CHAPTER 27

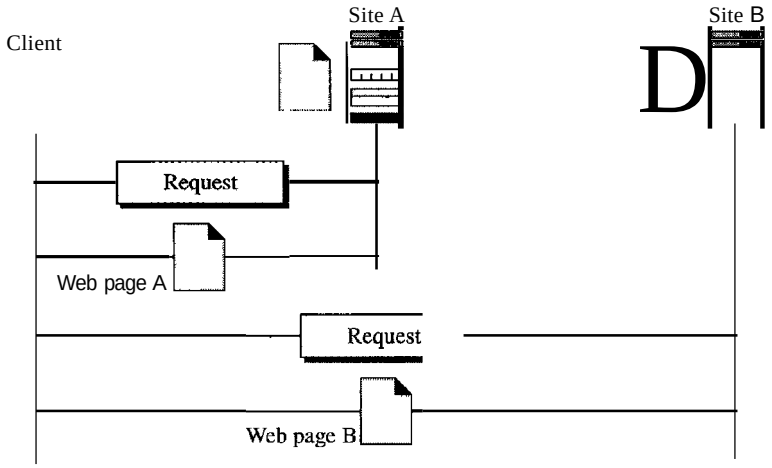
WWW and HTTP

The **World Wide Web** (WWW) is a repository of information linked together from points all over the world. The WWW has a unique combination of flexibility, portability, and user-friendly features that distinguish it from other services provided by the Internet. The WWW project was initiated by CERN (European Laboratory for Particle Physics) to create a system to handle distributed resources necessary for scientific research. **In** this chapter we first discuss issues related to the Web. We then discuss a protocol, HTTP, that is used to retrieve information from the Web.

27.1 ARCHITECTURE

The WWW today is a distributed clientJserver service, in which a client using a browser can access a service using a server. However, the service provided is distributed over many locations called *sites,* as shown **in** Figure 27.1.

Figure 27.1 *Architecture ofWWW*

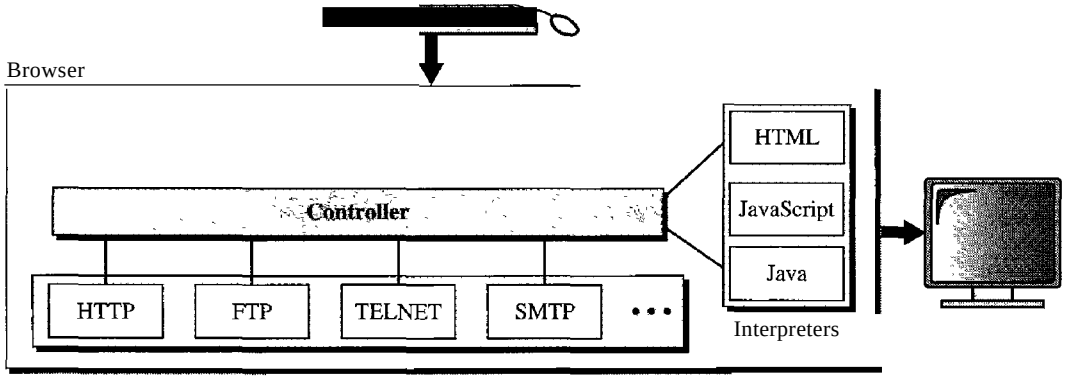


Each site holds one or more documents, referred to as *Web pages.* Each Web page can contain a link to other pages in the same site or at other sites. The pages can be retrieved and viewed by using browsers. Let us go through the scenario shown in Figure 27.1. The client needs to see some information that it knows belongs to site A. It sends a request through its browser, a program that is designed to fetch Web documents. The request, among other information, includes the address of the site and the Web page, called the URL, which we will discuss shortly. The server at site A finds the document and sends it to the client. When the user views the document, she finds some references to other documents, including a Web page at site B. The reference has the URL for the new site. The user is also interested in seeing this document. The client sends another request to the new site, and the new page is retrieved.

Client (Browser)

A variety of vendors offer commercial browsers that interpret and display a Web document, and all use nearly the same architecture. Each browser usually consists of three parts: a controller, client protocol, and interpreters. The controller receives input from the keyboard or the mouse and uses the client programs to access the document. After the document has been accessed, the controller uses one of the interpreters to display the document on the screen. The client protocol can be one of the protocols described previously such as FTP or HTIP (described later in the chapter). The interpreter can be HTML, Java, or JavaScript, depending on the type of document. We discuss the use of these interpreters based on the document type later in the chapter (see Figure 27.2).

Figure 27.2 *Browser*



Server

The Web page is stored at the server. Each time a client request arrives, the corresponding document is sent to the client. To improve efficiency, servers normally store requested files in a cache in memory; memory is faster to access than disk. A server can also become more efficient through multithreading or multiprocessing. In this case, a server can answer more than one request at a time.

Uniform Resource Locator

A client that wants to access a Web page needs the address. To facilitate the access of documents distributed throughout the world, HTTP uses locators. The uniform resource locator (URL) is a standard for specifying any kind of information on the Internet. The URL defines four things: protocol, host computer, port, and path (see Figure 27.3).

Figure 27.3 *URL*

The *protocol* is the client/server program used to retrieve the document. Many different protocols can retrieve a document; among them are FTP or HTTP. The most common today is HTTP.

The host is the computer on which the information is located, although the name of the computer can be an alias. Web pages are usually stored in computers, and computers are given alias names that usually begin with the characters "www". This is not mandatory, however, as the host can be any name given to the computer that hosts the Web page.

The URL can optionally contain the port number of the server. If the *port* is included, it is inserted between the host and the path, and it is separated from the host by a colon.

Path is the pathname of the file where the information is located. Note that the path can itself contain slashes that, in the UNIX operating system, separate the directories from the subdirectories and files.

Cookies

The World Wide Web was originally designed as a stateless entity. A client sends a request; a server responds. Their relationship is over. The original design of WWW, retrieving publicly available documents, exactly fits this purpose. Today the Web has other functions; some are listed here.

1. Some websites need to allow access to registered clients only.
2. Websites are being used as electronic stores that allow users to browse through the store, select wanted items, put them in an electronic cart, and pay at the end with a credit card.
3. Some websites are used as portals: the user selects the Web pages he wants to see.
4. Some websites are just advertising.

For these purposes, the cookie mechanism was devised. We discussed the use of cookies at the transport layer in Chapter 23; we now discuss their use in Web pages.

Creation and Storage of Cookies

The creation and storage of cookies depend on the implementation; however, the principle is the same.

1. When a server receives a request from a client, it stores information about the client in a file or a string. The information may include the domain name of the client, the contents of the cookie (information the server has gathered about the client such as name, registration number, and so on), a timestamp, and other information'depending on the implementation.
2. The server includes the cookie in the response that it sends to the client.
3. When the client receives the response, the browser stores the cookie in the cookie directory, which is sorted by the domain server name.

Using Cookies

When a client sends a request to a server, the browser looks in the cookie directory to see if it can find a cookie sent by that server. If found, the cookie is included in the request. When the server receives the request, it knows that this is an old client, not a new one. Note that the contents of the cookie are never read by the browser or disclosed to the user. It is a cookie *made* by the server and *eaten* by the server. Now let us see how a cookie is used for the four previously mentioned purposes:

1. The site that restricts access to registered clients only sends a cookie to the client when the client registers for the first time. For any repeated access, only those clients that send the appropriate cookie are allowed.
2. An electronic store (e-commerce) can use a cookie for its client shoppers. When a client selects an item and inserts it into a cart, a cookie that contains information about the item, such as its number and unit price, is sent to the browser. If the client selects a second item, the cookie is updated with the new selection information. And so on. When the client finishes shopping and wants to check out, the last cookie is retrieved and the total charge is calculated.
3. A Web portal uses the cookie in a similar way. When a user selects her favorite pages, a cookie is made and sent. If the site is accessed again, the cookie is sent to the server to show what the client is looking for.
4. A cookie is also used by advertising agencies. An advertising agency can place banner ads on some main website that is often visited by users. The advertising agency supplies only a URL that gives the banner address instead of the banner itself. When a user visits the main website and clicks on the icon of an advertised corporation, a request is sent to the advertising agency. The advertising agency sends the banner, a GIF file, for example, but it also includes a cookie with the ill of the user. Any future use of the banners adds to the database that profiles the Web behavior of the user. The advertising agency has compiled the interests of the user and can sell this information to other parties. This use of cookies has made them very controversial. Hopefully, some new regulations will be devised to preserve the privacy of users.

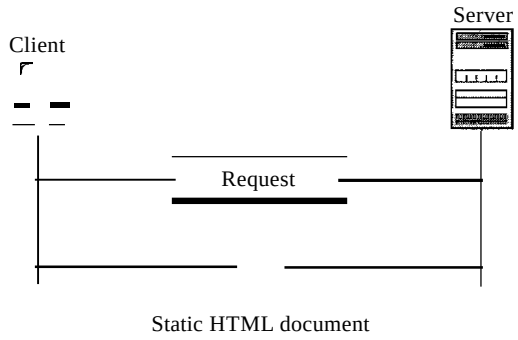
27.2 WEB DOCUMENTS

The documents in the WWW can be grouped into three broad categories: static, dynamic, and active. The category is based on the time at which the contents of the document are determined.

Static Documents

Static documents are fixed-content documents that are created and stored in a server. The client can get only a copy of the document. In other words, the contents of the file are determined when the file is created, not when it is used. Of course, the contents in the server can be changed, but the user cannot change them. When a client accesses the document, a copy of the document is sent. The user can then use a browsing program to display the document (see Figure 27.4).

Figure 27.4 *Static document*

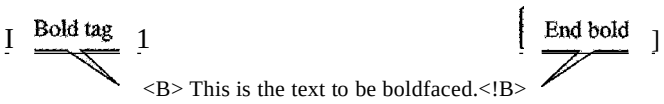


HTML

Hypertext Markup Language (HTML) is a language for creating Web pages. The term *markup language* comes from the book publishing industry. Before a book is typeset and printed, a copy editor reads the manuscript and puts marks on it. These marks tell the compositor how to format the text. For example, if the copy editor wants part of a line to be printed in boldface, he or she draws a wavy line under that part. In the same way, data for a Web page are formatted for interpretation by a browser.

Let us clarify the idea with an example. To make part of a text displayed in boldface with HTML, we put beginning and ending boldface tags (marks) in the text, as shown in Figure 27.5.

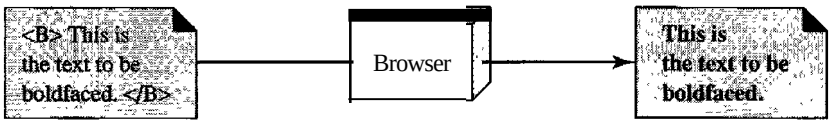
Figure 27.5 *Boldface tags*



The two tags <B> and </B> are instructions for the browser. When the browser sees these two marks, it knows that the text must be boldfaced (see Figure 27.6).

A markup language such as HTML allows us to embed formatting instructions in the file itself. The instructions are included with the text. In this way, any browser can read the instructions and format the text according to the specific workstation. One might

Figure 27.6 *Effect of boldface tags*



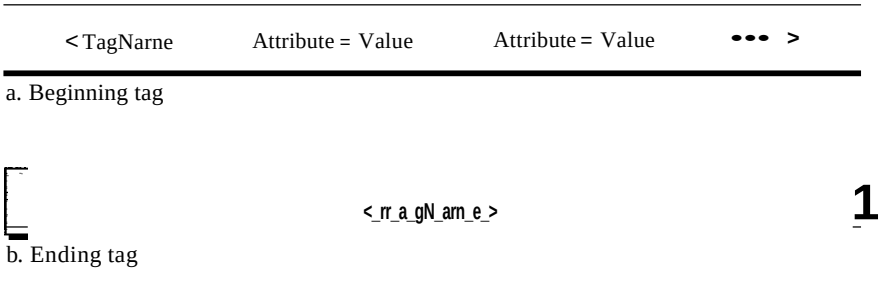
ask why we do not use the fonnatting capabilities of word processors to create and save formatted text. The answer is that different word processors use different techniques or procedures for formatting text. For example, imagine that a user creates formatted text on a Macintosh computer and stores it in a Web page. Another user who is on an IBM computer would not be able to receive the Web page because the two computers use different fonnatting procedures.

HTML lets us use only ASCII characters for both the main text and formatting instructions. In this way, every computer can receive the whole document as an ASCII document. The main text is the data, and the formatting instructions can be used by the browser to format the data.

A Web page is made up of two parts: the head and the body. The head is the first part of a Web page. The head contains the title of the page and other parameters that the browser will use. The actual contents of a page are in the body, which includes the text and the tags. Whereas the text is the actual infonnation contained in a page, the tags define the appearance of the document. Every HTML tag is a name followed by an optional list of attributes, all enclosed between less-than and greater-than symbols « and >).

An attribute, if present, is followed by an equals sign and the value of the attribute. Some tags can be used alone; others must be used in pairs. Those that are used in pairs are called *beginning* and *ending* tags. The beginning tag can have attributes and values and starts with the name of the tag. The ending tag cannot have attributes or values but must have a slash before the name of the tag. The browser makes a decision about the structure of the text based on the tags, which are embedded into the text. Figure 27.7 shows the fonnat of a tag.

Figure 27.7 *Beginning and ending tags*



One commonly used tag category is the text formatting tags such as <B> and <*/B*>, which make the text bold; <1> and <II>, which make the text italic; and <U> and <*IV*>, which underline the text.

Another interesting tag category is the image tag. Nontextual information such as digitized photos or graphic images is not a physical part of an HTML document. But we can use an image tag to point to the file of a photo or image. The image tag defines the address (URL) of the image to be retrieved. It also specifies how the image can be inserted after retrievaL We can choose from several attributes. The most common are SRC (source), which defines the source (address), and ALIGN, which defines the alignment of the image. The SRC attribute is required. Most browsers accept images in the GIF or IPEG formats. For example, the following tag can retrieve an image stored as imagel.gif in the directory /bin/images:

```
<IMG SRC= "/bin/images/image1.gif" ALIGN=MIDDLE >
```

A third interesting category is the hyperlink tag, which is needed to link documents together. Any item (word, phrase, paragraph, or image) can refer to another document through a mechanism called an *anchor.* The anchor is defined by <A ... > and <!A> tags, and the anchored item uses the URL to refer to another document. When the document is displayed, the anchored item is underlined, blinking, or boldfaced. The user can click on the anchored item to go to another document, which mayor may not be stored on the same server as the original document. The reference phrase is embedded between the beginning and ending tags. The beginning tag can have several attributes, but the one required is HREF (hyperlink reference), which defines the address (URL) of the linked document. For example, the link to the author of a book can be

```
<A HREF= "http://www.deanza.edu/forouzan"> Author </A>
```

What appears in the text is the word *Author,* on which the user can click to go to the author's Web page.

Dynamic Documents

A **dynamic document** is created by a Web server whenever a browser requests the document. When a request arrives, the Web server runs an application program or a script that creates the dynamic document. The server returns the output of the program or script as a response to the browser that requested the document. Because a fresh document is created for each request, the contents of a dynamic document can vary from one request to another. A very simple example of a dynamic document is the retrieval of the time and date from a server. Time and date are kinds of information that are dynamic in that they change from moment to moment. The client can ask the server to run a program such as the *date* program in UNIX and send the result of the program to the client.

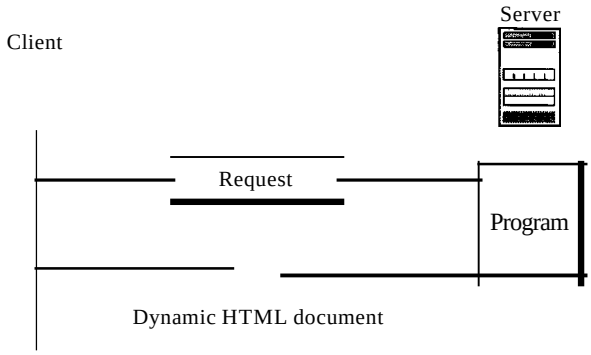
Common Gateway Interface (CGI)

The **Common** Gateway **Interface** (CGI) is a technology that creates and handles dynamic documents. CGI is a set of standards that defines how a dynamic document is written, how data are input to the program, and how the output result is used.

COl is not a new language; instead, it allows programmers to use any of several languages such as C, C++, Boume Shell, Kom Shell, C Shell, Tcl, or Perl. The only thing that CGI defines is a set of rules and tenns that the programmer must follow.

The tenn *common* in COl indicates that the standard defines a set of rules that is common to any language or platfonn. The tenn *gateway* here means that a COl program can be used to access other resources such as databases, graphical packages, and so on. The tenn *interface* here means that there is a set of predefined tenns, variables, calls, and so on that can be used in any COl program. A COl program in its simplest fonn is code written in one of the languages supporting COL Any programmer who can encode a sequence of thoughts in a program and knows the syntax of one of the above-mentioned languages can write a simple CGI program. Figure 27.8 illustrates the steps in creating a dynamic program using COl technology.

Figure 27.8 *Dynamic document using CGI*



Input In traditional programming, when a program is executed, parameters can be passed to the program. Parameter passing allows the programmer to write a generic program that can be used in different situations. For example, a generic copy program can be written to copy any file to another. A user can use the program to copy a file named *x* to another file named *y* by passing *x* and *y* as parameters.

The input from a browser to a server is sent by using *aform*. If the infonnation in a fonn is small (such as a word), it can be appended to the URL after a question mark. For example, the following URL is carrying fonn infonnation (23, a value):

http://www.deanzalcgi-binlprog.pl?23

When the server receives the URL, it uses the part of the URL before the question mark to access the program to be run, and it interprets the part after the question mark (23) as the input sent by the client. It stores this string in a variable. When the CGI program is executed, it can access this value.

If the input from a browser is too long to fit in the query string, the browser can ask the server to send a fonn. The browser can then fill the fonn with the input data and send it to the server. The infonnation in the fonn can be used as the input to the COl program.

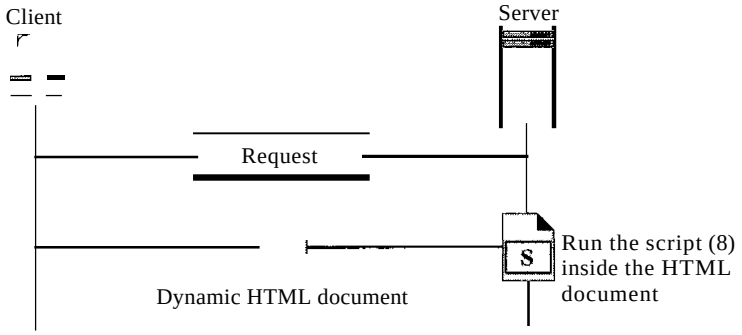
Output The whole idea of CGI is to execute a CGI program at the server site and send the output to the client (browser). The output is usually plain text or a text with HTML structures; however, the output can be a variety of other things. It can be graphics or binary data, a status code, instructions to the browser to cache the result, or instructions to the server to send an existing document instead of the actual output.

To let the client know about the type of document sent, a CGI program creates headers. As a matter of fact, the output of the CGI program always consists of two parts: a header and a body. The header is separated by a blank line from the body. This means any CGI program creates first the header, then a blank line, and then the body. Although the header and the blank line are not shown on the browser screen, the header is used by the browser to interpret the body.

Scripting Technologies for Dynamic Documents

The problem with CGI technology is the inefficiency that results if part of the dynamic document that is to be created is fixed and not changing from request to request. For example, assume that we need to retrieve a list of spare parts, their availability, and prices for a specific car brand. Although the availability and prices vary from time to time, the name, description, and the picture of the parts are fixed. If we use CGI, the program must create an entire document each time a request is made. The solution is to create a file containing the fixed part of the document using HTML and embed a script, a source code, that can be run by the server to provide the varying availability and price section. Figure 27.9 shows the idea.

Figure 27.9 *Dynamic document using server-site script*



A few technologies have been involved in creating dynamic documents using scripts. Among the most common are Hypertext Preprocessor (pHP), which uses the Perl language; Java Server Pages (JSP), which uses the Java language for scripting; Active Server Pages (ASP), a Microsoft product which uses Visual Basic language for scripting; and ColdFusion, which embeds SQL database queries in the HTML document.

Dynamic documents are sometimes referred to as server-site dynamic documents.

Active Documents

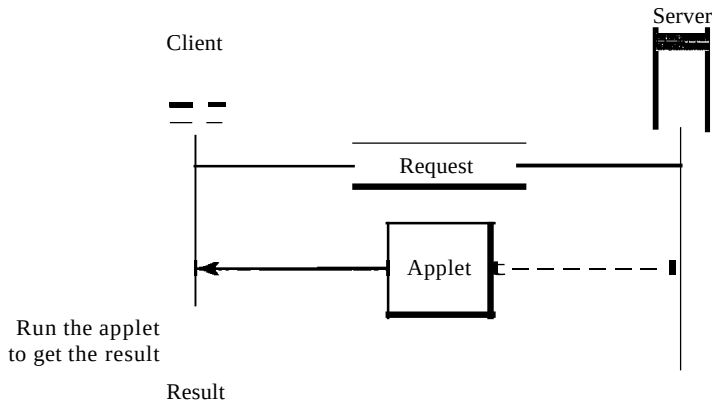
For many applications, we need a program or a script to be run at the client site. These are called active documents. For example, suppose we want to run a program that creates animated graphics on the screen or a program that interacts with the user. The program definitely needs to be run at the client site where the animation or interaction takes place. When a browser requests an active document, the server sends a copy of the document or a script. The document is then run at the client (browser) site.

Java Applets

One way to create an active document is to use Java applets. Java is a combination of a high-level programming language, a run-time environment, and a class library that allows a programmer to write an active document (an applet) and a browser to run it. It can also be a stand-alone program that doesn't use a browser.

An applet is a program written in Java on the server. It is compiled and ready to be run. The document is in byte-code (binary) format. The client process (browser) creates an instance of this applet and runs it. A Java applet can be run by the browser in two ways. In the first method, the browser can directly request the Java applet program in the URL and receive the applet in binary form. In the second method, the browser can retrieve and run an HTML file that has embedded the address of the applet as a tag. Figure 27.10 shows how Java applets are used in the first method; the second is similar but needs two transactions.

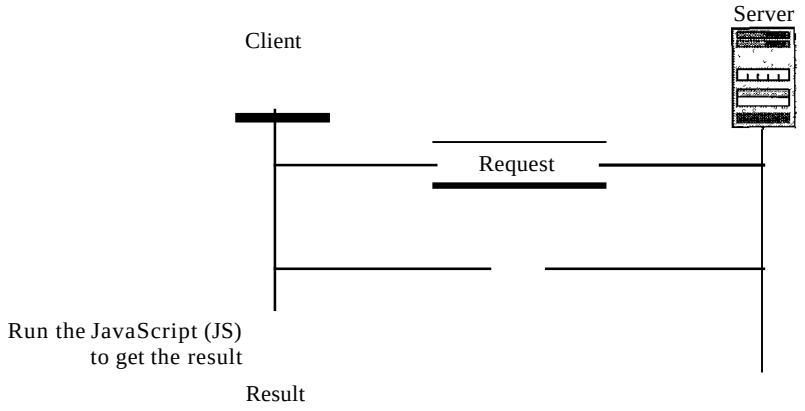
Figure 27.10 *Active document using Java applet*



JavaScript

The idea of scripts in dynamic documents can also be used for active documents. If the active part of the document is small, it can be written in a scripting language; then it can be interpreted and run by the client at the same time. The script is in source code (text) and not in binary form. The scripting technology used in this case is usually JavaScript. JavaScript, which bears a small resemblance to Java, is a very high level scripting language developed for this purpose. Figure 27.11 shows how JavaScript is used to create an active document.

Figure 27.11 *Active document using client-site script*



Active documents are sometimes referred to as client-site dynamic documents.

27.3 HTTP

The Hypertext Transfer Protocol (HTTP) is a protocol used mainly to access data on the World Wide Web. HTTP functions as a combination of FTP and SMTP. It is similar to FfP because it transfers files and uses the services of TCP. However, it is much simpler than FfP because it uses only one TCP connection. There is no separate control connection; only data are transferred between the client and the server.

HTTP is like SMTP because the data transferred between the client and the server look like SMTP messages. In addition, the format of the messages is controlled by MIME-like headers. Unlike SMTP, the HTTP messages are not destined to be read by humans; they are read and interpreted by the HTTP server and HTTP client (browser). SMTP messages are stored and forwarded, but HTTP messages are delivered immediately. The commands from the client to the server are embedded in a request message. The contents of the requested file or other information are embedded in a response message. HTTP uses the services of TCP on well-known port 80.

HTTP uses the services of TCP on well-known port 80.

HTTP Transaction

Figure 27.12 illustrates the HTTP transaction between the client and server. Although HTTP uses the services of TCP, HTTP itself is a stateless protocol. The client initializes the transaction by sending a request message. The server replies by sending a response.

Messages

The formats of the request and response messages are similar; both are shown in Figure 27.13. A request message consists of a request line, a header, and sometimes a body. A response message consists of a status line, a header, and sometimes a body.

Figure 27.12 *HTTP transaction*

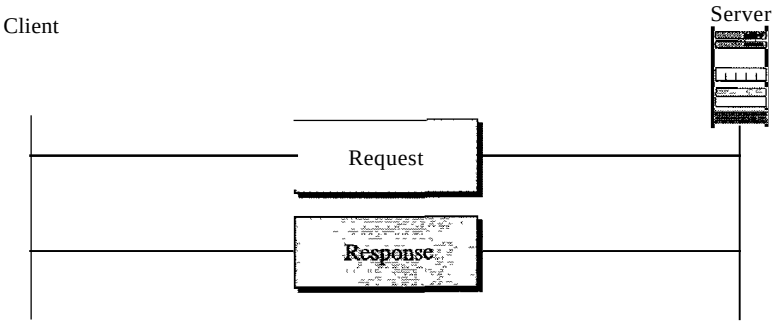
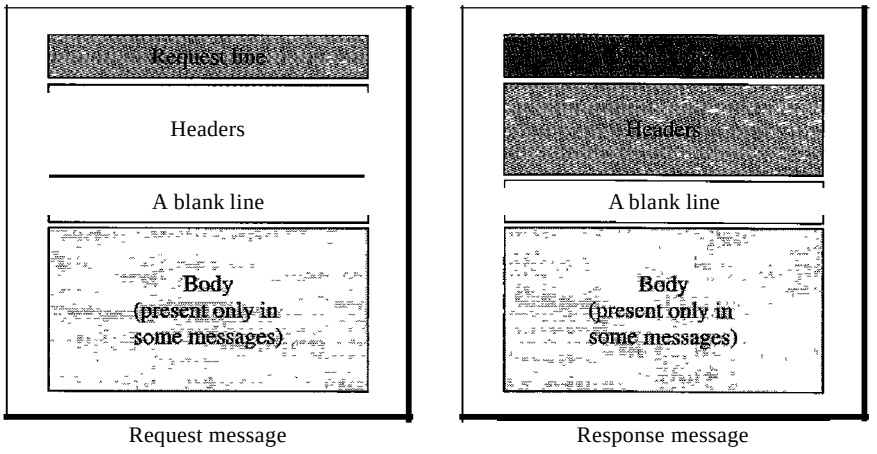
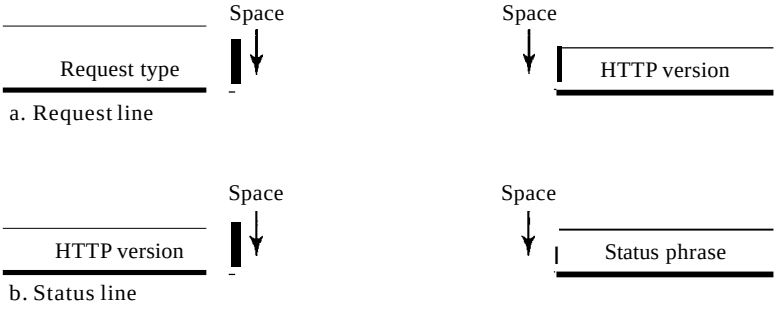


Figure 27.13 *Request and response messages*



Request and Status Lines The first line in a request message is called a request line; the first line in the response message is called the status line. There is one common field, as shown in Figure 27.14.

Figure 27.14 *Request and status lines*



- Request type. This field is used in the request message. In version 1.1 of HTTP, several request types are defined. The request type is categorized into *methods* as defined in Table 27.1.

Table 27.1 *Methods*

Method	*Action*
GET	Requests a document from the server
HEAD	Requests information about a document but not the document itself
POST	Sends some information from the client to the server
PUT	Sends a document from the server to the client
TRACE	Echoes the incoming request
CONNECT	Reserved
OPTION	Inquires about available options

- URL. We discussed the URL earlier in the chapter.
- Version. The most current version of HTTP is 1.1.
- Status code. This field is used in the response message. The status code field is similar to those in the FTP and the SMTP protocols. It consists of three digits. Whereas the codes in the 100 range are only informational, the codes in the 200 range indicate a successful request. The codes in the 300 range redirect the client to another URL, and the codes in the 400 range indicate an error at the client site. Finally, the codes in the 500 range indicate an error at the server site. We list the most common codes in Table 27.2.
- Status phrase. This field is used in the response message. It explains the status code in text form. Table 27.2 also gives the status phrase.

Table 27.2 *Status codes*

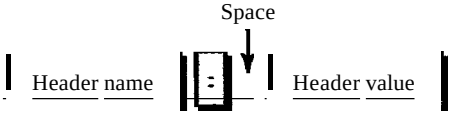
Code	*Phrase*	*Description*
	Informational	
100	Continue	The initial part of the request has been received, and the client may continue with its request.
101	Switching	The server is complying with a client request to switch protocols defined in the upgrade header.
	Success	
200	OK	The request is successful.
201	Created	A new URL is created.
202	Accepted	The request is accepted, but it is not immediately acted upon.
204	No content	There is no content in the body.

Table 27.2 *Status codes (continued)*

Code	*Phrase*	*Description*
	Redirection	
301	Moved permanently	The requested URL is no longer used by the server.
302	Moved temporarily	The requested URL has moved temporarily.
304	Not modified	The document has not been modified.
	Client Error	
400	Bad request	There is a syntax error in the request.
401	Unauthorized	The request lacks proper authorization.
403	Forbidden	Service is denied.
404	Not found	The document is not found.
405	Method not allowed	The method is not supported in this URL.
406	Not acceptable	The format requested is not acceptable.
	Server Error	
500	Internal server error	There is an error, such as a crash, at the server site.
501	Not implemented	The action requested cannot be performed.
503	Service unavailable	The service is temporarily unavailable, but may be requested in the future.

Header The header exchanges additional information between the client and the server. For example, the client can request that the document be sent in a special format, or the server can send extra information about the document. The header can consist of one or more header lines. Each header line has a header name, a colon, a space, and a header value (see Figure 27.15). We will show some header lines in the examples at the end of this chapter. A header line belongs to one of four categories: general header, request header, response header, and entity header. A request message can contain only general, request, and entity headers. A response message, on the other hand, can contain only general, response, and entity headers.

Figure 27.15 *Header format*



- General header The general header gives general information about the message and can be present in both a request and a response. Table 27.3 lists some general headers with their descriptions.

Table 27.3 *General headers*

Header	*Description*
Cache-control	Specifies infonnation about caching
Connection	Shows whether the connection should be closed or not
Date	Shows the current date
MIME-version	Shows the MIME version used
Upgrade	Specifies the preferred communication protocol

- Request header The request header can be present only in a request message. It specifies the client's configuration and the client's preferred document format. See Table 27.4 for a list of some request headers and their descriptions.

Table 27.4 *Request headers*

Header	*Description*
Accept	Shows the medium fonnat the client can accept
Accept-charset	Shows the character set the client can handle
Accept-encoding	Shows the encoding scheme the client can handle
Accept-language	Shows the language the client can accept
Authorization	Shows what pennissions the client has
From	Shows the e-mail address of the user
Host	Shows the host and port number of the server
If-modified-since	Sends the document if newer than specified date
If-match	Sends the document only if it matches given tag
If-non-match	Sends the document only if it does not match given tag
If-range	Sends only the portion of the document that is missing
If-unmodified-since	Sends the document if not changed since specified date
Referrer	Specifies the URL of the linked document
User-agent	Identifies the client program

- Response header The response header can be present only in a response message. It specifies the server's configuration and special information about the request. See Table 27.5 for a list of some response headers with their descriptions.

Table 27.5 *Response headers*

Header	*Description*
Accept-range	Shows if server accepts the range requested by client
Age	Shows the age of the document
Public	Shows the supported list of methods
Retry-after	Specifies the date after which the server is available
Server	Shows the server name and version number

- Entity header The entity header gives infonnation about the body of the document. Although it is mostly present in response messages, some request messages, such as POST or PUT methods, that contain a body also use this type of header. See Table 27.6 for a list of some entity headers and their descriptions.

Table 27.6 *Entity headers*

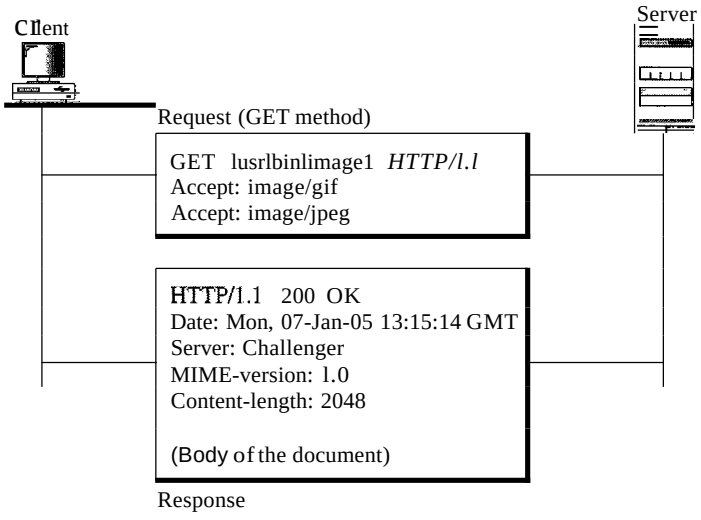
Header	*Description*
Allow	Lists valid methods that can be used with a URL
Content-encoding	Specifies the encoding scheme
Content-language	Specifies the language
Content-length	Shows the length of the document
Content-range	Specifies the range of the document
Content-type	Specifies the medium type
Etag	Gives an entity tag
Expires	Gives the date and time when contents may change
Last-modified	Gives the date and time of the last change
Location	Specifies the location of the created or moved document

Body The body can be present in a request or response message. Usually, it contains the document to be sent or received.

Example 27.1

This example retrieves a document. We use the GET method to retrieve an image with the path /usr/bin/imagel. The request line shows the method (GET), the URL, and the HTTP version (1.1). The header has two lines that show that the client can accept images in the GIF or JPEG format. The request does not have a body. The response message contains the status line and four lines of header. The header lines define the date, server, MIME version, and length of the document. The body of the document follows the header (see Figure 27.16).

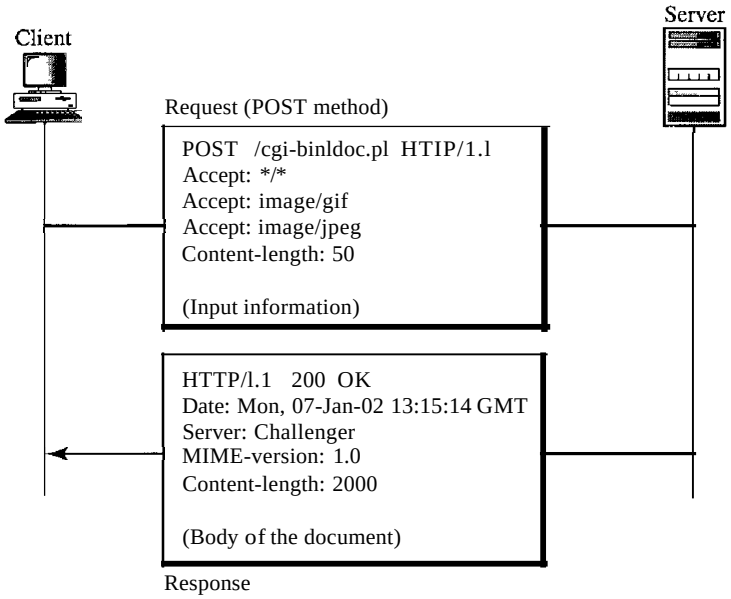
Figure 27.16 *Example 27.1*



Example 27.2

In this example, the client wants to send data to the server. We use the POST method. The request line shows the method (POST), URL, and HTTP version (1.1). There are four lines of headers. The request body contains the input information. The response message contains the status line and four lines of headers. The created document, which is a CGI document, is included as the body (see Figure 27.17).

Figure 27.17 *Example 27.2*



Example 27.3

HTTP uses ASCII characters. A client can directly connect to a server using TELNET, which logs into port 80. The next three lines show that the connection is successful.

We then type three lines. The first shows the request line (GET method), the second is the header (defining the host), the third is a blank, terminating the request.

The server response is seven lines starting with the status line. The blank line at the end terminates the server response. The file of 14,230 lines is received after the blank line (not shown here). The last line is the output by the client.

```
$ teinet www.mhhe.com 80
Trying 198.45.24.104 ...
Connected to www.mhhe.com (198.45.24.104).
Escape character is 11\]'.
GET /engcslcompscilforouzan HTTP/I.t
From: forouzanbehrouz@fbda.edu

HTTP/t.l 200 OK
Date: Thu, 28 Oct 2004 16:27:46 GMT
Server: Apache/l.3.9 (Unix) ApacheJServ/1.1.2 PHP/4.1.2 PHP/3.0.18
MIME-version: 1.0
Content-Type: text/html
```

```
Last-modified: Friday, 15-0ct-04 02:11:31 GMT
Content-length: 14230

Connection closed by foreign host.
```

Persistent Versus Nonpersistent Connection

HTTP prior to version 1.1 specified a nonpersistent connection, while a persistent connection is the default in version 1.1.

Nonpersistent Connection

In a nonpersistent connection, one TCP connection is made for each request/response. The following lists the steps in this strategy:

1. The client opens a TCP connection and sends a request.
2. The server sends the response and closes the connection.
3. The client reads the data until it encounters an end-of-file marker; it then closes the connection.

In this strategy, for N different pictures in different files, the connection must be opened and closed N times. The nonpersistent strategy imposes high overhead on the server because the server needs N different buffers and requires a slow start procedure each time a connection is opened.

Persistent Connection

HTTP version 1.1 specifies a persistent connection by default. In a persistent connection, the server leaves the connection open for more requests after sending a response. The server can close the connection at the request of a client or if a time-out has been reached. The sender usually sends the length of the data with each response. However, there are some occasions when the sender does not know the length of the data. This is the case when a document is created dynamically or actively. In these cases, the server informs the client that the length is not known and closes the connection after sending the data so the client knows that the end of the data has been reached.

HTTP version 1.1 specifies a persistent connection by default.

Proxy Server

HTTP supports proxy servers. A proxy server is a computer that keeps copies of responses to recent requests. The HTTP client sends a request to the proxy server. The proxy server checks its cache. If the response is not stored in the cache, the proxy server sends the request to the corresponding server. Incoming responses are sent to the proxy server and stored for future requests from other clients.

The proxy server reduces the load on the original server, decreases traffic, and improves latency. However, to use the proxy server, the client must be configured to access the proxy instead of the target server.

27.4 RECOMMENDED READING

For more details about subjects discussed in this chapter, we recommend the following books and sites. The items in brackets [...] refer to the reference list at the end of the text.

Books

HTTP is discussed in Chapters 13 and 14 of [Ste96], Section 9.3 of [PD03], Chapter 35 of [Com04], and Section 7.3 of [Tan03].

Sites

The following sites are related to topics discussed in this chapter.

- www.ietf.org/rfc.html Information about RFCs

RFCs

The following RFCs are related to WWW:

1614,1630,1737,1738

The following RFCs are related to HTTP:

2068,2109

27.5 KEY TERMS

active document
Active Server Pages (ASP)
applet
browser
ColdFusion
Common Gateway Interface (CGI)
dynamic document
entity header
general header
host
Hypertext Markup Language (HTML)
Hypertext Preprocessor (PHP)
Hypertext Transfer Protocol (HTTP)
Java
JavaScript
Java Server Pages (JSP)
nonpersistent connection
path
persistent connection
proxy server
request header
request line
request type
response header
static document
status code
status line
tag
uniform resource locator (URL)
Web
World Wide Web (WWW)

27.6 SUMMARY

- The World Wide Web (WWW) is a repository of information linked together from points all over the world.
- Hypertexts are documents linked to one another through the concept of pointers.
- Browsers interpret and display a Web document.
- A browser consists of a controller, client programs, and interpreters.
- A Web document can be classified as static, dynamic, or active.
- A static document is one in which the contents are fixed and stored in a server. The client can make no changes in the server document.
- Hypertext Markup Language (HTML) is a language used to create static Web pages.
- Any browser can read formatting instructions (tags) embedded in an HTML document.
- Tags provide structure to a document, define titles and headers, format text, control the data flow, insert figures, link different documents together, and define executable code.
- A dynamic Web document is created by a server only at a browser request.
- The Common Gateway Interface (CGI) is a standard for creating and handling dynamic Web documents.
- A CGI program with its embedded CGI interface tags can be written in a language such as C, C++, Shell Script, or Perl.
- An active document is a copy of a program retrieved by the client and run at the client site.
- Java is a combination of a high-level programming language, a run-time environment, and a class library that allows a programmer to write an active document and a browser to run it.
- Java is used to create applets (small application programs).
- The Hypertext Transfer Protocol (HTTP) is the main protocol used to access data on the World Wide Web (WWW).
- HTTP uses a TCP connection to transfer files.
- An HTTP message is similar in form to an SMTP message.
- The HTTP request line consists of a request type, a URL, and the HTTP version number.
- The uniform resource locator (URL) consists of a method, host computer, optional port number, and path name to locate information on the WWW.
- The HTTP request type or method is the actual command or request issued by the client to the server.
- The status line consists of the HTTP version number, a status code, and a status phrase.
- The HTTP status code relays general information, information related to a successful request, redirection information, or error information.
- The HTTP header relays additional information between the client and server.

- An HTTP header consists of a header name and a header value.
- An HTTP general header gives general information about the request or response message.
- An HTTP request header specifies a client's configuration and preferred document format.
- An HTTP response header specifies a server's configuration and special information about the request.
- An HTTP entity header provides information about the body of a document.
- HTTP, version 1.1, specifies a persistent connection.
- A proxy server keeps copies of responses to recent requests.

27.7 PRACTICE SET

Review Questions

1. How is HTTP related to WWW?
2. How is HTTP similar to SMTP?
3. How is HTTP similar to *FTP?*
4. What is a URL and what are its components?
5. What is a proxy server and how is it related to HTTP?
6. Name the common three components of a browser.
7. What are the three types of Web documents?
8. What does HTML stand for and what is its function?
9. What is the difference between an active document and a dynamic document?
10. What does CGI stand for and what is its function?
11. Describe the relationship between Java and an active document.

Exercises

12. Where will each figure be shown on the screen?

```
Look at the following picture:
then tell me what you feel:
<IMG SRC="PictureslFunnyl.gif" ALIGN=middle>
<lMG SRC="Pictures/Funny2.gif" ALIGN=bottom>
<B>What is your feeling? <IE>
```

13. Show the effect of the following HTML segment.

```
The publisher of this book is <A HREF="www.mhhe">
McGraw-Hill Publisher <fA>
```

14. Show a request that retrieves the document /usr/users/doc/docl. Use at least two general headers, two request headers, and one entity header.
15. Show the response to Exercise 14 for a successful request.
16. Show the response to Exercise 14 for a document that has permanently moved to /usr/deads/doc1.

17. Show the response to Exercise 14 if there is a syntax error in the request.
18. Show the response to Exercise 14 if the client is unauthorized to access the document.
19. Show a request that asks for information about a document at /bin/users/file. Use at least two general headers and one request header.
20. Show the response to Exercise 19 for a successful request.
21. Show the request to copy the file at location /bin/usr/bin/file1 to /bin/file1.
22. Show the response to Exercise 21.
23. Show the request to delete the file at location /bin/file!.
24. Show the response to Exercise 23.
25. Show a request to retrieve the file at location /bin/etc/file!. The client needs the document only if it was modified after January 23, 1999.
26. Show the response to Exercise 25.
27. Show a request to retrieve the file at location /bin/etc/filel. The client should identify itself.
28. Show the response to Exercise 27.
29. Show a request to store a file at location /bin/letter. The client identifies the types of documents it can accept.
30. Show the response to Exercise 29. The response shows the age of the document as well as the date and time when the contents may change.