CHAPTERTHREE: NETWORK HARDWARE AND SOFTWARE COMPONENTS

3.1 Hardware and Software Components

A network component's functions are not necessarily handled by a specific device. Many devices combine several networking functions. For example: a router could have a built-in switch, a residential gateway that includes a broadband modem, etc. So, be sure to check the product specification before buying to avoid duplication. You must also check interfaces that are supported by a product. They must be compatible with the ports available in your computers or other devices.

A network component's functions may also be performed by a software application. For example, Windows XP provides built-in support for Network Bridging that handle a bridge's functions in a home network with mixed media. There are also built-in or add-on software applications that handle modem, router, or gateway functions. However, the software-only alternative is mostly suitable for small networks. Some of the hardware components are:

3.1.1 Network Adapter(Network Interface Card)
Network adapter works as an interface between a computer or device and a network. You may need Ethernet, Wi-Fi, HomePNA, or HomePlug network adapter depending on the type of network your computer is connecting to. Network adapter converts a computer message into electrical or optical signals for transmission across the network. A network adapter is identified in a network through a MAC address that is hard-coded onto the hardware by its manufacturer.

Network Adapter Cards

Built-in network adapter is integrated with a computer motherboard. Internal network adapter is installed inside a computer on an expansion slot. It is often called NIC (network interface card) usually inserted into a PCI slot in a PC or a mini PCI slot in a notebook.

3.1.2 Modem

Modem means modulator-demodulator. At the sending end, a modem modulates a carrier with the data (baseband signal) to prepare it for transmission. At the receiving end, the modulated carrier is demodulated (i.e. converted back to the original shape) and the data is extracted. A modem also performs other functions, such as digital-to-analog/analog-to-digital conversion, compression/decompression, error correction, and encryption/decryption.

Modem in Internet access

3.1.3 Repeater

Repeater receives signal from a transmitter, amplifies it, and retransmits it to a receiver. A repeater is put in a network to extend the network to a longer distance or a greater area. There can be more than one repeater between a transmitter and a receiver, however the number of repeaters is not unlimited, because additional repeaters may introduce more interference or noise.

Repeater

3.1.4 Hub

Hub is the central connection point in a network. Hub is used in a network that uses star topology. A sending computer transmits its signal to a hub, the hub then retransmits the signal to all other computers. A passive hub functions as a relay station that receives and retransmits signal. An active hub functions as a repeater that regenerates signal before retransmitting.

Hub

Using a hub, the network bandwidth (capacity) is shared by all available computers, therefore each computer only uses a portion of bandwidth. That's why hub is mostly used in small networks where there are only a few connected devices or computers. However, hub is not required if there are only two computers in a network. In that case, a direct connection using cable or wireless link can be used to connect both computers.

3.1.5 Switch

Like hub, switch works as the central connection point in a network. However when a switch receives a packet from a sending computer, it examines the destination address (i.e. MAC address of the destination computer) from the packet header and retransmits the packet to the destination computer only. That's possible because a switch maintains a table that maps all its ports with all connected devices' MAC addresses.

Switch

3.1.6 Wireless Access Point

Access point in a wireless LAN (Wi-Fi) functions like a hub or a switch in wired network. It connects computers or devices together to create a wireless network. Most wireless access points also function as a network bridge that connects the Wi-Fi network to a wired network such as Ethernet. An access point has an interface to a broadband modem or a router that is used when the Wi-Fi network connects to the Internet. Some access points come as a multi-function device that incorporates the functions of switch, bridge, router, or broadband modem. An access point is also known as base station.

Wireless (Wi-Fi) Access Point.

Data transfer rate decreases as the distance from a computer or a device to the access point increases. A Wi-Fi access point provides wireless network coverage

3

within an area of up to about 100 meters outdoor. In typical indoor application, an access point can cover an area of up to about 50 meters. The exact coverage depends on the access point transceiver and antenna design. Physical obstacles and interference from other wireless networks can reduce the wireless signal range. An area that is within a Wi-Fi network coverage is popularly known as hotspot. Many public places such as airports, hotels, and cafs provide public Wi-Fi hotspots that have broadband connection to the Internet. Such hotspots can be accessed by the public for free or with a fee. To connect to a Wi-Fi hotspot, your wireless network adapter must be compatible with the hotspot's access point.

3.1.7 Router
Router functions to forward packets across different networks. Router maintains a routing table. The routing table contains IP addresses of other networks routers. In a static router the routing table is configured manually, while a dynamic router can communicate with other routers and configure the routing table according to information it receives from other routers.

Router in OSI Model protocol stack

3.1.8 Residential Gateway
Residential gateway is basically a router that is configured to enable the sharing of a single Internet connection (subscription) by multiple users in a home network. However when you buy a residential gateway, it most likely incorporates other functions such as hub, switch, wireless access point, or bridge. Some residential gateways also already include broadband (cable/DSL) modem.

Residential Gateway

By using a residential gateway to connect your home network to the Internet, you don't need to always turn on a computer as an ICS host.
With a residential gateway, you don't have to manually set an IP address for each computer in your network because a residential gateway usually has DHCP server. Using DHCP, IP address for each computer is assigned dynamically by the residential gateway.

A residential gateway also keeps your computers anonymous on the Internet because it translates the IP address of each computer to an IP address assigned by the ISP. This function is called Network Address Translation (NAT).

Besides, a residential gateway protects your home network from intruders that try to gain access through certain applications in your computers because it has built-in firewall.

Residential gateway is also known as broadband router or Internet gateway device (IGD).

3.1.9 Gateway

Gateway functions to connect two completely different networks. It performs protocol translation. Although gateway is considered a Layer 7 device in many publications, it actually works across the seven layers of the OSI Model. In Internet Telephony, a gateway connects the VoIP network to the PSTN.

Gateway

The following table summarizes network components along with their functions and the corresponding layers in the OSI Model:

Network Component	Functions	OSI Model
Network Adapter	converts a computer message into electrical/optical signals for transmission across a network.	Physical (Layer 1)
M o d e m	puts a message (baseband signal) on a carrier for efficient transmission; takes the baseband signal from the carrier.	Physical (Layer 1)
Repeater (Regenerator)	receives signal, amplifies it, then retransmits it.	Physical (Layer 1)

Bridge	connects networks with different Layer 2 protocols; divides a network into several segments to filter traffic.	Data Link (Layer 2)
Hub	connects computers in a network; receives a packet from a sending computer and transmits it to all other computers.	Physical (Layer 1)
Switch	connects computers in a network; receives a packet from a sending computer and transmits it only to its destination.	Data Link (Layer 2)
Access Point	Connects computers in a wireless network; connects the wireless network to wired networks; connects it to the Internet.	Data Link (Layer 2)
Router	Forwards a packet to its destination by examining the packet destination network address.	Network (Layer 3)
Residential Gateway	Connects a home network to the Internet; hides all computers in the home network from the Internet.	Network (Layer 3)
Gateway	Connects two totally different networks; translates one signaling/protocol into another.	All layers

3.2 Network Operating Systems

Any modern Operating System contains built-in software designed to simplify networking of a computer. Typical O/S software includes an implementation of TCP/IP protocol stack and related utility programs like ping and traceroute. This

includes the necessary device drivers and other software to automatically enable a device's Ethernet interface. Mobile devices also normally provide the programs needed to enable Wi-Fi, Bluetooth, or other wireless connectivity.

The early versions of Microsoft Windows did not provide any computer networking support. Microsoft added basic networking capability into its operating system starting with Windows 95 and Windows for Workgroups. Microsoft also introduced its Internet Connection Sharing (ICS) feature in Windows 98 Second Edition (Win98 SE). Contrast that with Unix, which was designed from the beginning with networking capability. Nearly any consumer O/S today qualifies as a network operating system due to the popularity of the Internet.

Network operating systems (NOSs) distribute their functions over a number of networked computers they add functions that allow access to shared resources by a number of users concurrently.

Client systems contain specialized software that allows them to request shared resources that are controlled by server systems responding to a client request. The NOS enhances the reach of the client PC by making remote services available as extensions of the local native operating system.

NOSs also support multiple user accounts at the same time and enables concurrent access to shared resources by multiple clients. A NOS server is a multitasking system.
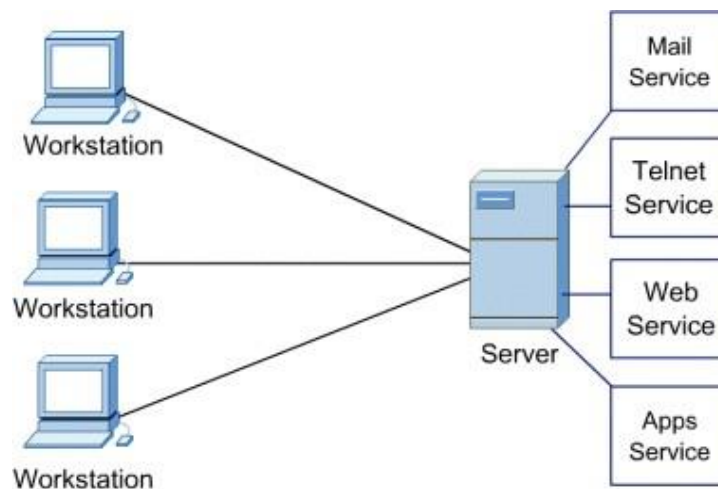
Several clients in a network

3.2.1 Choosing a NOS
The main features to consider when selecting a NOS include:

- Performance

- Management and monitoring tools

- Security

- Scalability

- Robustness/fault tolerance

3.2.2 Types

There are two popular competing NOS families. Windows based and Unix based. The former is proprietary whereas the latter is open source.

Windows NOS

Windows server-based networks that run Windows NT Server or Windows 2000 Server are based on the concept of the domain. A domain is a group of computers and users that serves a boundary of administrative authority.

Windows NT domains and Windows 2000 domains, although similar in function, interact with one another differently. In Windows NT 4.0, the Domain Structure of Windows NT was entirely different from the Domain Structure in Windows 2000.

Instead of Active Directory, Windows NT provides an administrative tool called the User Manager for Domains. It is accessed from the domain controller and is used to create, manage, and remove domain user accounts. Each NT domain requires one Primary Domain Controller (PDC). A domain can also have one or more Backup Domain Controllers (BDCs).

Windows 2000 and 2003 Family of Operating Systems includes:

- Windows 2000 Professional

- Windows 2000 Server

- Windows 2000 Advanced Server

Unix/Linux

Linux is an operating system similar to UNIX. It runs on many different computers and was first released in 1991. Linux is portable, which means versions can be found running on name brand or clone PCs. It offers many features adopted from other versions of UNIX.

The UNIX NOS was developed in 1969, and it has evolved into many varieties.

The source code is opened, that is, available at no cost to anyone who wants to modify it. It is written in C programming language so businesses, academic institutions, and even individuals can develop their own versions. There are hundreds of different versions of UNIX. Linux is sometimes referred to as "UNIX Lite", and it is designed to run on Intel-compatible PCs. Linux brings the advantages of UNIX to home and small business computers.

The following are a few of the most popular types:

- Red Hat Linux

- Linux Mandrake

- Caldera eDesktop and eServer

- Debian GNU/Linux

- Corel Linux

- Turbo Linux

- Ubuntu

Other Software and Programs

A popular use of a Linux system is a web server. Web server software uses Hypertext Transfer Protocol (HTTP) to deliver files to users that request them,using a web browser from their workstation.

A Mail Server is a system that is configured with the proper programs and servicesthat enable handling the exchange of e-mail sent from one client to another.

Review Questions

i) Describe the following network devices and what they do:
   - Switch
   - Gateway
   - Repeater
ii) Network Operating systems are said to be multi-user and multi-tasking. Differentiate these two terms.
iii) How does a network operating system differ from a standalone operating system?
iv) What factors will you consider before choosing a network operating system?
v) Describe the role of software in supporting a computer network.