MODUL SITEM INFORMASI MANAGEMEN

(MAN 611)

MODUL PERTEMUAN 06

IT Infrastructure

DISUSUN OLEH

Dr. Fransiskus Adikara, S.Kom, MMSI

UNIVERSITAS ESA UNGGUL

2019

IT INFRASTRUCTURES

1. Kemampuan Akhir Yang Diharapkan

After reading this session, you will be able to answer the following questions:

1. *What is IT infrastructure and what are its components?*
2. *What are the stages and technology drivers of IT infrastructure evolu- tion?*

2. Uraian dan Contoh

1. IT INFRASTRUCTURE

An IT infrastructure includes investment in hardware, software, and services—such as consulting, education, and training—that are shared across the entire firm or across entire business units in the firm. A firm's IT infrastructure provides the foundation for serving customers, working with vendors, and managing internal firm business processes (see Figure 5.1).

Supplying firms worldwide with IT infrastructure (hardware and software) in 2012 is estimated to be a $3.6 trillion industry when telecommunications, networking equipment, and telecommunications services (Internet, telephone, and data transmission) are included. This does not include IT and related business process consulting services, which add another $400 billion. Investments in infrastructure account for between 25 and 50 percent of information technology expenditures in large firms, led by financial services firms where IT investment is well over half of all capital investment.

DEFINING IT INFRASTRUCTURE

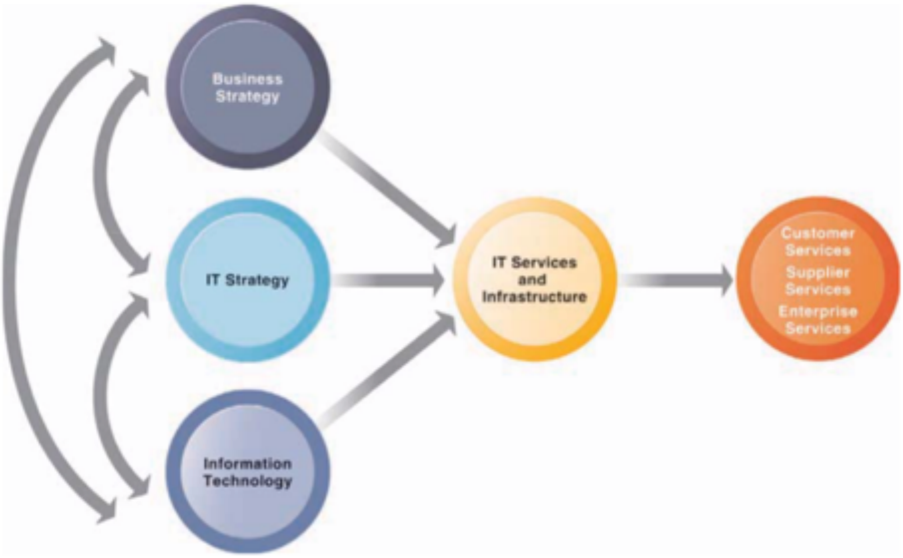
An IT infrastructure consists of a set of physical devices and software applica- tions that are required to operate the entire enterprise. But an IT infrastructure is also a set of firmwide services budgeted by management and comprising both human and technical capabilities. These services include the following:

- Computing platforms used to provide computing services that connect employees, customers, and suppliers into a coherent digital environment, including large mainframes, midrange computers, desktop and laptop computers, and mobile handheld and remote cloud computing services.
- Telecommunications services that provide data, voice, and video connectivity to employees, customers, and suppliers
- Data management services that store and manage corporate data and provide capabilities for analyzing the data
- Application software services, including online software services, that provide enterprise-wide capabilities such as enterprise resource planning, customer relationship management, supply chain management, and knowledge management systems that are shared by all business units
- Physical facilities management services that develop and manage the physical installations required for computing, telecommunications, and data management services

- IT management services that plan and develop the infrastructure, coordi- nate with the business units for IT services, manage accounting for the IT expenditure, and provide project management services
- IT standards services that provide the firm and its business units with policies that determine which information technology will be used, when, and how
- IT education services that provide training in system use to employees and offer managers training in how to plan for and manage IT investments
- 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

This "service platform" perspective makes it easier to understand the business value provided by infrastructure investments. For instance, the real business value of a fully loaded personal computer operating at 3 giga- hertz that costs about $1,000 and a high-speed Internet connection is hard to understand without knowing who will use it and how it will be used. When we look at the services provided by these tools, however, their value becomes more apparent: The new PC makes it possible for a high-cost employee making $100,000 a year to connect to all the company's major systems and the public Internet. The high-speed Internet service saves this employee about one hour per day in reduced wait time for Internet information. Without this PC and Internet connection, the value of this one employee to the firm might be cut in half.

FIGURE 5.1 CONNECTION BETWEEN THE FIRM, IT INFRASTRUCTURE, AND BUSINESS CAPABILITIES



The services a firm is capable of providing to its customers, suppliers, and employees are a direct function of its IT infrastructure. Ideally, this infrastructure should support the firm's business and information systems strategy. New information technologies have a powerful impact on business and IT strategies, as well as the services that can be provided to customers.

EVOLUTION OF IT INFRASTRUCTURE

The IT infrastructure in organizations today is an outgrowth of over 50 years of evolution in computing platforms. There have been five stages in this evolution, each representing a different configuration of computing power and infrastructure elements (see Figure 5.2). The five eras are general-pur- pose mainframe and minicomputer computing, personal computers, client/ server networks, enterprise computing, and cloud and mobile computing.

Technologies that characterize one era may also be used in another time period for other purposes. For example, some companies still run traditional mainframe systems or use mainframe computers as massive servers supporting large Web sites and corporate enterprise applications.

General-Purpose Mainframe and Minicomputer Era: (1959 to Present) The introduction of the IBM 1401 and 7090 transistorized machines in 1959 marked the beginning of widespread commercial use of **mainframe** computers. In 1965, the mainframe computer truly came into its own with the introduction of the IBM 360 series. The 360 was the first commercial computer with a power- ful operating system that could provide time sharing, multitasking, and virtual memory in more advanced models. IBM has dominated mainframe computing from this point on. Mainframe computers became powerful enough to support thousands of online remote terminals connected to the centralized mainframe using proprietary communication protocols and proprietary data lines.

The mainframe era was a period of highly centralized computing under the control of professional programmers and systems operators (usually in a cor- porate data center), with most elements of infrastructure provided by a single vendor, the manufacturer of the hardware and the software.

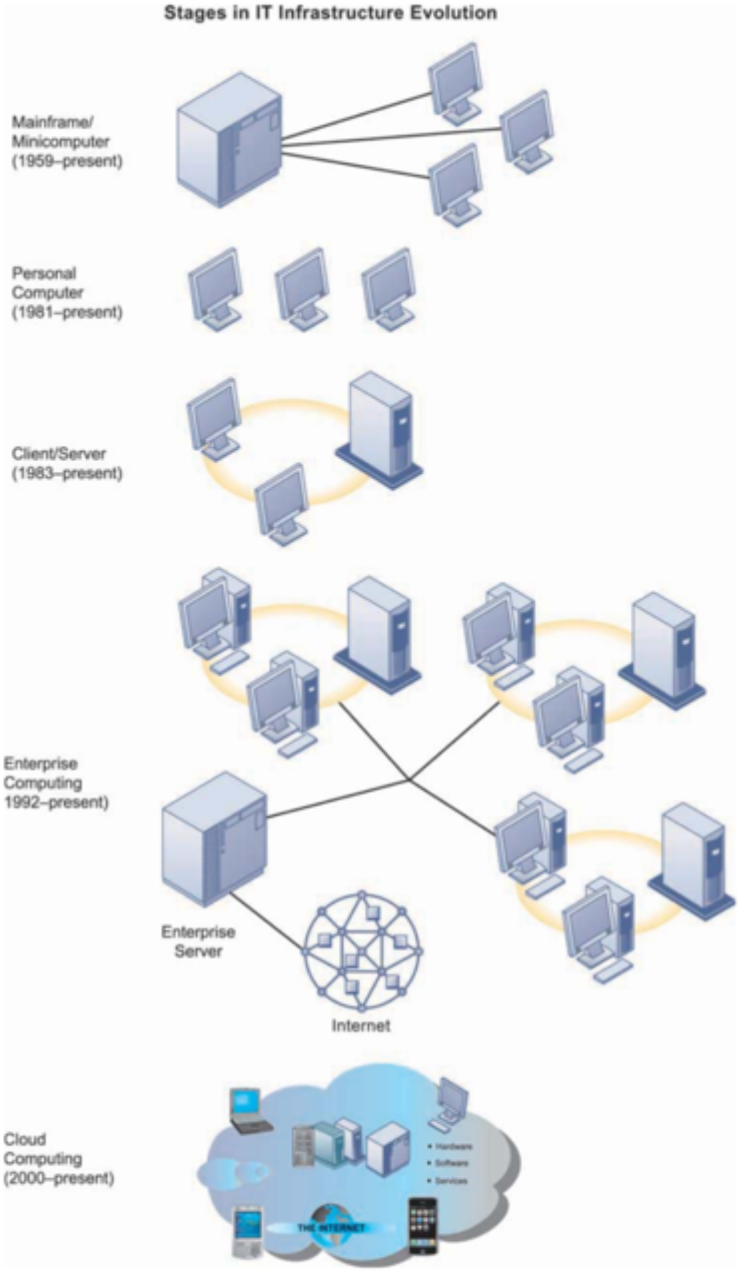
This pattern began to change with the introduction of **minicomputers** pro- duced by Digital Equipment Corporation (DEC) in 1965. DEC minicomputers (PDP-11 and later the VAX machines) offered powerful machines at far lower prices than IBM mainframes, making possible decentralized computing, custom- ized to the specific needs of individual departments or business units rather than time sharing on a single huge mainframe. In recent years, the minicomputer has evolved into a midrange computer or midrange server and is part of a network.

Personal Computer Era: (1981 to Present)

Although the first truly personal computers (PCs) appeared in the 1970s (the Xerox Alto, the MITS Altair 8800, and the Apple I and II, to name a few), these machines had only limited distribution to computer enthusiasts. The appearance of the IBM PC in 1981 is usually considered the beginning of the PC era because this machine was the first to be widely adopted by American businesses. At first using the DOS operating system, a text-based command language, and later the Microsoft Windows operating system, the **Wintel PC** computer (Windows oper- ating system software on a computer with an Intel microprocessor) became the standard desktop personal computer. In 2012, there are an estimated 1.2 billion PCs in the world, and 300 million new PCs are sold each year. 90% are thought to run a version of Windows, and 10% run a Macintosh OS. The Wintel domi- nance as a computing platform is receding as iPhone and Android device sales increase. Nearly one billion people worldwide own smartphones, and most of these users access the Internet with their mobile devices.

Proliferation of PCs in the 1980s and early 1990s launched a spate of personal desktop productivity software tools—word processors, spreadsheets, electronic presentation software, and small data management programs—that were very valuable to both home and corporate users. These PCs were stand-alone systems until PC operating system software in the 1990s made it possible to link them into networks.

FIGURE 5.2 ERAS IN IT INFRASTRUCTURE EVOLUTION



Illustrated here are the typical computing configurations characterizing each of the five eras of IT infrastructure evolution.

Client/Server Era (1983 to Present)

In **client/server computing**, desktop or laptop computers called **clients** are networked to powerful **server** computers that provide the client computers with a variety of services and capabilities. Computer processing work is split between these two types of machines. The client is the user point of entry, whereas the server typically processes and stores shared data, serves up Web pages, or manages network activities. The term “server” refers to both the soft- ware application and the physical computer on which the network software runs. The server could be a mainframe, but today, server computers typically are more powerful versions of personal computers, based on inexpensive chips and often using multiple processors in a single computer box., or in server racks.

The simplest client/server network consists of a client computer networked to a server computer, with processing split between the two types of machines. This is called a *two-tiered client/server architecture*. Whereas simple client/server networks can be found in small businesses, most cor- porations have more complex, **multitiered** (often called **N-tier**) **client/ server architectures** in which the work of the entire network is balanced over several different levels of servers, depending on the kind of service being requested (see Figure 5.3).

For instance, at the first level, a **Web server** will serve a Web page to a client in response to a request for service. Web server software is responsible for locating and managing stored Web pages. If the client requests access to a corporate system (a product list or price information, for instance), the request is passed along to an **application server**. Application server software han- dles all application operations between a user and an organization's back-end business systems. The application server may reside on the same computer as the Web server or on its own dedicated computer. Chapters 6 and 7 provide more detail on other pieces of software that are used in multitiered client/ server architectures for e-commerce and e-business.

Client/server computing enables businesses to distribute computing work across a series of smaller, inexpensive machines that cost much less than cen- tralized mainframe systems. The result is an explosion in computing power and applications throughout the firm.

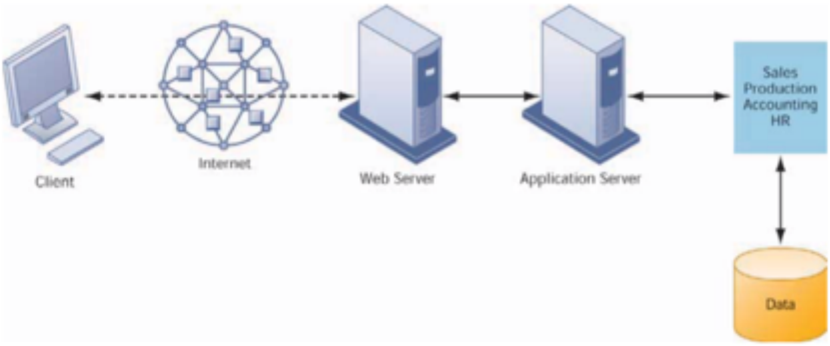
Novell NetWare was the leading technology for client/server networking at the beginning of the client/server era. Today, Microsoft is the market leader with its **Windows** operating systems (Windows Server, Windows 8, Windows 7, and Windows Vista).

Enterprise Computing Era (1992 to Present)

In the early 1990s, firms turned to networking standards and software tools that could integrate disparate networks and applications throughout the firm into an enterprise-wide infrastructure. As the Internet developed into a trusted com- munications environment after 1995, business firms began seriously using the *Transmission Control Protocol/Internet Protocol (TCP/IP)* networking standard to tie their disparate networks together. We discuss TCP/IP in detail in Chapter 7.

The resulting IT infrastructure links different pieces of computer hardware and smaller networks into an enterprise-wide network so that informa- tion can flow freely across the organization and between the firm and other organizations. It can link different types of computer hardware, including mainframes, servers, PCs, and mobile devices, and it includes public infrastruc- tures such as the telephone system, the Internet, and public network services. The enterprise infrastructure also requires software to link disparate applica- tions and enable data to flow freely among different parts of the business, such as enterprise applications (see Chapters 2 and 9) and Web services (discussed in Section 5.4).

FIGURE 5.3 A MULTITIERED CLIENT/SERVER NETWORK (N-TIER)



In a multitiered client/server network, client requests for service are handled by different levels of servers.

Cloud and Mobile Computing Era (2000 to Present)

The growing bandwidth power of the Internet has pushed the client/server model one step further, towards what is called the "Cloud Computing Model." **Cloud computing** refers to a model of computing that provides access to a shared pool of computing resources (computers, storage, applications, and services) over a network, often the Internet. These "clouds" of computing resources can be accessed on an as-needed basis from any connected device and location. Currently, cloud computing is the fastest growing form of com- puting, with companies spending about $109 billion on public cloud services in 2012, and an estimated $207 billion by the end of 2016 (Gartner, 2012).

Thousands or even hundreds of thousands computers are located in cloud data centers, where they can be accessed by desktop computers, laptop computers, tablets, entertainment centers, smartphones, and other client machines linked to the Internet, with both personal and corporate computing increasingly moving to mobile platforms. IBM, HP, Dell, and Amazon operate huge, scalable cloud computing centers that provide computing power, data storage, and high-speed Internet connections to firms that want to maintain their IT infrastructures remotely. Software firms such as Google, Microsoft, SAP, Oracle, and Salesforce. com sell software applications as services delivered over the Internet.

We discuss cloud and mobile computing in more detail in Section 5.3. The Learning Tracks include a table titled Comparing Stages in IT Infrastructure Evolution, which compares each era on the infrastructure dimensions introduced.

TECHNOLOGY DRIVERS OF INFRASTRUCTURE

EVOLUTION

The changes in IT infrastructure we have just described have resulted from developments in computer processing, memory chips, storage devices, telecommunications and networking hardware and software, and software design that have exponentially increased computing power while exponentially reducing costs. Let's look at the most important developments.

Moore's Law and Microprocessing Power

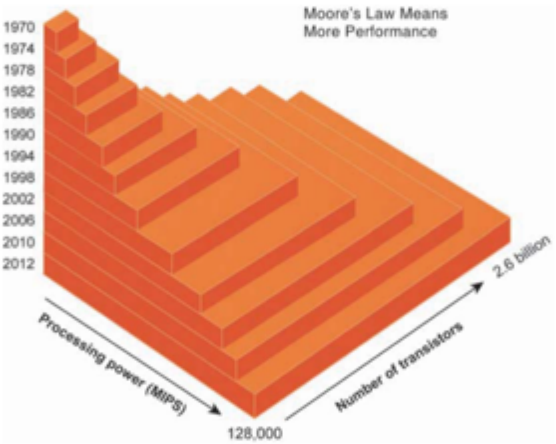
In 1965, Gordon Moore, the director of Fairchild Semiconductor's Research and Development Laboratories, an early manufacturer of integrated circuits, wrote in *Electronics* magazine that since the first microprocessor chip was introduced in 1959, the number of components on a chip with the smallest manufacturing costs per component (generally transistors) had doubled each year. This asser- tion became the foundation of **Moore's Law**. Moore later reduced the rate of growth to a doubling every two years.

This law would later be interpreted in multiple ways. There are at least three variations of Moore's Law, none of which Moore ever stated: (1) the power of microprocessors doubles every 18 months; (2) computing power doubles every 18 months; and (3) the price of computing falls by half every 18 months.

Figure 5.4 illustrates the relationship between number of transistors on a microprocessor and millions of instructions per second (MIPS), a common measure of processor power. Figure 5.5 shows the exponential decline in the cost of transistors and rise in computing power. For instance, in 2012, you can buy an Intel i7 quad-core processor on Amazon for about $355, and you will be purchasing a chip with 2.5 billion transistors, which works out to about one ten- millionth of a dollar per transistor.

Exponential growth in the number of transistors and the power of processors coupled with an exponential decline in computing costs is likely to continue. Chip manufacturers continue to miniaturize components. Today's transistors should no longer be compared to the size of a human hair but rather to the size of a virus.

FIGURE 5.4 MOORE'S LAW AND MICROPROCESSOR PERFORMANCE

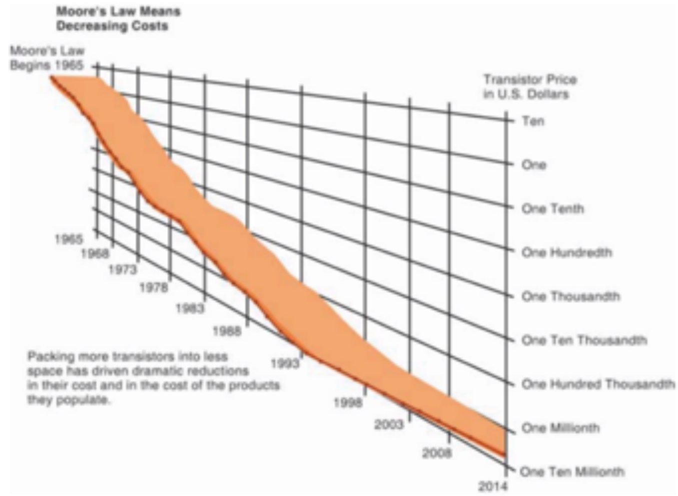


Packing over 2 billion transistors into a tiny microprocessor has exponentially increased processing power. Processing power has increased to over 128,000 MIPS (2.6 billion instructions per second).
Source: Authors' estimate.

By using nanotechnology, chip manufacturers can even shrink the size of transistors down to the width of several atoms. **Nanotechnology** uses individ- ual atoms and molecules to create computer chips and other devices that are thousands of times smaller than current technologies permit. Chip manufactur- ers are trying to develop a manufacturing process that could produce nanotube processors economically (Figure

5.6). IBM has just started making microproces- sors in a production setting using this technology.

FIGURE 5.5 FALLING COST OF CHIPS



Packing more transistors into less space has driven down transistor costs dramatically as well as the cost of the products in which they are used.

Source: Authors' estimate.

The Law of Mass Digital Storage

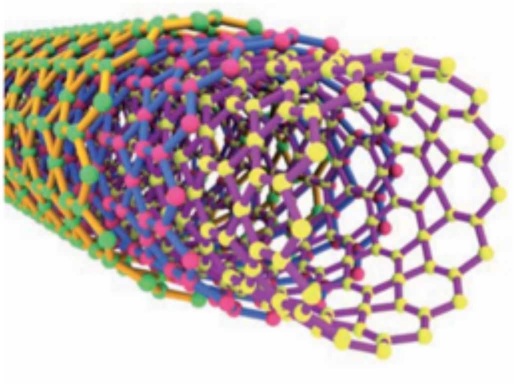
A second technology driver of IT infrastructure change is the Law of Mass Digital Storage. The amount of digital information is roughly doubling every year (Gantz and Reinsel, 2011; Lyman and Varian, 2003). Fortunately, the cost of storing digital information is falling at an exponential rate of 100 percent a year. Figure 5.7 shows that the number of megabytes that can be stored on mag- netic media for $1 from 1950 to the present roughly doubled every 15 months. In 2012, a 500 gigabyte hard disk drive sells at retail for about $60.

Metcalfe's Law and Network Economics

Moore's Law and the Law of Mass Storage help us understand why computing resources are now so readily available. But why do people want more com- puting and storage power? The economics of networks and the growth of the Internet provide some answers.

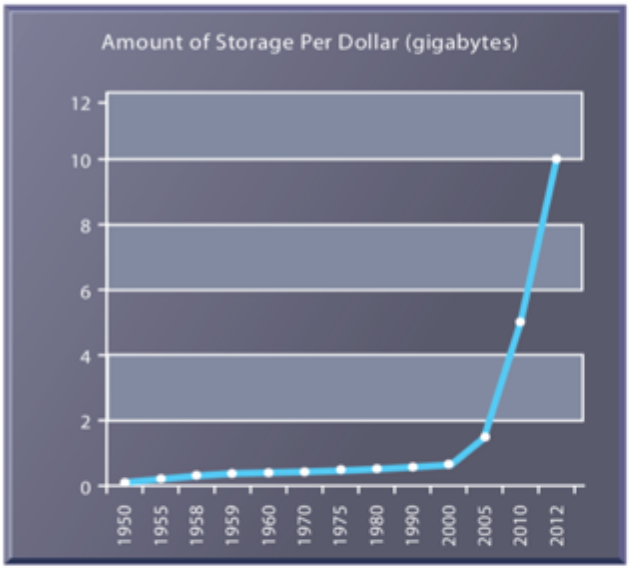
Robert Metcalfe—inventor of Ethernet local area network technology— claimed in 1970 that the value or power of a network grows exponentially as a function of the number of network members. Metcalfe and others point to the *increasing returns to scale* that network members receive as more and more people join the network. As the number of members in a network grows linearly, the value of the entire system grows exponentially and continues to grow forever as members increase. Demand for information technology has been driven by the social and business value of digital networks, which rapidly multiply the number of actual and potential links among network members.

FIGURE 5.6 EXAMPLE OF NANOTUBES



Nanotubes are tiny tubes about 10,000 times thinner than a human hair. They consist of rolled-up sheets of carbon hexagons and have the potential uses as minuscule wires or in ultrasmall electronic devices and are very powerful conductors of electrical current. © Tyler Boyes/Shutterstock.

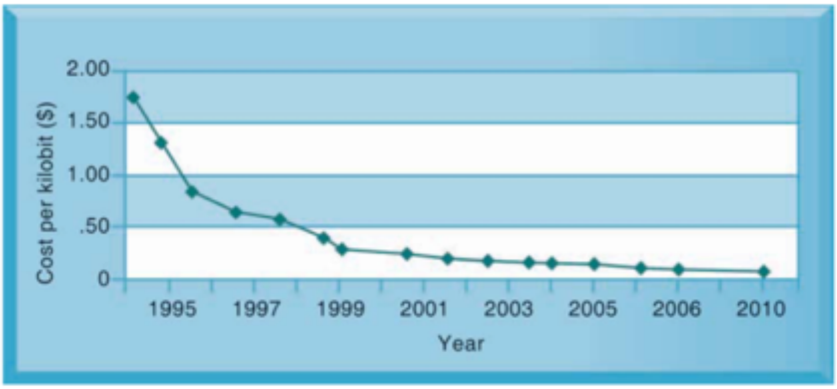
FIGURE 5.7 THE AMOUNT OF STORAGE PER DOLLAR RISES EXPONENTIALLY, 1950–2012



Since the first magnetic storage device was used in 1955, the amount of storage a dollar buys has risen exponentially, doubling the amount of digital storage for each dollar expended every 15 months on average.

Source: Authors' estimates.

FIGURE 5.8 **EXPONENTIAL DECLINES IN INTERNET COMMUNICATIONS COSTS**



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. Digital subscriber line (DSL) and cable modems now deliver a kilobit of communication for a retail price of around 2 cents.

Source: Authors.

Declining Communications Costs and the Internet

A fourth technology driver transforming IT infrastructure is the rapid decline in the costs of communication and the exponential growth in the size of the Internet. An estimated 2.3 billion people worldwide now have Internet access (Internet World Stats, 2012). Figure 5.8 illustrates the exponentially declining cost of communication both over the Internet and over telephone networks (which increasingly are based on the Internet). As communication costs fall toward a very small number and approach 0, utilization of communication and computing facilities explode.

To take advantage of the business value associated with the Internet, firms must greatly expand their Internet connections, including wireless connectiv- ity, and greatly expand the power of their client/server networks, desktop cli- ents, and mobile computing devices. There is every reason to believe these trends will continue.

Standards and Network Effects

Today's enterprise infrastructure and Internet computing would be impossi- ble—both now and in the future—without agreements among manufacturers and widespread consumer acceptance of **technology standards**. Technology standards are specifications that establish the compatibility of products and the ability to communicate in a network (Stango, 2004).

Technology standards unleash powerful economies of scale and result in price declines as manufacturers focus on the products built to a single standard. Without these economies of scale, computing of any sort would be far more expensive than is currently the case. Table 5.1 describes important standards that have shaped IT infrastructure.

Beginning in the 1990s, corporations started moving toward standard comput- ing and communications platforms. The Wintel PC with the Windows operating system and Microsoft Office desktop productivity applications became the standard desktop and mobile client computing platform. (It now shares the spotlight with other standards, such as Apple's iOS and Macintosh operating systems and the Android operating system.) Widespread adoption of Unix-Linux as the enterprise server operating system of choice made possible the replacement of proprietary and expensive mainframe infrastructures. In telecommunications, the Ethernet standard enabled PCs to connect together in small local area networks (LANs; see Chapter 7), and the TCP/IP standard enabled these LANs to be connected into firmwide networks, and ultimately, to the Internet.

TABLE 5.1 SOME IMPORTANT STANDARDS IN COMPUTING

STANDARD	SIGNIFICANCE
American Standard Code for Information Interchange (ASCII) (1958)	Made it possible for computer machines from different manufacturers to exchange data; later used as the universal language linking input and output devices such as keyboards and mice to computers. Adopted by the American National Standards Institute in 1963.
Common Business Oriented Language (COBOL) (1959)	An easy-to-use software language that greatly expanded the ability of programmers to write business-related programs and reduced the cost of software. Sponsored by the Defense Department in 1959.
Unix (1969–1975)	A powerful multitasking, multiuser, portable operating system initially developed at Bell Labs (1969) and later released for use by others (1975). It operates on a wide variety of computers from different manufacturers. Adopted by Sun, IBM, HP, and others in the 1980s, it became the most widely used enterprise-level operating system.
Transmission Control Protocol/Internet Protocol (TCP/IP) (1974)	Suite of communications protocols and a common addressing scheme that enables millions of computers to connect together in one giant global network (the Internet). Later, it was used as the default networking protocol suite for local area networks and intranets. Developed in the early 1970s for the U.S. Department of Defense.
Ethernet (1973)	A network standard for connecting desktop computers into local area networks that enabled the widespread adoption of client/server computing and local area networks, and further stimulated the adoption of personal computers.
IBM/Microsoft/Intel Personal Computer (1981)	The standard Wintel design for personal desktop computing based on standard Intel processors and other standard devices, Microsoft DOS, and later Windows software. The emergence of this standard, low-cost product laid the foundation for a 25-year period of explosive growth in computing throughout all organizations around the globe. Today, more than 1 billion PCs power business and government activities every day.
World Wide Web (1989–1993)	Standards for storing, retrieving, formatting, and displaying information as a worldwide web of electronic pages incorporating text, graphics, audio, and video enables creation of a global repository of billions of Web pages.

3. Latihan dan Jawaban

1) What is IT infrastructure and what are its components?

   IT infrastructure is the shared technology resources that provide the platform for the firm’s specific information system applications. IT infrastructure includes hardware, software, and services that are shared across the entire firm. Major IT infrastructure components include computer hardware platforms, operating system platforms, enterprise software platforms, networking and telecommunications platforms, database management software, Internet platforms, and consulting services and systems integrators.

2) What are the stages and technology drivers of IT infrastructure evolution?

The five stages of IT infrastructure evolution are: the mainframe era, the personal computer era, the client/server era, the enterprise computing era, and the cloud and mobile computing era. Moore’s Law deals with the exponential increase in processing power and decline in the cost of computer technology, stating that every 18 months the power of microprocessors doubles and the price of computing falls in half. The Law of Mass Digital Storage deals with the exponential decrease in the cost of storing data, stating that the number of kilobytes of data that can be stored on magnetic media for $1 roughly doubles every 15 months. Metcalfe’s Law states that a network’s value to participants grows exponentially as the network takes on more members. The rapid decline in costs of communi- cation and growing agreement in the technology industry to use computing and communications standards is also driving an explosion of computer use.

4. Daftar Pustaka

1. Management Information Systems, Managing Digital Firm, 11th Ed, Kenneth C. Laudon, Jane. P. Laudon. (L&L)
2. Management Information Systems With Misource 2007, 8th Ed James A. O'brien, And George Marakas
3. Managing Information Technology 5th Edition Martin, Brown, Dehayes