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Telecommunication, the Internet, and Wireless Technology

DISUSUN OLEH

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TELECOMMUNICATION, THE INTERNET, AND WIRELESS TECHNOLOGY

1. Kemampuan Akhir Yang Diharapkan

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

1. What are the principal components of telecommunications networks and key networking technologies?
2. What are the different types of networks?
3. How do the Internet and Internet technology work and how do they support communication and e-business?
4. What are the principal technologies and standards for wireless networking, communication, and Internet access?
5. Why are radio frequency identifica- tion (RFID) and wireless sensor networks valuable for business?

2. Uraian dan Contoh

2.1. TELECOMMUNICATIONS AND NETWORKING IN TODAY'S BUSINESS WORLD

A. NETWORKING AND COMMUNICATION TRENDS

Firms in the past used two fundamentally different types of networks: telephone networks and computer networks. Telephone networks historically handled voice communication, and computer networks handled data traffic. Telephone networks were built by telephone companies throughout the twenti- eth century using voice transmission technologies (hardware and software), and these companies almost always operated as regulated monopolies throughout the world. Computer networks were originally built by computer companies seeking to transmit data between computers in different locations.

Thanks to continuing telecommunications deregulation and informa- tion technology innovation, telephone and computer networks are converg- ing into a single digital network using shared Internet-based standards and equipment. Telecommunications providers today, such as AT&T and Verizon, offer data transmission, Internet access, cellular telephone service, and television programming as well as voice service. Cable companies, such as Cablevision and Comcast, offer voice service and Internet access. Computer networks have expanded to include Internet telephone and video services. Increasingly, all of these voice, video, and data communications are based on Internet technology.

Both voice and data communication networks have also become more powerful (faster), more portable (smaller and mobile), and less expensive. For instance, the typical Internet connection speed in 2000 was 56 kilobits per second, but today more than 68 percent of the 239 million U.S. Internet users have high-speed broadband connections provided by telephone and cable TV companies running at 1 to 15 million bits per second. The cost for this service has fallen exponen- tially, from 25 cents per kilobit in 2000 to a tiny fraction of a cent today.

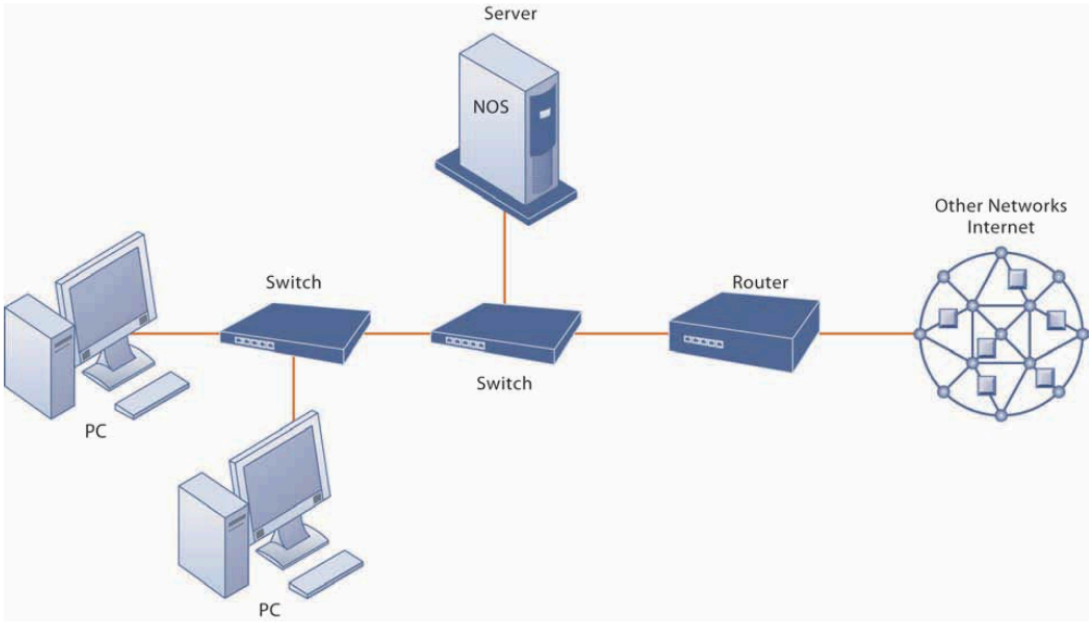
Increasingly, voice and data communication, as well as Internet access, are taking place over broadband wireless platforms, such as cell phones, mobile handheld devices, and PCs in wireless networks. In a few years, more than half the Internet users in the United States will use smartphones and mobile netbooks to access the Internet. In 2012, 122 million Americans (50% of all Internet users) accessed the Internet through mobile devices, and this number is expected to grow to 135 million by 2015 (eMarketer, 2012).

B. WHAT IS A COMPUTER NETWORK?

If you had to connect the computers for two or more employees together in the same office, you would need a computer network. Exactly what is a network? In its simplest form, a network consists of two or more connected computers. Figure 7.1 illustrates the major hardware, software, and transmis- sion components used in a simple network: a client computer and a dedicated server computer, network interfaces, a connection medium, network operating system software, and either a hub or a switch.

Each computer on the network contains a network interface device to link the computer to the network. The connection medium for linking network components can be a telephone wire, coaxial cable, or radio signal in the case of cell phone and wireless local area networks (Wi-Fi networks).

FIGURE 7.1 COMPONENTS OF A SIMPLE COMPUTER NETWORK



Illustrated here is a very simple computer network, consisting of computers, a network operating system (NOS) residing on a dedicated server computer, cable (wiring) connecting the devices, switches, and a router.

The network operating system (NOS) routes and manages communi- cations on the network and coordinates network resources. It can reside on every computer in the network, or it can reside primarily on a dedicated server computer for all the applications on the network. A server computer is a computer on a network that performs important network functions for client computers, such as serving up Web pages, storing data, and storing the network operating system (and hence controlling

the network). Server software such as Microsoft Windows Server, Linux, and Novell Open Enterprise Server are the most widely used network operating systems.

Most networks also contain a switch or a hub acting as a connection point between the computers. Hubs are very simple devices that connect network components, sending a packet of data to all other connected devices. A switch has more intelligence than a hub and can filter and forward data to a specified destination on the network.

What if you want to communicate with another network, such as the Internet? You would need a router. A router is a communications processor used to route packets of data through different networks, ensuring that the data sent gets to the correct address.

Network switches and routers have proprietary software built into their hardware for directing the movement of data on the network. This can create network bottlenecks and makes the process of configuring a network more complicated and time-consuming. Software-defined networking (SDN) is a new networking approach in which many of these control functions are man- aged by one central program, which can run on inexpensive commodity servers that are separate from the network devices themselves. This is especially help- ful in a cloud computing environment with many different pieces of hardware because it allows a network administrator to manage traffic loads in a flexible and more efficient manner.

Networks in Large Companies

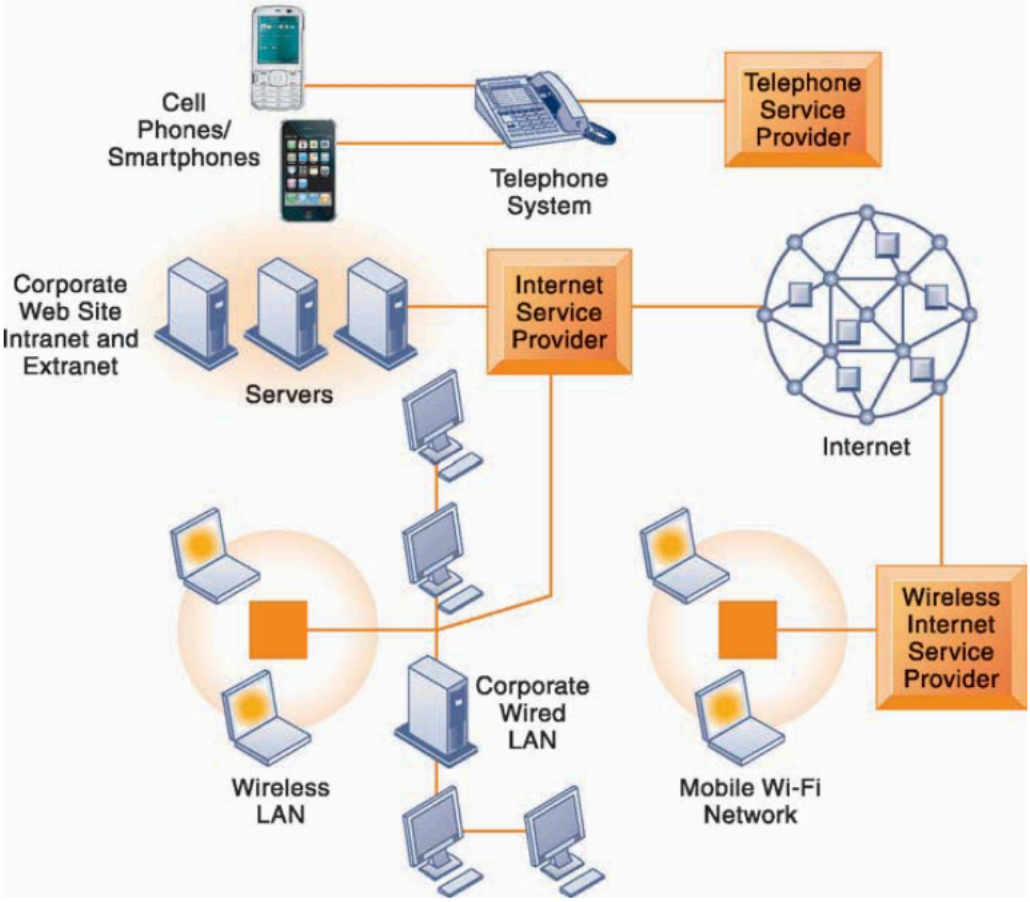
The network we've just described might be suitable for a small business. But what about large companies with many different locations and thousands of employ- ees? As a firm grows, and collects hundreds of small local area networks, these networks can be tied together into a corporate-wide networking infrastructure. The network infrastructure for a large corporation consists of a large number of these small local area networks linked to other local area networks and to firmwide corporate networks. A number of powerful servers support a corporate Web site, a corporate intranet, and perhaps an extranet. Some of these servers link to other large computers supporting back-end systems.

Figure 7.2 provides an illustration of these more complex, larger scale corporate-wide networks. Here you can see that the corporate network infra- structure supports a mobile sales force using cell phones and smartphones, mobile employees linking to the company Web site, internal company networks using mobile wireless local area networks (Wi-Fi networks), and a videoconfer- encing system to support managers across the world. In addition to these com- puter networks, the firm's infrastructure usually includes a separate telephone network that handles most voice data. Many firms are dispensing with their traditional telephone networks and using Internet telephones that run on their existing data networks (described later).

As you can see from this figure, a large corporate network infrastructure uses a wide variety of technologies—everything from ordinary telephone service and corporate data networks to Internet service, wireless Internet, and cell phones. One of the major problems facing corporations today is how to integrate all the different communication networks and channels into a coherent system that enables information to flow from one part of the corporation to another, and from one system to another. As more and

more communication networks become digital, and based on Internet technologies, it will become easier to integrate them.

FIGURE 7.2 CORPORATE NETWORK INFRASTRUCTURE



Today's corporate network infrastructure is a collection of many different networks from the public switched telephone network, to the Internet, to corporate local area networks linking workgroups, departments, or office floors.

C. KEY DIGITAL NETWORKING TECHNOLOGIES

Contemporary digital networks and the Internet are based on three key technologies: client/server computing, the use of packet switching, and the development of widely used communications standards (the most important of which is Transmission Control Protocol/Internet Protocol, or TCP/IP) for linking disparate networks and computers.

Client/Server Computing

Client/server computing, introduced in Chapter 5, is a distributed comput- ing model in which some of the processing power is located within small, inexpensive client computers, and resides literally on desktops, laptops, or in handheld devices. These powerful clients are linked to one another through a network that is controlled by a network server computer. The server sets the rules of communication for the network and provides every client with an address so others can find it on the network.

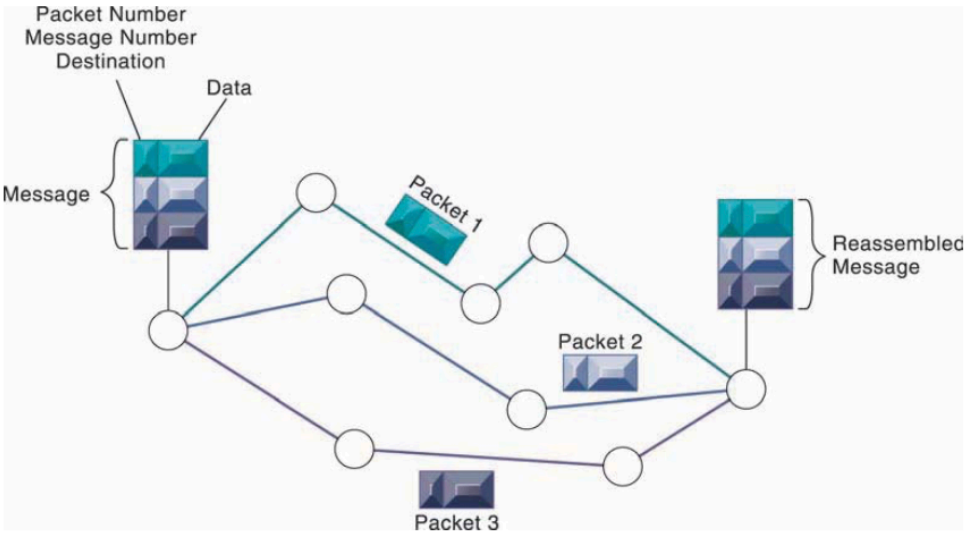
Client/server computing has largely replaced centralized mainframe computing in which nearly all of the processing takes place on a central large mainframe computer. Client/server computing has extended computing to departments, workgroups, factory floors, and other parts of the business that could not be served by a centralized architecture. The Internet is the largest implementation of client/server computing.

Packet Switching

Packet switching is a method of slicing digital messages into parcels called packets, sending the packets along different communication paths as they become available, and then reassembling the packets once they arrive at their destinations (see Figure 7.3). Prior to the development of packet switching, computer networks used leased, dedicated telephone circuits to communicate with other computers in remote locations. In circuit-switched networks, such as the telephone system, a complete point-to-point circuit is assembled, and then communication can proceed. These dedicated circuit-switching techniques were expensive and wasted available communications capacity—the circuit was maintained regardless of whether any data were being sent.

Packet switching makes much more efficient use of the communica- tions capacity of a network. In packet-switched networks, messages are first broken down into small fixed bundles of data called packets. The packets include information for directing the packet to the right address and for checking transmission errors along with the data. The packets are transmit- ted over various communications channels using routers, each packet traveling independently. Packets of data originating at one source will be routed through many different paths and networks before being reassembled into the original message when they reach their destinations.

FIGURE 7.3 PACKED-SWITCHED NETWORKS AND PACKET COMMUNICATIONS



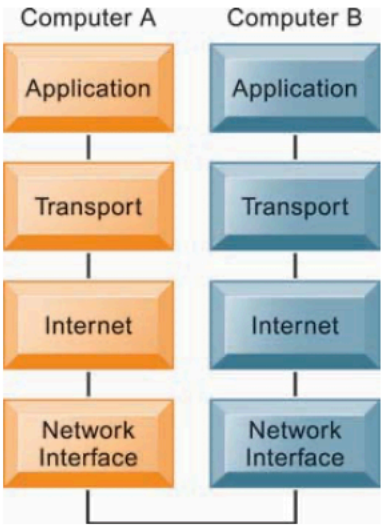
Data are grouped into small packets, which are transmitted independently over various communications channels and reassembled at their final destination.

TCP/IP and Connectivity

In a typical telecommunications network, diverse hardware and software components need to work together to transmit information. Different components in a network communicate with each other only by adhering to a common set of rules called protocols. A protocol is a set of rules and proce- dures governing transmission of information between two points in a network.

In the past, many diverse proprietary and incompatible protocols often forced business firms to purchase computing and communications equipment from a single vendor. But today, corporate networks are increasingly using a single, common, worldwide standard called Transmission Control Protocol/Internet Protocol (TCP/IP). TCP/IP was developed during the early 1970s to support U.S. Department of Defense Advanced Research Projects Agency (DARPA) efforts to help scientists transmit data among different types of computers over long distances.

FIGURE 7.4 THE TRANSMISSION CONTROL PROTOCOL/INTERNET PROTOCOL (TCP/IP) REFERENCE MODEL



This figure illustrates the four layers of the TCP/IP reference model for communications.

TCP/IP uses a suite of protocols, the main ones being TCP and IP. TCP refers to the Transmission Control Protocol, which handles the movement of data between computers. TCP establishes a connection between the computers, sequences the transfer of packets, and acknowledges the packets sent. IP refers to the Internet Protocol (IP), which is responsible for the delivery of packets and includes the disassembling and reassembling of packets during transmission. Figure 7.4 illustrates the four-layered Department of Defense reference model for TCP/IP, and the layers are described as follows:

1. Application layer. The Application layer enables client application programs to access the other layers and defines the protocols that applications use to exchange data. One of these application protocols is the Hypertext Transfer Protocol (HTTP), which is used to transfer Web page files.

2. Transport layer. The Transport layer is responsible for providing the Application layer with communication and packet services. This layer includes TCP and other protocols.

3. Internet layer. The Internet layer is responsible for addressing, routing, and packaging data packets called IP datagrams. The Internet Protocol is one of the protocols used in this layer.

4. Network Interface layer. At the bottom of the reference model, the Network Interface layer is responsible for placing packets on and receiving them from the network medium, which could be any networking technology.

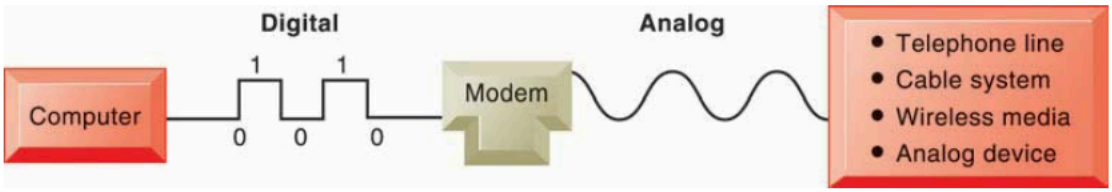
Two computers using TCP/IP are able to communicate even if they are based on different hardware and software platforms. Data sent from one computer to the other passes downward through all four layers, starting with the sending computer's Application layer and passing through the Network Interface layer. After the data reach the recipient host computer, they travel up the layers and are reassembled into a format the receiving computer can use. If the receiving computer finds a damaged packet, it asks the sending computer to retransmit it. This process is reversed when the receiving computer responds.

2.2. COMMUNICATIONS NETWORKS

A. SIGNALS: DIGITAL VS. ANALOG

There are two ways to communicate a message in a network: either using an analog signal or a digital signal. An analog signal is represented by a continuous waveform that passes through a communications medium and has been used for voice communication. The most common analog devices are the telephone handset, the speaker on your computer, or your iPod earphone, all of which create analog waveforms that your ear can hear.

FIGURE 7.5 FUNCTIONS OF THE MODEM



A modem is a device that translates digital signals into analog form (and vice versa) so that computers can transmit data over analog networks such as telephone and cable networks.

A digital signal is a discrete, binary waveform, rather than a continuous waveform. Digital signals communicate information as strings of two discrete states: one bit and zero bits, which are represented as on-off electrical pulses. Computers use digital signals and require a modem to convert these digital signals into analog signals that can be sent over (or received from) telephone lines, cable lines, or wireless media that use analog signals (see Figure 7.5). Modem stands for modulator-demodulator. Cable modems connect your computer to the Internet using a cable network. DSL modems connect your computer to the Internet using a telephone company's landline network.

Wireless modems perform the same func- tion as traditional modems, connecting your computer to a wireless network that could be a cell phone network, or a Wi-Fi network. Without modems, computers could not communicate with one another using analog networks (which include the telephone system and cable networks).

B. TYPES OF NETWORKS

There are many different kinds of networks and ways of classifying them. One way of looking at networks is in terms of their geographic scope (see Table 7.1).

Local Area Networks

If you work in a business that uses networking, you are probably connecting to other employees and groups via a local area network. A local area network (LAN) is designed to connect personal computers and other digital devices within a half-mile or 500-meter radius. LANs typically connect a few comput- ers in a small office, all the computers in one building, or all the computers in several buildings in close proximity. LANs also are used to link to long-distance wide area networks (WANs, described later in this section) and other networks around the world using the Internet.

Review Figure 7.1, which could serve as a model for a small LAN that might be used in an office. One computer is a dedicated network file server, providing users with access to shared computing resources in the network, including software programs and data files.

The server determines who gets access to what and in which sequence. The router connects the LAN to other networks, which could be the Internet or another corporate network, so that the LAN can exchange information with networks external to it. The most common LAN operating systems are Windows, Linux, and Novell. Each of these network operating systems supports TCP/IP as their default networking protocol.

Ethernet is the dominant LAN standard at the physical network level, specifying the physical medium to carry signals between computers, access control rules, and a standardized set of bits used to carry data over the system. Originally, Ethernet supported a data transfer rate of 10 megabits per second (Mbps). Newer versions, such as Gigabit Ethernet, support a data transfer rate of 1 gigabit per second (Gbps), respectively, and are used in network backbones.

The LAN illustrated in Figure 7.1 uses a client/server architecture where the network operating system resides primarily on a single file server, and the server provides much of the control and resources for the network. Alternatively, LANs may use a peer-to-peer architecture. A peer-to-peer network treats all processors equally and is used primarily in small networks with 10 or fewer users. The various computers on the network can exchange data by direct access and can share peripheral devices without going through a separate server.

In LANs using the Windows Server family of operating systems, the peer-to- peer architecture is called the workgroup network model, in which a small group of computers can share resources, such as files, folders, and printers, over the network without a dedicated server. The Windows domain network model, in contrast, uses a dedicated server to manage the computers in the network.

Larger LANs have many clients and multiple servers, with separate servers for specific services, such as storing and managing files and databases (file servers or database servers), managing printers (print servers), storing and managing e-mail (mail servers), or storing and managing Web pages (Web servers).

Metropolitan and Wide Area Networks

Wide area networks (WANs) span broad geographical distances—entire regions, states, continents, or the entire globe. The most universal and powerful WAN is the Internet. Computers connect to a WAN through public networks, such as the telephone system or private cable systems, or through leased lines or satellites. A metropolitan area network (MAN) is a network that spans a metropolitan area, usually a city and its major suburbs. Its geographic scope falls between a WAN and a LAN.

C. TRANSMISSION MEDIA AND TRANSMISSION SPEED

Networks use different kinds of physical transmission media, including twisted pair wire, coaxial cable, fiber optics, and media for wireless transmission. Each has advantages and limitations. A wide range of speeds is possible for any given medium depending on the software and hardware configuration. Table 7.2 compares these media.

Bandwidth: Transmission Speed

The total amount of digital information that can be transmitted through any telecommunications medium is measured in bits per second (bps). One signal change, or cycle, is required to transmit one or several bits; therefore, the transmission capacity of each type of telecommunications medium is a function of its frequency. The number of cycles per second that can be sent through that medium is measured in hertz—one hertz is equal to one cycle of the medium.

The range of frequencies that can be accommodated on a particular telecommunications channel is called its bandwidth. The bandwidth is the difference between the highest and lowest frequencies that can be accommodated on a single channel. The greater the range of frequencies, the greater the bandwidth and the greater the channel's transmission capacity.

2.3. THE GLOBAL INTERNET

We all use the Internet, and many of us can't do without it. It's become an indispensable personal and business tool. But what exactly is the Internet? How does it work, and what does Internet technology have to offer for business? Let's look at the most important Internet features.

A. WHAT IS THE INTERNET?

The Internet has become the world's most extensive, public communication system that now rivals the global telephone system in reach and range. It's also the world's largest implementation of client/server computing and internet- working, linking millions of individual networks all over the world. This global network of networks began in the

early 1970s as a U.S. Department of Defense network to link scientists and university professors around the world.

Most homes and small businesses connect to the Internet by subscribing to an Internet service provider. An Internet service provider (ISP) is a commercial organization with a permanent connection to the Internet that sells temporary connections to retail subscribers. EarthLink, NetZero, AT&T, and Time Warner are ISPs. Individuals also connect to the Internet through their business firms, universities, or research centers that have designated Internet domains.

There are a variety of services for ISP Internet connections. Connecting via a traditional telephone line and modem, at a speed of 56.6 kilobits per second (Kbps) used to be the most common form of connection worldwide, but it has been largely replaced by broadband connections. Digital subscriber line, cable, satellite Internet connections, and T lines provide these broadband services.

Digital subscriber line (DSL) technologies operate over existing telephone lines to carry voice, data, and video at transmission rates ranging from 385 Kbps all the way up to 40 Mbps, depending on usage patterns and distance. Cable Internet connections provided by cable television vendors use digital cable coaxial lines to deliver high-speed Internet access to homes and businesses. They can provide high-speed access to the Internet of up to 50 Mbps, although most providers offer service ranging from 1 Mbps to 6 Mbps. In areas where DSL and cable services are unavailable, it is possible to access the Internet via satellite, although some satellite Internet connections have slower upload speeds than other broadband services.

T1 and T3 are international telephone standards for digital communication. They are leased, dedicated lines suitable for businesses or government agencies requiring high-speed guaranteed service levels. T1 lines offer guaranteed delivery at 1.54 Mbps, and T3 lines offer delivery at 45 Mbps. The Internet does not provide similar guaranteed service levels, but simply “best effort.”

B. INTERNET ADDRESSING AND ARCHITECTURE

The Internet is based on the TCP/IP networking protocol suite described earlier in this chapter. Every computer on the Internet is assigned a unique Internet Protocol (IP) address, which currently is a 32-bit number represented by four strings of numbers ranging from 0 to 255 separated by periods. For instance, the IP address of www.microsoft.com is 207.46.250.119.

When a user sends a message to another user on the Internet, the message is first decomposed into packets using the TCP protocol. Each packet contains its destination address. The packets are then sent from the client to the network server and from there on to as many other servers as necessary to arrive at a specific computer with a known address. At the destination address, the pack- ets are reassembled into the original message.

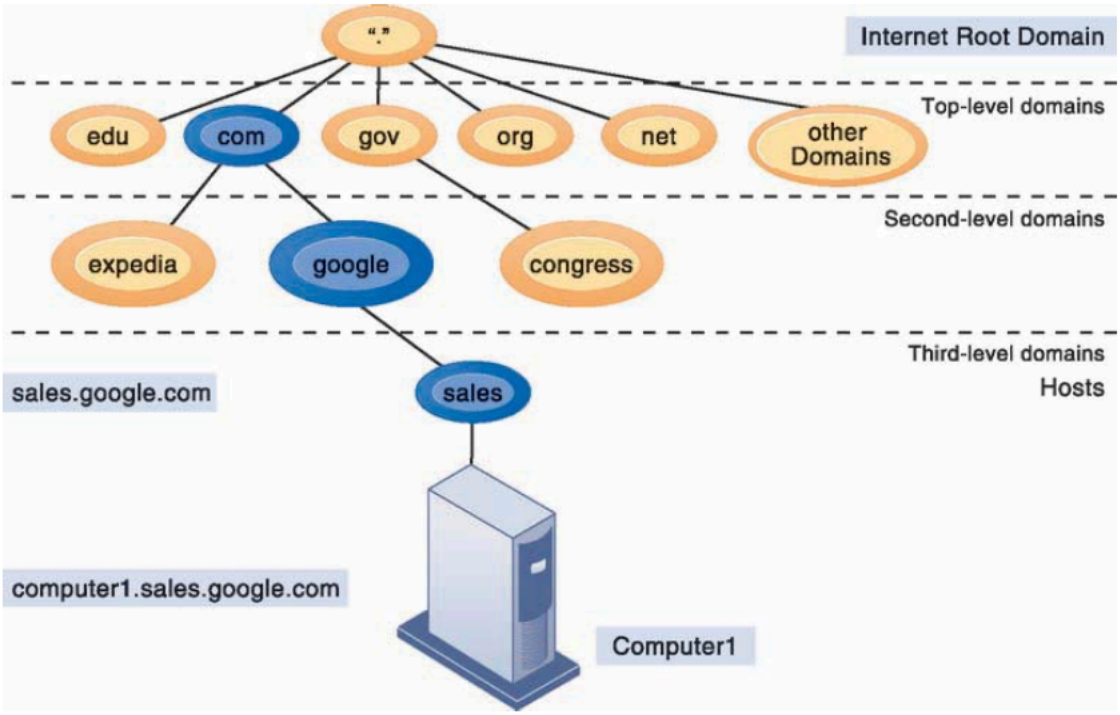
The Domain Name System

Because it would be incredibly difficult for Internet users to remember strings of 12 numbers, the Domain Name System (DNS) converts domain names to IP addresses.

The domain name is the English-like name that corresponds to the unique 32-bit numeric IP address for each computer connected to the Internet. DNS servers maintain a database containing IP addresses mapped to their corresponding domain names. To access a computer on the Internet, users need only specify its domain name.

DNS has a hierarchical structure (see Figure 7.6). At the top of the DNS hierarchy is the root domain. The child domain of the root is called a top-level domain, and the child domain of a top-level domain is called is a second- level domain. Top-level domains are two- and three-character names you are familiar with from surfing the Web, for example, .com, .edu, .gov, and the various country codes such as .ca for Canada or .it for Italy. Second-level domains have two parts, designating a top-level name and a second-level name—such as buy.com, nyu.edu, or amazon.ca. A host name at the bottom of the hierarchy designates a specific computer on either the Internet or a private network.

FIGURE 7.6 THE DOMAIN NAME SYSTEM



Domain Name System is a hierarchical system with a root domain, top-level domains, second-level domains, and host computers at the third level.

The most common domain extensions currently available and officially approved are shown in the following list. Countries also have domain names such as .uk, .au, and .fr (United Kingdom, Australia, and France, respectively), and there is a new class of "internationalized" top-level domains that use non- English characters (ICANN, 2010). In the future, this list will expand to include many more types of organizations and industries.

.com Commercialorganizations/businesses .edu Educationalinstitutions

.gov U.S. government agencies

.mil U.S.military

.net Networkcomputers

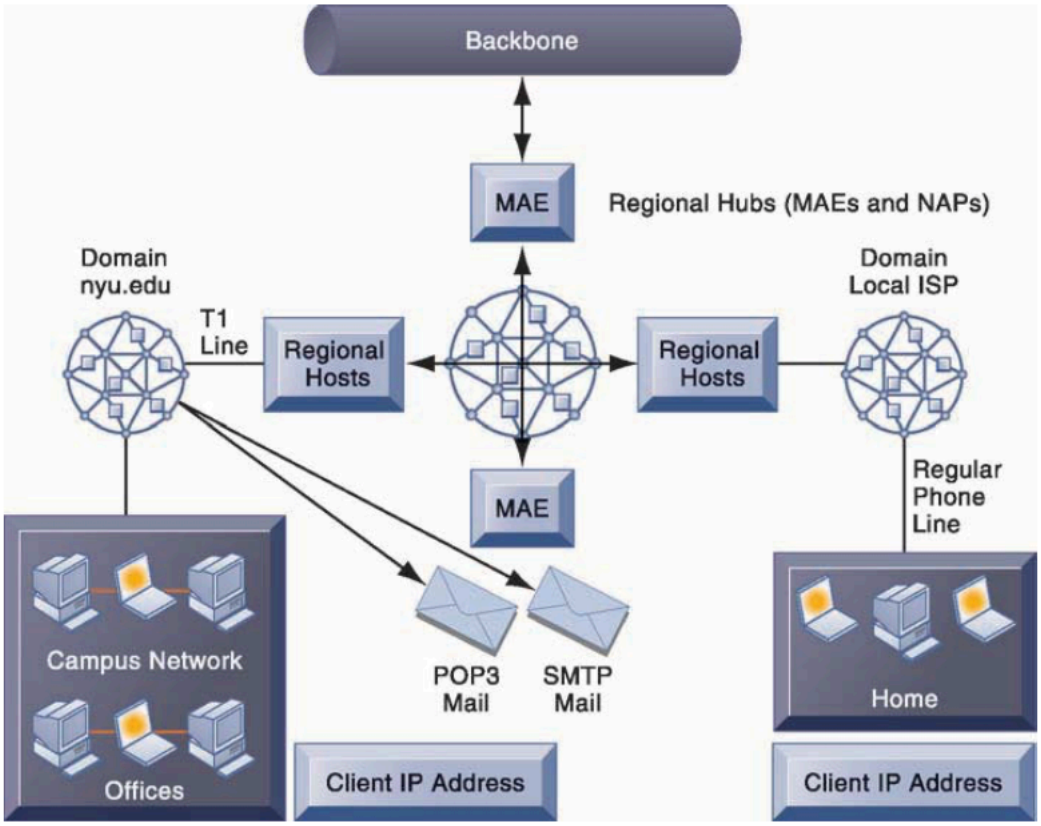
.org Nonprofit organizations and foundations .biz Businessfirms

.info Informationproviders

Internet Architecture and Governance

Internet data traffic is carried over transcontinental high-speed backbone networks that generally operate in the range of 45 Mbps to 2.5 Gbps (see Figure 7.7). These trunk lines are typically owned by long-distance telephone companies (called network service providers) or by national governments.

FIGURE 7.7 INTERNET NETWORK ARCHITECTURE



The Internet backbone connects to regional networks, which in turn provide access to Internet service providers, large firms, and government institutions. Network access points (NAPs) and metropolitan area exchanges (MAEs) are hubs where the backbone intersects regional and local networks and where backbone owners connect with one another.

Local connection lines are owned by regional telephone and cable television companies in the United States that connect retail users in homes and busi- nesses to

the Internet. The regional networks lease access to ISPs, private com- panies, and government institutions.

Each organization pays for its own networks and its own local Internet connection services, a part of which is paid to the long-distance trunk line owners. Individual Internet users pay ISPs for using their service, and they generally pay a flat subscription fee, no matter how much or how little they use the Internet. A debate is now raging on whether this arrangement should continue or whether heavy Internet users who download large video and music files should pay more for the bandwidth they consume. The Interactive Session on Organizations explores this topic, by examining the pros and cons of network neutrality.

No one “owns” the Internet, and it has no formal management. However, worldwide Internet policies are established by a number of professional orga- nizations and government bodies, including the Internet Architecture Board (IAB), which helps define the overall structure of the Internet; the Internet Corporation for Assigned Names and Numbers (ICANN), which assigns IP addresses; and the World Wide Web Consortium (W3C), which sets Hypertext Markup Language and other programming standards for the Web.

These organizations influence government agencies, network owners, ISPs, and software developers with the goal of keeping the Internet operat- ing as efficiently as possible. The Internet must also conform to the laws of the sovereign nation-states in which it operates, as well as the techni- cal infrastructures that exist within the nation-states. Although in the early years of the Internet and the Web there was very little legislative or executive interference, this situation is changing as the Internet plays a growing role in the distribution of information and knowledge, including content that some find objectionable.

The Future Internet: IPv6 and Internet2

The Internet was not originally designed to handle the transmission of massive quantities of data and billions of users. Because many corporations and governments have been given large blocks of millions of IP addresses to accommodate current and future workforces, and because of sheer Internet population growth, the world is about to run out of available IP addresses using the old addressing convention. The old addressing system is being replaced by a new version of the IP addressing schema called IPv6 (Internet Protocol version 6), which contains 128-bit addresses (2 to the power of 128), or more than a quadrillion possible unique addresses. IPv6 is not compatible with the existing Internet addressing system, so the transition to the new standard will take years.

Internet2 is an advanced networking consortium representing over 350 U.S. universities, private businesses, and government agencies work- ing with 66,000 institutions across the United States and international net- working partners from more than 50 countries. To connect these commu- nities, Internet2 developed a high-capacity 100 Gbps network that serves as a testbed for leading-edge technologies that may eventually migrate to the public Internet, including telemedicine, distance learning, and other advanced applications not possible with consumer-grade Internet services. The fourth generation of this network is being rolled out to provide 8.8 terabits of capacity.

3. Latihan dan Jawaban

1) What are the principal components of telecommunications networks and key networking technologies?

   A simple network consists of two or more connected computers. Basic network components include computers, network interfaces, a connection medium, network operating system software, and either a hub or a switch. The networking infrastructure for a large company includes the traditional telephone system, mobile cellular communication, wireless local area networks, videoconferencing systems, a cor- porate Web site, intranets, extranets, and an array of local and wide area networks, including the Internet.

   Contemporary networks have been shaped by the rise of client/server computing, the use of packet switching, and the adoption of Transmission Control Protocol/Internet Protocol (TCP/IP) as a universal communications standard for linking disparate networks and computers, including the Internet. Protocols provide a common set of rules that enable communication among diverse components in a telecommunications network.

2) What are the different types of networks?

   The principal physical transmission media are twisted copper telephone wire, coaxial copper cable, fiber-optic cable, and wireless transmission.

   Local area networks (LANs) connect PCs and other digital devices together within a 500-meter radius and are used today for many corporate computing tasks. Wide area networks (WANs) span broad geographical distances, ranging from several miles to continents, and are private networks that are independently managed. Metropolitan area networks (MANs) span a single urban area.

   Digital subscriber line (DSL) technologies, cable Internet connections, and T1 lines are often used for high-capacity Internet connections.

3) How do the Internet and Internet technology work, and how do they support communication and e-business?

   The Internet is a worldwide network of networks that uses the client/server model of computing and the TCP/IP network reference model. Every computer on the Internet is assigned a unique numeric IP address. The Domain Name System (DNS) converts IP addresses to more user-friendly domain names. Worldwide Internet policies are established by organizations and government bodies, such as the Internet Architecture Board (IAB) and the World Wide Web Consortium (W3C).

   Major Internet services include e-mail, newsgroups, chatting, instant messaging, Telnet, FTP, and the Web. Web pages are based on Hypertext Markup Language (HTML) and can display text, graphics, video, and audio. Web site directories, search engines, and RSS technology help users locate the

information they need on the Web. RSS, blogs, social networking, and wikis are features of Web 2.0.

Firms are also starting to realize economies by using VoIP technology for voice transmission and by using virtual private networks (VPNs) as low-cost alternatives to private WANs.

4) What are the principal technologies and standards for wireless networking, communication, and Internet access?

Cellular networks are evolving toward high-speed, high-bandwidth, digital packet-switched transmission. Broadband 3G networks are capable of transmitting data at speeds ranging from 144 Kbps to more than 2 Mbps. 4G networks capable of transmission speeds that could reach 1 Gbps are starting to be rolled out.

Major cellular standards include Code Division Multiple Access (CDMA), which is used primarily in the United States, and Global System for Mobile Communications (GSM), which is the standard in Europe and much of the rest of the world.

Standards for wireless computer networks include Bluetooth (802.15) for small personal area net- works (PANs), Wi-Fi (802.11) for local area networks (LANs), and WiMax (802.16) for metropolitan area networks (MANs).

5) Why are radio frequency identification (RFID) and wireless sensor networks valuable for business?

Radio frequency identification (RFID) systems provide a powerful technology for tracking the movement of goods by using tiny tags with embedded data about an item and its location. RFID readers read the radio signals transmitted by these tags and pass the data over a network to a computer for processing. Wireless sensor networks (WSNs) are networks of interconnected wireless sensing and transmitting devices that are embedded into the physical environment to provide measurements of many points over large spaces.

4. Daftar Pustaka

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