the foundation for serving customers, working with vendors and managing internal business processes. Businesses rely on IS infrastructure to support business processes, decision making and competitive strategy





2.2 Levels of IT Infrastructure

A typical firm's IT infrastructure can be divided into three major levels: public, enterprise and business unit. Each level has its own unique hardware, software, and service components.

- Public-level includes the Internet, public telephone networks on which businesses are increasingly reliant, industry-operated networks, cable systems, satellite systems, and cellular telephone networks.
- Enterprise level may include email, Web sites, intranets, extranets, and enterprise applications.
- Business units concentrate on those infrastructure components that service the four functional areas of a typical business: sales & marketing, production & manufacturing, finance, and human resources.

2.3 Evolution of IT Infrastructure: 1950-2005

Reviewing the evolution of corporate IT infrastructure can offer some insight into where we may be headed.

Evolution of the IT Infrastructure

- Electronic accounting machine (1930-1950): dominated by machines that began to replace humans in the accounting department. Because almost all of the computing was done in the accounting and finance functional area, future IT departments tended to be under the purview of the Chief Financial Officer.
- General purpose Mainframe and Mini computer Era (1959 – Present); the mainframe era began with highly centralized computing with networks of terminals concentrated in the computing department. While early models contained proprietary software and data, today's mainframes are able to process a wide variety of software and data. It's interesting to note that IBM began this era and remains the single largest supplier of mainframe computing. While the experts and pundits predicted the death of the mainframe in the mid 1980s, the mainframe has evolved and remains a strong, viable component in many IT infrastructures because of its ability to process huge amounts of data and transmissions.
- Personal computer Era (1981 – Present): it's interesting to note that the advances developed for personal computer in the home has given rise to much of the advances in corporate computing in the last 25 years. As the home user became more comfortable with using computers, and more applications were developed for personal computers, more employees demanded increased use of computers in the workplace. While the Wintel standard has dominated this era, open-source software is starting to put a big dent into that stronghold.
- Client / Server Era (1983 – present): as the desktop and laptop personal computers became more powerful and cheaper, businesses began using them to replace mini-computers and some mainframe computers by networking them together. Client node is the user point of entry to the network, while the server typically processes and stores data, serves the web pages or manages network activities. Large companies use a multi-tiered client/server architecture that has several different levels of servers. Client / server computing enables businesses to distribute computing work across a series of smaller, inexpensive machines, resulting in explosion in computing power and application throughout the organization.

- Enterprise Computing Era (1992 to present): use of internet to link different pieces of computer hardware and smaller networks into an enterprise-wide network so that information can flow freely across the organization and between the organization and other organizations. The era has seen an explosive growth in functionality and popularity.
- Cloud computing Era (2000 to present): model of computing where organizations and individuals obtain computing power and software applications over the internet, rather than purchasing their own hardware and software.

2.4. Technology Drivers of Infrastructure Evolution

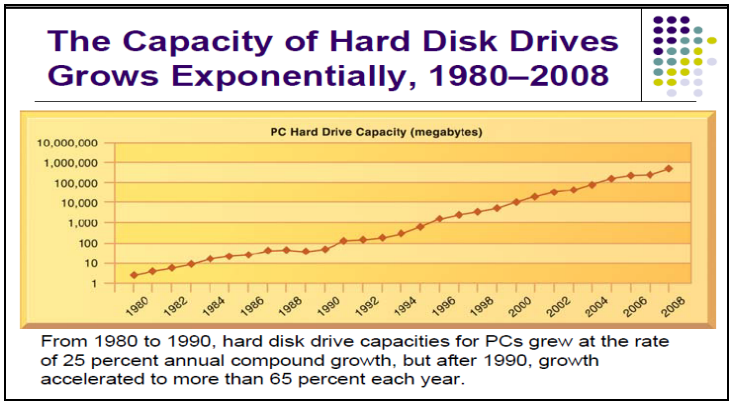
Changes in IT infrastructure have resulted from development in computing processing power, memory chip, storage devices, telecommunications and networking hardware and software, and software design that have exponentially increased computing power while exponentially reducing costs. Other technological drivers of the IT infrastructure includes;

Moore's Law and Micro-processing power. According to Moore's law:

- The power of microprocessors doubles every 18 months,
- The computer power doubles every 18 months thus
- The price of computing falls by half every 18 months.

Law of Mass Digital Storage:

- The amount of digital information is roughly doubling every year,
- The capacity of hard disk drives grow exponentially
- The cost of storing data declines exponentially at a rate of 100 % per year.

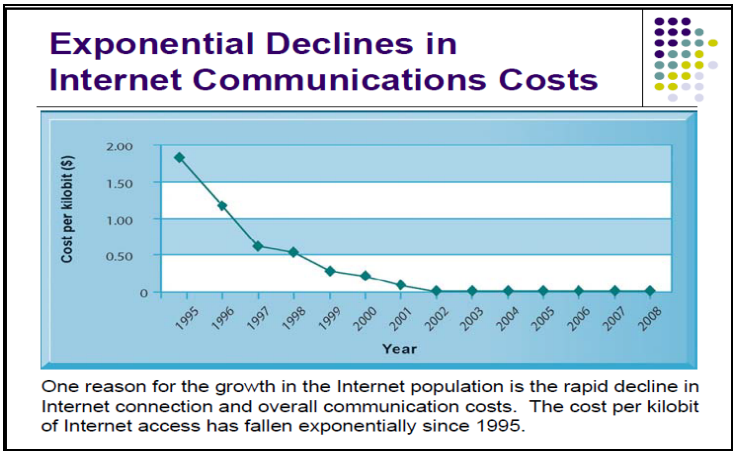


Metcalfe's Law and Network Economies

- Invented by Robert Metcalfe inventor of Ethernet local area network technology
- The value of network grows ***exponentially*** as a function of network members. As the number of members in a network grows linearly, the value of the entire system grows exponentially and continue to grow forever a members increase. Demand for IT has been driven by social and business value of digital networks, which rapidly multiply the number of actual and potential links among network members.

Declining Communication Costs and the Internet.

- One reason for the growth in the Internet population is the rapid decline in internet connection and overall communication costs. There has been an exponential decline in the cost of communication bother over the internet and telephone networks, and the costs fall and approach zero, the utilization of communication and computing facilities explodes.



One reason for the growth in the Internet population is the rapid decline in Internet connection and overall communication costs. The cost per kilobit of Internet access has fallen exponentially since 1995.

Standards and Network Effects

- Development and use of technology standards; specifications that establishes the compatibility of products and the ability to communicate in a network. These standards unleash powerful economies of scale and result in prices declines as manufacturers focus on the product built to single standard.

2.5 Infrastructure Components

The IT infrastructure today is composed of seven major components, which constitute investments that must be coordinated with one another to provide the firm with a coherent infrastructure.

- **Computer hardware platforms**; Includes the client machines (Desktop PCs, mobile computing devices such as iphones, blackberrys and laptops) and the servers
- **Operating System Platforms**: the systems that manages the resources and activities of the computer. Operations such as logging on, file management, and network connectivity are controlled by the operating system. Example Windows, Linux, Unix etc
- **Enterprise Software Applications**: Integrating applications into seamless processes across the organization is the goal of enterprise software applications. Customer relationship management and supply chain management systems are the two most popular applications in this category. Example, Enterprise Resource Planning software, middleware software for achieving firm-wide/ organization-wide integration by linking the existing application systems.
- **Data Management and Storage**: Extensive Data storage facilities as the amount of new digital information in the world is doubling every three years driven part by e-commerce and e-business. Storage area networks (SANs) provide a cohesive, economical way to consolidate data from across any and all systems within the business
- **Networking / Telecommunication Platforms**: Networking and telecommunication facilities
- **Internet platform**: The Internet and its technology standards continue to expand the services businesses are able to provide their employees, customers, suppliers, and business partners. Intranets and extranets built on Internet technologies give businesses an easy and inexpensive method of providing services that were cost prohibitive a few years ago.
- Consulting and System Integration Services; Systems used in many medium and large-sized companies and organizations are so complex that most businesses simply can't manage by themselves. Software integration ensures that the new Infrastructure works with the organization's older **legacy systems** and ensures that the new elements of the infrastructure work with one another

Legacy systems are generally older transaction processing systems created for mainframes and mini-computers that continue to be used to avoid high cost of replacing or re-designing them.

2.6 Contemporary Hardware Platforms and Software Trends

Organizations faces a number of challenges in such as;

- the need to integrate information stored in different applications, on different platforms.
- Need to build resilient infrastructures that can withstand huge increases in peak loads and routine assaults from hackers and viruses while conserving electrical power.
- Need to increase their service level to respond to growing customer and employee expectations for service.

The following hardware and software trends addresses these challenges

Hardware Trends

a). Emerging Mobile Digital platform

Mobile computing devices such as cell phones & smart phones have taken up many of the functions of hand held computers; transmission of data, surfing the web, transmitting e-mails and instant messages, displaying digital content and exchanging data with internal corporate systems.

b). Grid Computing

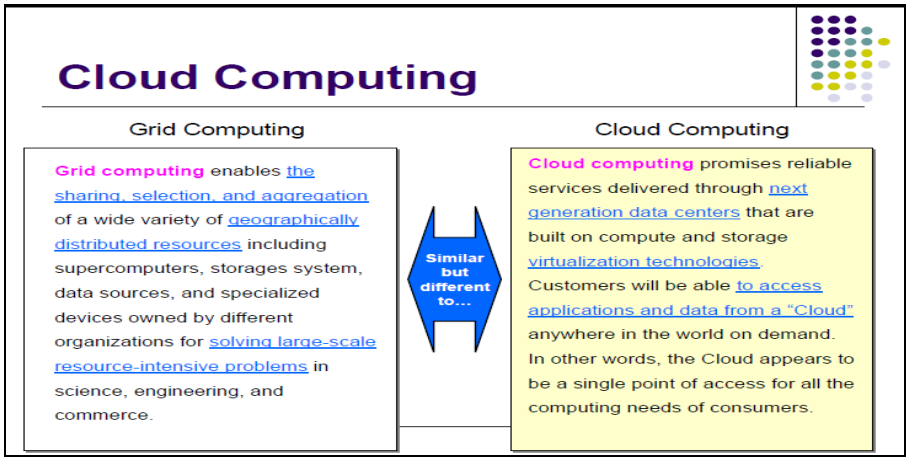
Grid computing involves connecting geographically remote computers into a single network to create a virtual super computer by combining the computational power of all computers on the grid. It was not possible until high-speed internet connections enabled organizations to connect remote machines economically and move enormous quantities of data.

It requires software programs to control and allocate resources on the grid and the client machines can still perform their traditional tasks while running on the grid applications on the background. The business case for grid computing includes; cost saving, speed of computation and agility

c). Cloud Computing and Computing Utility

Model of computing where organizations and individuals obtain computing power and software applications over the internet, rather than purchasing their own hardware and software. Data are permanently stored in remote servers in massive data centers and accessed and updated over the internet using the client computers. Cloud computing will gradually shift organizations from having a fixed infrastructure capacity towards a more flexible infrastructure, some of it internally owned and other rented from giant computer centers.

Cloud computing has introduced the concept of BPO – Business process Outsourcing.



d). Autonomic Computing

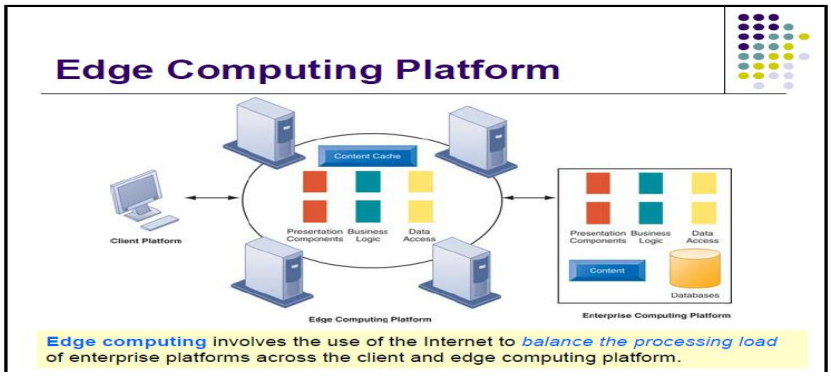
Industry –wide effort to develop systems that can configure themselves, optimize and tune themselves, heal themselves when broken and protect themselves from outside intruders and self-destruction. e.g., Windows XP and Max X OS automatically downloadpatches and updates

e). Edge Computing

Edge computing is a multi-tier, load-balancing scheme for Web-based applications (**Content Delivery Network**)

Advantages

- Processing load is distributed closer to the user and handled by lower-cost servers.
- Lowers cost of hardware
- Increases service levels
- Provides firm greater flexibility in responding to service requests
- Seasonal spikes in demand can be off-loaded to other edge servers



f). Virtualization and Multi-core Processors

Virtualization is the process of presenting a set of computing resources (computing power or data storage) so that they can be accessed in ways that are not restricted by physical configuration or geographic location. Server virtualization enables companies to run more than one operating system at the same time on a single machine. Server virtualization software runs between the operating system and the hardware, masking server resources, including the number and identity of physical servers, processors and operating systems from server users. Example VMare software.

g). Multi-core Processors

An integrated circuit to which two or more processors have been attached for enhanced performance, reduced power consumption and more efficient simultaneous processing of multiple tasks. Used to reduce the power requirements and hardware sprawl.

Software Trends

a). Linux and Open Source

Open sources software: software produced by a community of several hundred thousand programmers around the world. It is free and can be modified by users.

Linux : a open source operating system.

b). Software for the Web: Java and Ajax

Java: Operating system independent, processor-independent, Object-oriented programming language which is the leading interactive programming language for the Web.

Ajax: (Asynchronous JavaScript and XML) a web development technique for creating interactive Web applications.

c). Web services and Service- oriented architecture

Web services; a set of loosely coupled software components that exchange information with each other using universal Web communication standards and languages. The foundation is XML Extensible Markup Language.

A collection of Web Services that are used to build a firm's software systems constitute what is called **Service-Oriented Architecture (SOA).** SOA is a set of self-contained services that communicate with each other to create a working software application. Business tasks are accomplished by executing a series of these services.

d). Software outsourcing

Three external sources for software:

1. Software packages and enterprise software
2. Software outsourcing (domestic or offshore)
   - Domestic:
     - Primarily for middleware, integration services, software support
   - Offshore:
     - Primarily for lower level maintenance, data entry, call centers, although outsourcing for new-program development is increasing
3. Software as a service (SaaS)
   - Accessed with Web browser over Internet
   - Ranges from free or low-cost services for individuals to business and enterprise software

- Users pay on subscription or per-transaction
- E.g. Salesforce.com
- Service Level Agreements (SLAs): formal agreement with service providers

2.7 Management Challenges

The challenges of creating and managing a good IT infrastructure include:

a) Making wise infrastructure investments; IT Infrastructure investments is usually very heavy and thus the question is should an organization purchase its own IT infrastructure components or rent them from external suppliers?

b) Coordinating infrastructure components:

c) Building a Responsive IT Infrastructure: Building a technology infrastructure that will support existing applications while remaining responsive to change is a key to long-term enterprise productivity.

d) Dealing with scalability and technology change: the question is how does the Infrastructure scale?. Scalability is the ability of a computer, product, or system to expand to serve a large number of users without breaking down.

For mobile computing and cloud computing

- New policies and procedures for managing these new platforms
- Contractual agreements with firms running clouds and distributing software required

e) Management and governance: Who controls and manages the IT infrastructure. Should the IT department have the mandate and responsibility of making their own IT decisions?, Should IT be centrally controlled and managed?

Solution Guidelines

Does your company spend too little on IT infrastructure thereby foregoing opportunities for new or improved products and services? Or does your company spend too much on IT infrastructure thereby wasting precious resources that could be utilized elsewhere? By answering the following questions, your company could align its IT spending with its needs.

- Inventory the market demand for your firm's services
- Analyze your firm's five-year business strategy
- Examine your firm's IT strategy, infrastructure, and cost for the next five years
- Determine where your firm is on the bell curve between old technologies and brand new ones
- Benchmark your service levels against your competitors
- Benchmark your IT expenditures against your competitors

Chapter Review Questions ?

1. What is IT infrastructure and what are its component
2. Define I.T. infrastructure from both a technology and a services perspective. Which services does I.T. infrastructure comprise?
3. Name and describe the different levels of I.T Infrastructure.
4. What are the Moore‘s Law and the law of Mass Digital Storage? What aspects of infrastructure change do they help explain?.
5. List each of the era in the I.T. Infrastructure evolution and describe their distinguishing characteristics
6. What are the challenges of managing IT Infrastructure in Business Organizations.

Reference

1. Laudon K, Laudon J, Management Information Systems, Managing the digital firm (Eleventh Edition).