Network & Internet

Introduction

- The need to share information and resources among different computers has led to linked computer systems, called network
- Network: computers are connected together so that the data can be transferred from machine to machine.
- Share resources(printer), exchange messages, save time, save money.

Network Fundamentals

- Network Classifications
  - Scope
    - Local area network (LAN)
    - Metropolitan area (MAN)
    - Wide area network (WAN)
  - Ownership
    - Closed
    - open
  - Topology (configuration)
    - Bus (Ethernet)
    - Star (Wireless networks with central Access Point)

Network Classifications

- LAN: Normally consists of a collection of computers in a single building.
  - Example: computers in university.
- MAN: network of intermediate size
- WAN: links computers over a greater distance-perhaps in neighboring cities.

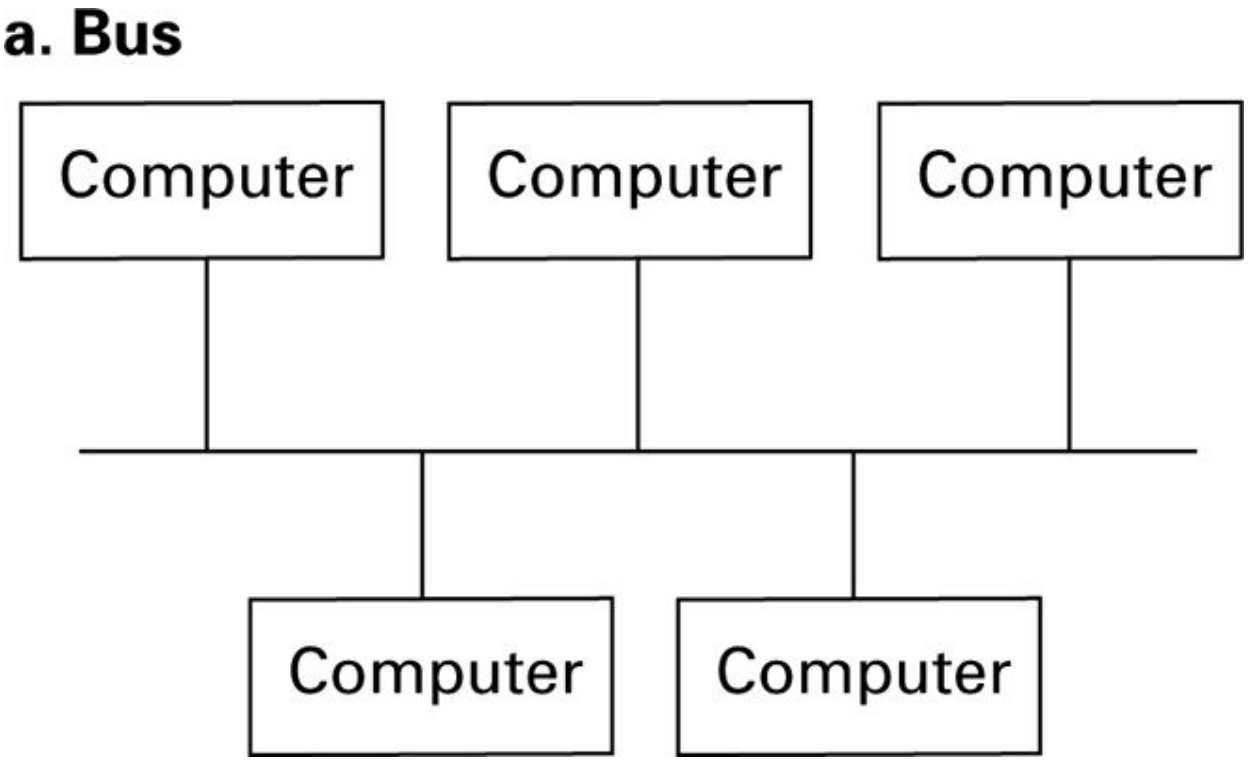
Network Classifications

- Open network: open network design for a public domain are freely circulated and often grow in popularity.
  - the internet is an open system.
- Communication thought the internet is governed by an open collection of standards known as TCP/IP protocol.
- Closed network: innovations owned and controlled by a particular entity.

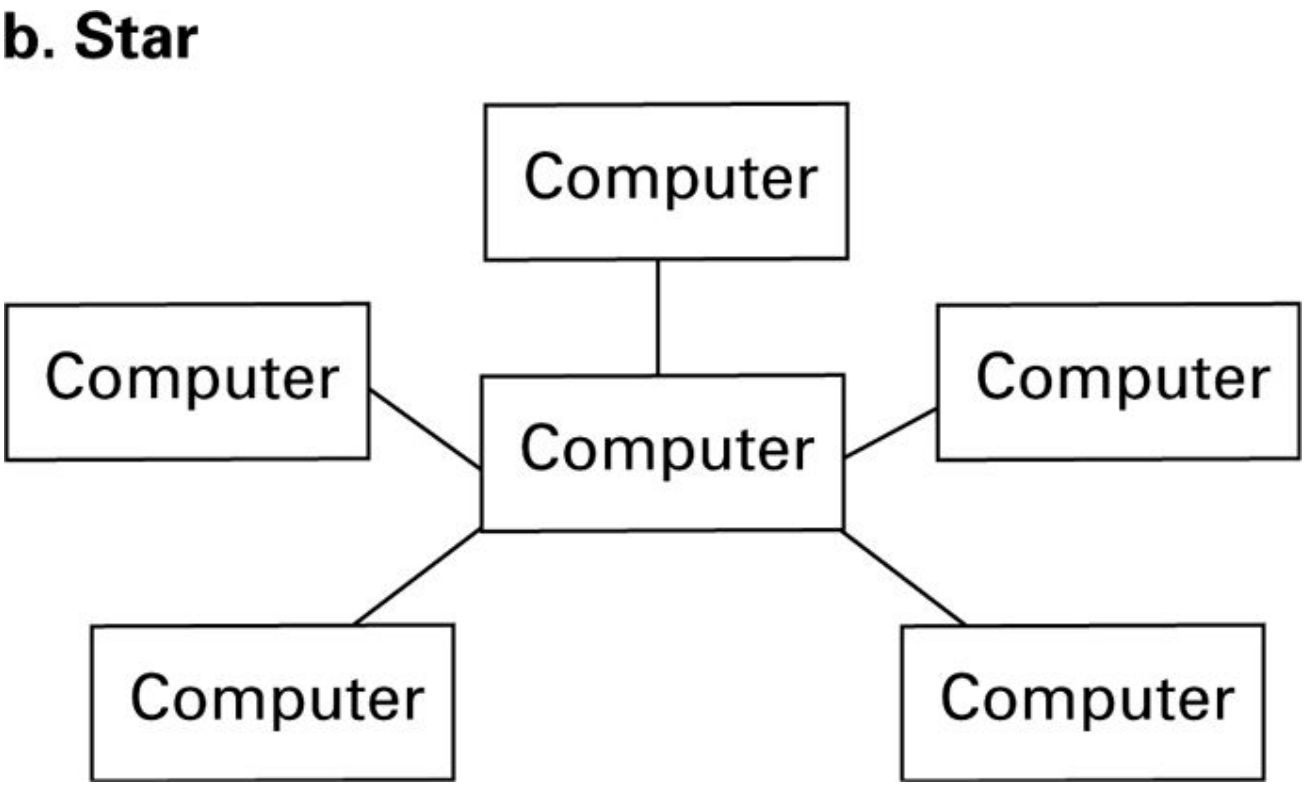
Network Topologies

- Network topology refer to the pattern in which the machines are connected.
- Bus: all the machines are connected to a common communication line called a bus.
- Star: one machine serve as a central focal point to which all the others are connected.

Network Topologies



Network Topologies



Network Classifications

- Bus topology was popularized in the 1990s under set of standards known as Ethernet.
- The star was popularized in the 1970s.
- Today, the star configuration is popular in wireless networks where communication is conducted by means of radio broadcast and the central machine called the access point (AP).
- The different between the bus and star not always by the physical arrangement of equipment, it also about the machines them selves as communicating directly (bus) or indirectly through an intermediary central machine.

Network Classifications

- Sometimes a bus network is created by running links from each computer to a central location where they are connected to a device called a hub.
- Hub is little more than a very short bus, all it does is really any signal it receives back out to all the machines connected to it.

Protocols

- For network to function reliably, it is important to establish rules by which activities are conducted, such rules called protocols
- Let us consider the problem of coordinating the transmission of messages among computers in a network.
- Without rules, all the computers might insist on transmitting messages at the same time or fails to assist other machines when that assistance is required.

Protocols

- In a bus network, transmitting messages is controlled by the protocol known as Carrier Sense, Multiple Access with Collision Detection (CSMA/CD).
- This protocol dictates “decide” that each message be broadcast to all the machines on the bus.
- To transmit a message, a machine waits until the bus is silent , and at this time it begins transmitting while continuing to monitor the bus.

Protocols

- If another machine also begins transmitting, both machines detect the clash and pause for a brief, before trying to transmit again.
- CSMA/CD is not compatible with wireless star networks which communicate through a central AP. This is because a machine may be unable to detect that its transmission are colliding with those of another. (hidden terminal problem) “none of the end system can hear each other”

Protocols

- Wireless networks adopts policy that trying to avoid collisions rather than trying to detect it (CSMA/CA) , Carrier Sense, Multiple Access with Collision avoidance, within a protocol called as WiFi

Protocols

- This protocol (CSMA/CA) to a void collision, when a collision occur, messages must be retransmitted.
- This protocol give advantages to machine that have already been waiting an opportunity to transmit.
- The basic different between the CA and the CD, is that when a machine need to transmit a message and find communication channel silent, it doesn't start transmitting immediately, it waits for a short period of time and then starts transmitting only if the channel has remained silent throughout that period.

Protocols

- Each individual station must be able to hear all the others, to solve this problem, some WiFi networks require that each machine send a short message “request” message to the AP and wait until the AP acknowledge that request before transmitting an entire message.

Combining Networks

- Sometimes it is necessary to connect existing networks to make an extended communication system.
- This is done by connecting the networks to larger version networks.
- This is done by using different devices such as:
  - Repeaters, bridges, and switches

Combining Networks

- Repeater: device that simply passes signals back and forth between the two originals buses (the simplest device).
- Bridge: more complex than a repeater, it is connects two buses, but it doesn't necessarily pass all messages a cross the connection.
- It looks at the destination address and forwards a message a cross the connection only when that message destined for a computer on the other side.

Combining Networks

- A switch : is a bridge with multiple connections, allowing it to connect several buses rather than just two.
- A switch considers the destination of all messages and forwards only those messages destined for other spokes.
- Sometimes, the network that is connected have incompatible characteristics.
  - Example: the characteristics for WiFi or not readily compatible with an Ethernet network.

Combining Networks

- In this case, the networks must be connected in manner that build a network of networks known as internet
- Note: internet is different than Internet
  - Example of internet is Internet
- In the network of networks, each original network maintain their individually functions, and continue to work as autonomous networks.

Combining Networks

- The connection between these networks is handled by router, which is a special purpose computer used for forwarding messages.
- Note that the task of router is different than others in that routers provides links between networks while allowing each network to maintains its unique internal characteristics (Figure 4.5)

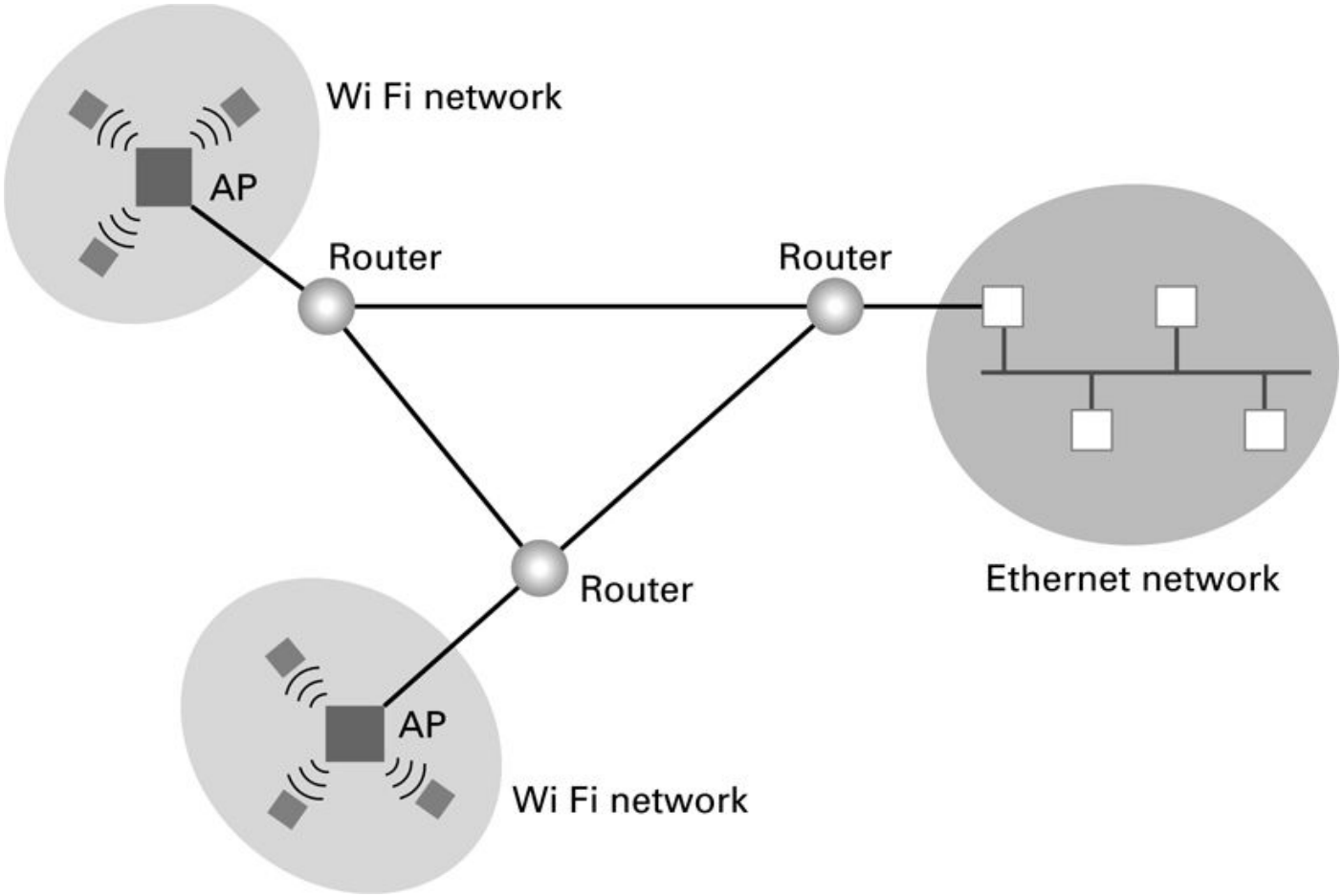


Figure 4.5 Routers connecting two WiFi networks and an Ethernet network to form an internet

Combining Networks

- As shown in Figure 4.5, if machines in WiFi network want to send message to machine in Ethernet network, it first sends the message to the AP in its network. Then the AP sends the message to its associated router, then the router forward it to router of the Ethernet.
- Note that each machine have address
- (its original address within its own network and its internet address)

Combining Networks

- When the machine want to send a message to a machine, it attaches the internet address of the destination machine and direct the message to its local router.
- For this forwarding purpose, each router maintains a forwarding table that contains the router's knowledge about the direction in which message should be sent depending on their destination address.

Combining Networks

- The point at which one network is linked to an internet is often called “gate way”.

Methods of Process Communication

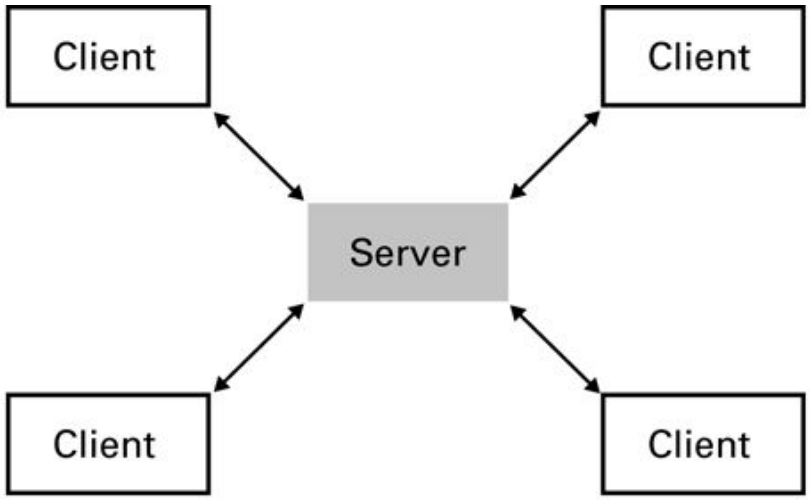
- The activities (process) executing on the different computers within a network must communicate to coordinate their actions.
  - Such communication called (inter-process communication).
- A popular convention “method” used for inter-process communication is the client/server model.

Methods of Process Communication

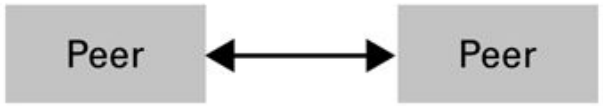
- Client: the process “machine” which make request of other processes
- Server: which satisfies “response” to the requests made by clients.
- Example: if we attach a printer to network, all the machines on the network use to, so in this case it plays the role of server (print server).
- Example: file server, this is used to reduce the cost of magnetic disk, and removing the duplicates copies of files.
  - One machine on the network was equipped with a high –capacity mass storage that contains all of the organization’s record, and others machines request access to these records.

Methods of Process Communication

- Another model of process communication is the peer-to-peer (p2p),Figure 4.6 (machine can be client and server at the same time).
- Example of usage:
  - Instant messaging: when people carry on a written conversation over the internet.
  - Distribution a file such as music and motion pictures via the internet..
  - In this case one peer may receive a file from another and then provides file to other peers.
  - The collection of peers participating in such a distribution is sometimes called swarm.



a. Server must be prepared to serve multiple clients at any time.



b. Peers communicate as equals on a one-to-one basis.

Figure 4.6 The client/server model compared to the peer-to-peer model

Methods of Process Communication

- We can see that p2p model replaced the client/server model for file sharing for the reasons of distribution the services task over many peers rather than concentrating it at one server.
- This lack of a centralized task (in p2p) of operation leads to a more efficient systems.

Methods of Process Communication

- Unfortunately, The lack of a central server makes legal efforts to enforce copy-right laws more difficult.
- Note: a process might use the peer-to-peer model to communicate with another process and later use the client/server model to communicate with another process over the same network
- Thus it would be more accurate to speak of communicating by means of p2p model rather than communication over p2p network.

Distributed Systems

- Software units that execute as processes on different computers.
- Many modern software systems such as global information system, company-wide accounting system are designed as DS.

The Internet

- As we mentioned before the Internet is an example of internet.
- The Internet was originated from research projects going back to the early of 1960s.
- Today the Internet links a worldwide combination of LANs, MANs, and WANs involving millions of computers.

Internet Architecture

- The Internet (networks) are constructed and maintained by organization called Internet Service Provider (ISP).
- The system of networks operated by the ISP can be classified in a hierarchy according to the role they play in the overall Internet structure (4.7)
- At the top of this hierarchy are relatively few tier-1 ISP that consist of very high- speed, high-capacity, international WANs.

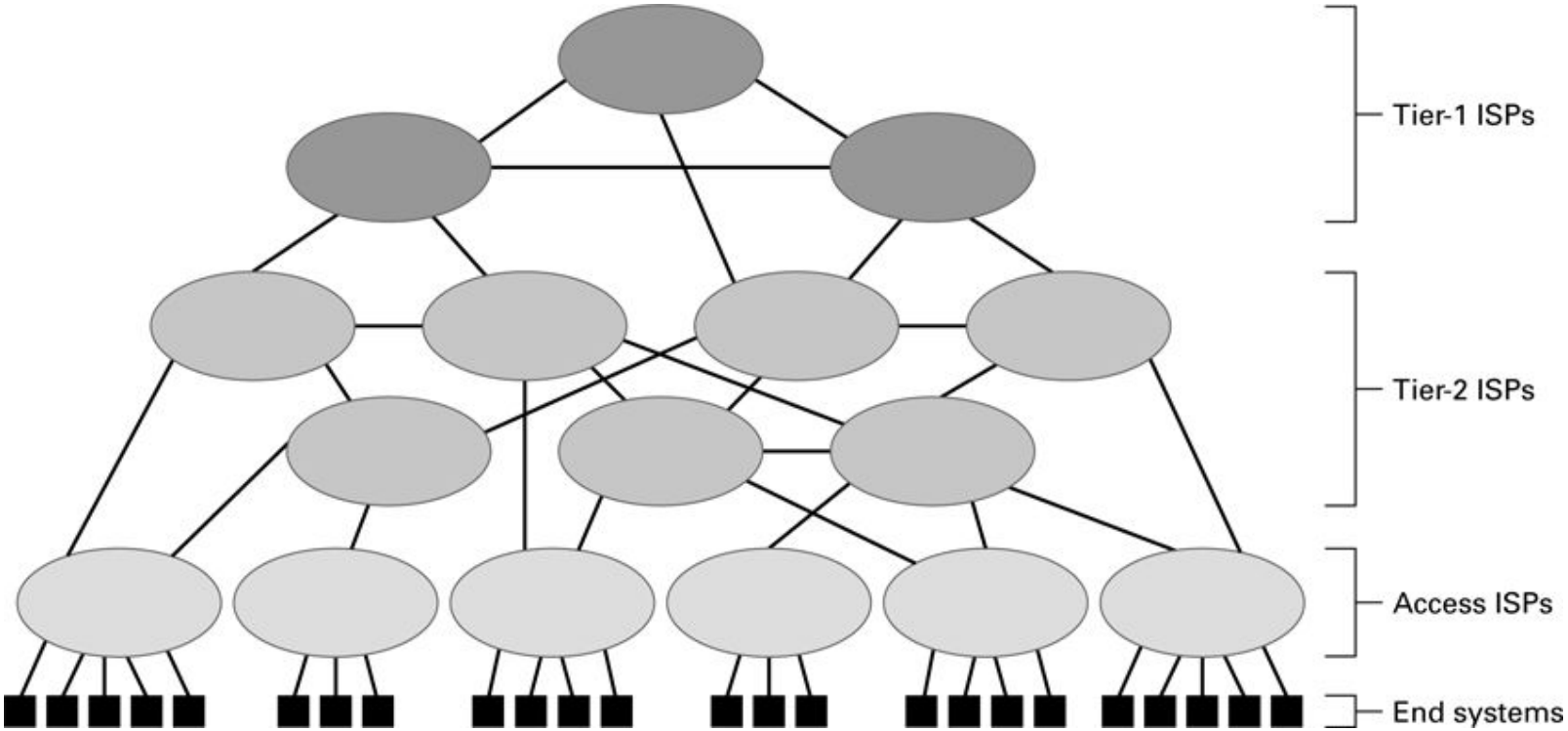


Figure 4.7 Internet Composition

Internet Architecture

- These network are though of as the backbone of the internet, they are typically operated by large companies that are in the communication business.
- The tier-2 ISPs tend to be more regional in scope and less potent to their capabilities. These networks are tend to be operated by companies in the communications business.

Internet Architecture

- Tier-1 and tier-2 are essentially networks of routers that collectively provide the Internet's communications infrastructure. They can be thought as the core of the internet.
- Access to this core is usually provided by an intermediary called an access ISP.
- An access ISP is essentially an independent internet, operated by a single authority that is in business of supplying Internet access to individual users.

Internet Architecture

- End system or host: the devices that individual users connect to the access ISPs.
- The end systems are not just computers, they range over different devices such as video camera, telephones and so on.
- Finally, the Internet is an essentially a communication system, and thus any devices that would benefit from communicating with other devices is end system.

Internet Architecture

- The fastest growing end systems are wireless connections based WiFi technology.
- The strategy is to connect the AP to an access ISP and thus provide Internet access through that ISP to end systems within the AP's broadcast range.

Internet Architecture

- Other popular technique for connecting to access ISP's use telephone lines or cable/satellite systems.
- These technologies used to provide direct connection to an end systems (router or AP connected to an access ISP by means of existing cable or telephone line).
- Existing cable and satellite links are more compatible with high speed transfer than traditional telephone lines.

Internet Addressing

- As mentioned before that each machine in the network have an address.
- In the Internet, addresses are known as IP address “Internet protocol”.
- Originally, each IP address was a pattern of 32 bits.
- Currently it is 128-bits (IPv6).

Internet Addressing

- Blocks of numbered of IP address are awarded to ISPs by the internet corporation for assigned Names and Numbers (ICANN), which a corporation established to coordinate the internet's operation.
- ICANN: Allocates IP addresses to ISPs who then assign those addresses within their regions.
- IP address are traditionally written in dotted decimal notation in which the bytes of the address are separated by periods and each byte is expressed as an integer represented in traditional base ten notation

Internet Addressing

- For example, using dotted decimal notation, the pattern 5.2 would represent the two-byte bit pattern 0000010100000010.
- The bit pattern 17.12.25 would be represent the three-byte bit pattern.
- In summary, a 32 bit IP address might appear as 192.207.177.133.

Internet Addressing

- Address in bit-pattern form are rarely conducive to human consumption, so that the internet has an alternative addressing system in which machines are identified by mnemonic names.
- This addressing system is based on the concept of a domain (region of the internet).
- The domain is assigned a mnemonic domain name, which is unique among all the domain names throughout the Internet.

Internet Addressing

- As an example of domain is aw.com
- Note that the suffix following the period used to reflect the domain's classification, which in this case is "commercial"
- These suffixes are called top-level domain (TLD).
- edu for educational organization.
- org for non-profit organization.
- In addition to TLDs, there are also two-letter TLDs for specific countries (called country-code TLDs) such as au for Australia and ca for Canada.

Internet Addressing

- Each domain must be registered with ICANN- the process handled by companies called registrars.
- Then the organization that registered the domain is free to extend it (sub-domain.
- Example: enterprise.aw.com

- The sub-domain often represent different networks within the domain.

Internet Addressing

- For example: if nowhere university was assigned the domain nowhere.edu, then an individual computer might have a name such as r2.comp.nowhere.edu, meaning that the computer r2 is in the sub-domain comp within the domain nowhere.com

Internet Addressing

- As mentioned before, messages always transferred over the internet by means of IP address.
- If the human send a message to a machine using a mnemonic address, the software being used must be able to convert it into an IP address before transmitting the message.
- This conversion is performed with the aid of servers called (name server).

Internet Addressing

- The server used as an Internet-wide directory system known as the domain name system (DNS).
- The process of using the DNS to perform a translation is called a DNS lookup
- So the domain name must be represented within DNS

Internet Applications

- Electronic Mail: one of the most popular uses of Internet is email, a system by which messages are transferred among Internet users.
- For the purpose of providing email service, there must be a particular machine within a domain to play the role of a mail server.
- Mail server are established within domain operated by access ISPs for providing mail services to users within its realm.

Electronic Mail

- When a user sends email, it is first transferred to the user's mail server, then it is forwarded to the destination mail server.
- The protocol used to transfer mails is SMTP (simple mail transfer protocol).
- Because SMTP was designed for transferring text messages encoded with ASCII, additional protocols such as MIME (multi purpose Internet Mail Extension) have been developed to convert non-ASCII data to SMTP compatible format

Electronic Mail

- Two popular protocols used for accessing email that has arrived and accumulated at a user's mail server:
  - POP3 (post office protocol version3)
  - IMAP (Internet Mail Access Protocol)
- POP3: user transfer (download) message to his/her computer where they can be read.
- IMAP: allows a user to store and manipulate message.

Electronic Mail

- With the role of mail server, it is easy to understand the structure of email address.
- NNN@iugaza.edu.ps

Username,
Account name

domain

File Transfer Protocol (FTP)

- One means of transferring files is to attach them to email messages.
- FTP protocol for transferring files across the Internet.
- To transfer a file using FTP, a user at one computer uses a software package that implements FTP to establish contact with another computer.

File Transfer Protocol (FTP)

- FTP has become a popular way of providing limited access to data via the Internet.
- Example: you want to allow certain people to retrieve a file while prevent access by anyone else, you need to place the file in a machine with FTP server facilities and guard access via a password.
- A machine in the Internet used in this manner is sometimes called an FTP site

Telnet and Secure Shell

- One of the early uses of the Internet was to allow computer users to access computers from great distance.
- telnet is a protocol system that was established for this purpose.
- Using telnet, a user can contact the telnet server at a distance computer and then follow login procedure to gain access to the distance machine.
- telnet has some shortcoming, communication via telnet is not encrypted, because the use's password is part of the communication during the login process

Telnet and Secure Shell

- Secure shell (SSH) is an alternative to telnet that offers a solution to this problem by provides encryption of data being transferred.

VOIP

- An example of a more recent Internet applications
- Consider it as in which, the Internet infrastructure is used to provide voice communication similar to that of traditional telephone systems
- VOIP consists of two process on different machines transferring audio data via the p2p model.
- Example of VOIP is Skype, which consists of application software that allows pc users to place call, and communicate with other skype users

VOIP

- One drawback to Skype is that it is proprietary systems, and thus much of its operational structure is not publicly unknown.
- For instance, to receive a call, Skype user must leave his/her pc connected to the Internet and available to Skype system, which means that some of the PCs resources may be used to support other Skype communications without the pc owner's awareness.

Internet Radio

- Transmission of radio station programming- a process called webcasting as apposed to broadcasting, because the signal transferred via the Internet rather than “over the air”.
- Internet Radio is example of streaming audio, which refers to the transfer of sound data on a real-time bases.

Some Concepts, Internet Radio

- Unicast: refer to one sender sending message to one receiver
- N-unicast: single sender (server) sending message to multiple unicast.
- The N-unicast has the drawback of placing a substantial burden on the station's server. Indeed, N-unicast forces the server to send message to each of it's clients on a real-time basis.
- Some alternatives attempts to alleviate this problem.
- One applies the p2p model in manner of file sharing system, that is, one peer has received data, it begins to distribute that data to those peers that are still waiting. Meaning that much of the distribution problem is transferred from the data's source to the peers.

Some Concepts, Internet Radio

- Another alternative, multicast, transfers the distribution problem to the Internet routers. Server transmits a message to multiple clients by means of a single address (the group address) and relies on the routers in the Internet to produce and forward copies of the message to the appropriate destination.
- When a client want to receive the message from a particular station, want to subscribe to a particular group, and notifies its nearest router of its desire.

World Wide Web

- The information is disseminated over the Internet based on the concept of hypertext.
- Hypertext: referred to text document that contained links, called hyperlink, to other documents.
- Hypertext ha been expanded to encompass images, audio, and video, which called hypermedia.

World Wide Web

- By using a hypertext, documents can explore related documents or follow a train from document to document.
- These documents within such a web can reside on different machines, forming a network wide web.
- The web that has evolved on the Internet spans the entire globe and is known as the world wide web (WWW, W3, or the web)
- Hypertext document on the WWW is called a web-page
- A collection of closely related web-pages is called a web-site
- First software for implementing the WWW was in December 1990.

Web Implementation

- Software package that allows to access hypertext on the Internet
- Two categories:
- Package that play the role of client
- Package that play the role of the server
- Package on the client: resides the user's computer, obtaining materials requested by the user and presenting these materials.
- The client is often referred to as a browser "web browser"

Web Implementation

- The server package (web-server): resides on a computer containing hypertext documents to be accessed.
- Hypertext documents are normally transferred between browsers and web-servers using hypertext transfer protocol (HTTP).
- To locate and retrieve documents on the WWW, each document is given a unique address called a uniform Resource Locator (URL)
- As shown in Figure 4.8, a URL is consists of four segments

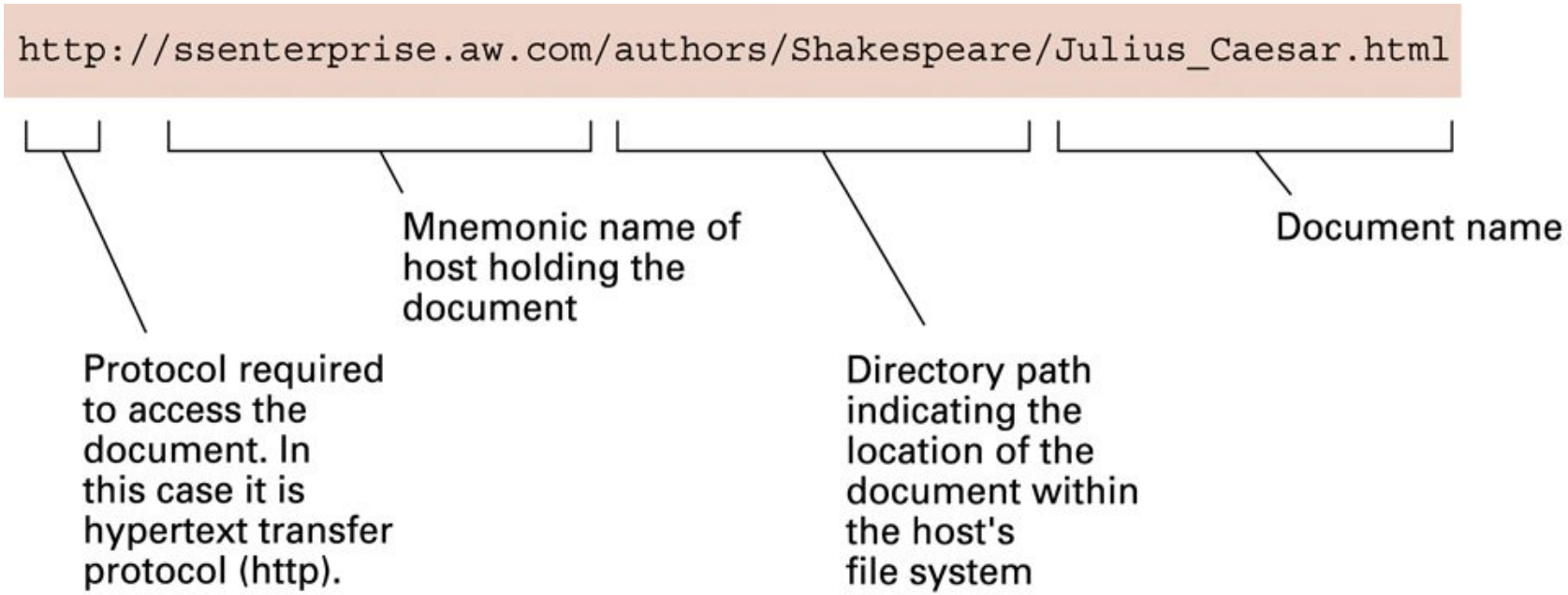


Figure 4.8 A Typical URL

Web Implementation

- Some times a URL might not explicitly contain all the segments.
- Some times a URL consists of only a protocol and mnemonic address.
- In this case, the web server at the computer will return a predetermined document, called home page.

HTML

- A traditional hypertext documents is similar to a text file.
- The different is that a hypertext document also contains special symbols called tags.
- Tags: describe how the document should appear in screen, what multimedia resources should be in the document, a link to another documents.
- This system of tags is known as hypertext markup language (HTML).

HTML

- The html encoded version “source version” is shown in figure 4.9a
- Note that the tag are delineated by the symbol < >
- The html source document consists of two sections:
- <head> </head>
- <body> </body>
- The head contains preliminary information about the document
- The body contains the meat (materials to be presented) of the documents.

a. The page encoded using HTML.

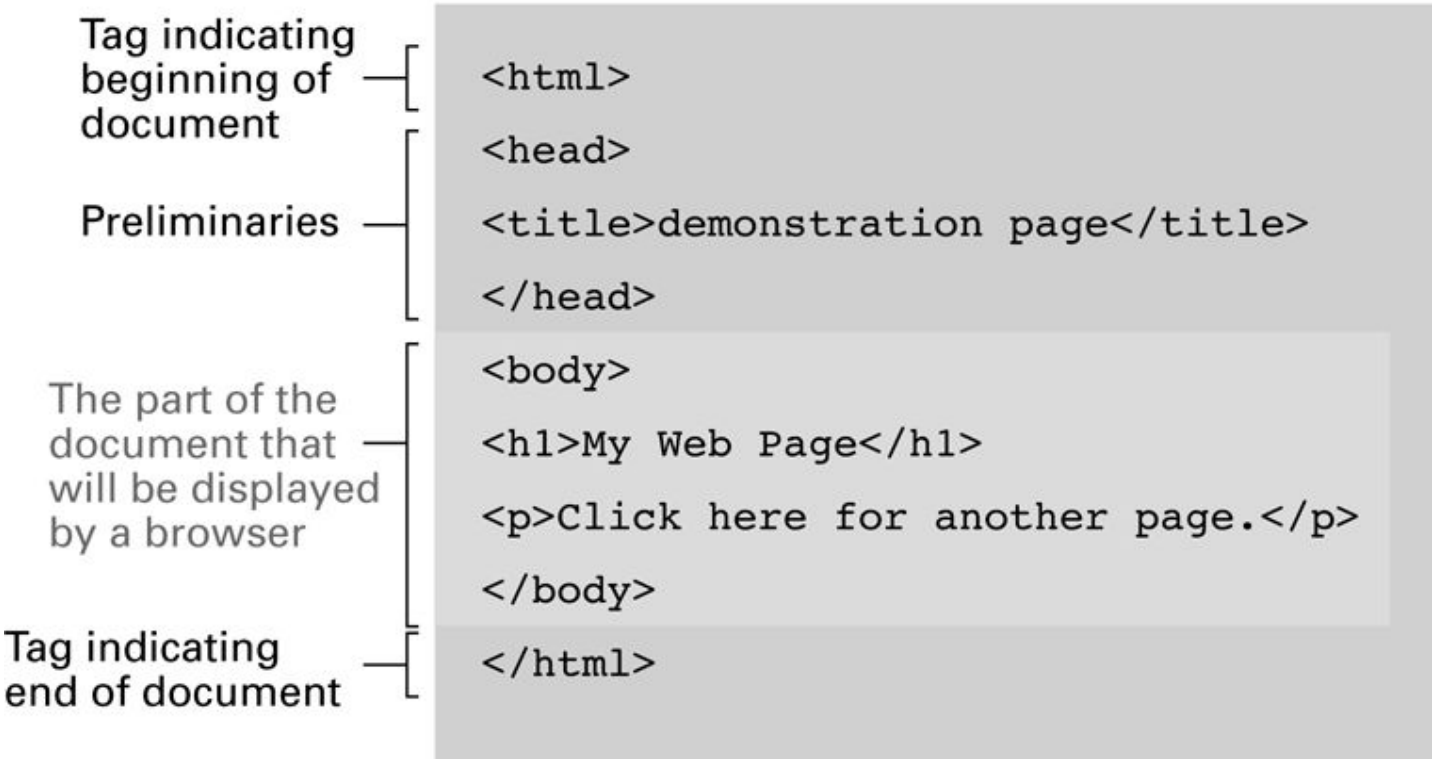
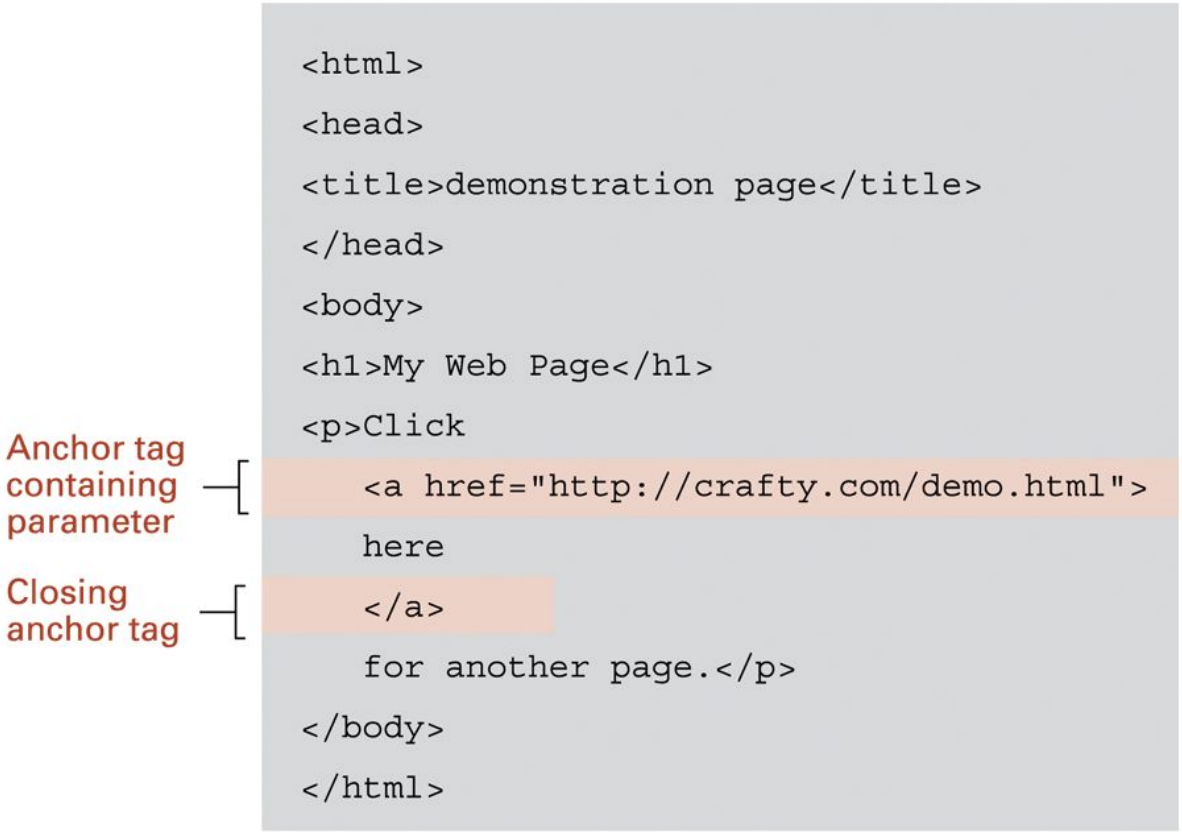


Figure 4.9 A simple Web page

b. The page as it would appear on a computer screen.

Figure 4.9 A simple Web page

a. The page encoded using HTML.




```
<html>
<head>
<title>demonstration page</title>
</head>
<body>
<h1>My Web Page</h1>
<p>Click
   <a href="http://crafty.com/demo.html">
   here
   </a>
   for another page.</p>
</body>
</html>
```

Figure 4.10 An enhanced simple Web page

HTML

-   is an anchor tag, Links to other documents and content
-   to start a new paragraph
- <h1> </h1> level-one heading

- How the image could be included in the web page?
  - <img src = . . . >
  - If you write the tag immediately after the body, then the image will be at the top of the page, else if you write the tag at before </body> then the image will be at the bottom of the page.

Client-side and server-side activities

- Consider the steps that would be required to retrieve the web page that shown in Figure 4.10.
- First, role of the client, the browser would use the information in a URL to contact the web server who controlling access to the page, and ask a copy of the page.
- The server would response by sending the text document.
- The browser would then interpret the HTML tags to determine how the page should be displayed.

Client-side and server-side activities

- What if we want web page that allow the customers to fill out an order form and submit the order?
- This needs additional activities by either the browser which called client side (activities performed by a client) and the server-side (activities performed by a server)
- Example: travel agent want customer to be able to identify the desired destination and dates of travel
- The customer specify the destination (client side), then this information would be transferred back to the agent's server where it would be used to construct a customized web-page (Server-side).
- Example 2: the search engine.

Client-side and server-side activities

- There are some programs that control the client side activities:
  - Java script within the HTML code
  - Applets
  - System flash
- For the server side:
  - CGI (common gateway interface) by which clients could request the execution of programs stored at the server
  - JSP
  - ASP

Security

- Attacks:
- computer system and its contents can be attacked via network connections.
- Many of attacks use malicious software (malware)
- Such software might be transferred to, and executed on, the computer itself
  - viruses, worms, Trojan horses, and spyware
- or it might attack the computer from a distance
  - denial of service(DoS)

Attacks(Virus)

- Virus: is software(piece of code) that infects a computer by inserting itself into programs that already reside in the machine.
  - when the "host" program is executed, the virus is also executed.

Attacks(Worms)

- worm: is an autonomous(مستقل) program that transfers itself through a network, taking up residence(الذي يقيم) in computers and forwarding copies of itself to other computers

Attacks(Trojan horses)

- Trojan horse: is a program that enters a computer system disguised as a desirable program, such as a game or a useful utility package, that is willingly imported by the victim.
- هو برنامج الذي يدخل في نظام الكمبيوتر متنكرا في شكل برنامج مرغوب ، مثل لعبة أو حزمة برمجية مفيدة ، والتي يتم استيرادها من قبل الضحية عن طيب خاطر.

Attacks(Spyware)

- Spyware: (sometimes called sniffing soft-
- ware), which is software that collects information about activities at the computer on which it resides and reports that information back to the instigator of the attack(المحرض على الهجوم)

Attacks(Phishing)

- Phishing: is a technique of obtaining(الحصول على) information explicitly by simply asking for it.
- مرتكب الجريمة يرسل رسائل البريد الإلكتروني على أنه مؤسسة مالية ، أومكتب حكومي ، أو غيره.
- البريد الإلكتروني يطلب من الضحية المحتملة الحصول على معلومات يفترض أن هناك حاجة لها لأغراض مشروعة. لكن هذه المعلومات المجموعة تستخدم من قبل مرتكب الجريمة لأغراض عدائية.

Attacks(Denial of service)

- Denial of service : is the process of overloading a computer with requests
- عملية إغراق الحاسوب المستهدف بالطلبات(طلبات البيانات)

  - Spam: unwanted junk email

Protection

- Firewalls: A primary prevention(الوقاية) technique is to filter traffic passing through a point in the network, usually with a program called a firewall.
  - Masquerading as a party other than one's self is known as spoofing.
  - التنكر كجزء من الشبكة spoofing
- Some variations of firewalls are designed for specific purposes-an example being spam filters , proxy server.

Firewall

- spam filter: which are firewalls designed to block unwanted email
- proxy server: is a software unit that acts as a intermediary between a client and a server with the goal of shielding the client from adverse actions of the server.
  - الهدف منه حماية العميل من الإجراءات السلبية لملقم.

Protection(Antivirus software)

- is used to detect and to remove the presence وجود of known viruses and other infections

- antivirus software must be routinely maintained by downloading updates from the software's vendor

Encryption

- Encryption use to maintain data confidentially
- many traditional Internet applications have been altered to incorporate encryption techniques, producing what are called "secure versions" of the applications.
- لقد تم تغيير العديد من تطبيقات الإنترنت التقليدية لإدماج تقنيات التشفير ، وانتاج ما يسمى ب "إصدارات آمنة" من التطبيقات.

Encryption

- FTPS which is a secure version of FTP, and SSH which is the replacement for telnet.
- secure version of HTTP, known as HTTPS.
- The backbone of HTTPS is the protocol system known as Secure Sockets Layer (SSL), which provide secure communication links between Web clients and servers

Encryption(Public-Key Encryption)

- public-key encryption : is an encryption system in which knowing how to encrypt messages does not allow one to decrypt messages.
- هو نظام التشفير حيث أن معرفة شخص كيفية تشفير الرسائل لا يعني أنه يسمح له فك تشفير الرسائل.
- A public-key encryption system involves the use of two values called keys.
- One key, known as the public key, is used to encrypt messages; the other key, known as the private key, is required to decrypt messages

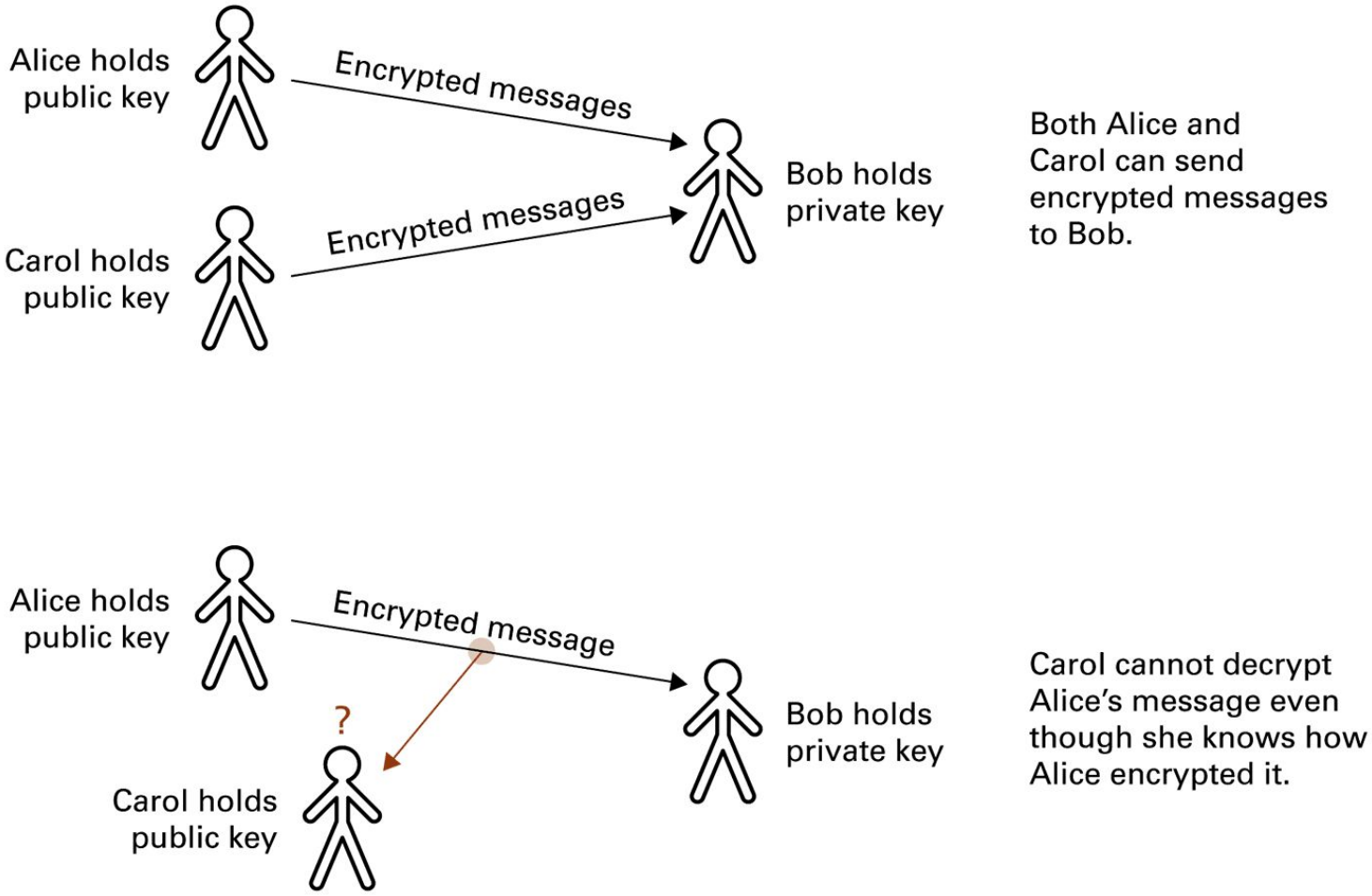


Figure 4.16 Public-key encryption

Encryption(Public-Key Encryption)

- Certificates and Digital Signatures