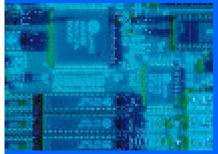
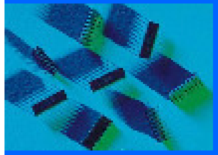




Lecture 12
Network Applications and Sockets

Textbook: Ch. 26

Main Topics

A. WORLD WIDE WEB AND HTTP (26.1)
- Browser
- HTTP

B. FTP (26.2)
- Connections

C. Emails (26.3)
- Sending and retrieving

D. DNS (26.6)
- Name Spaces
- Resolution

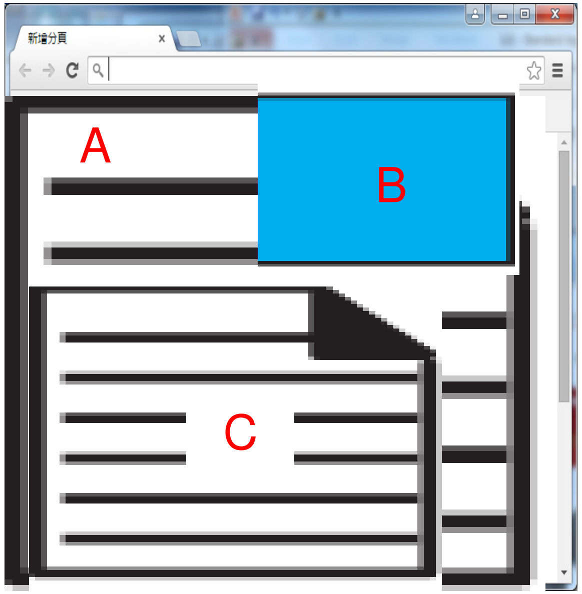
E. Sockets (25)

A. World Wide Web

- Consists of webpages with various items
  - Text, image, video, etc.

- Consider the main document (file A) of a webpage contains a reference to an image file (file B) and a reference to a text file (file C)
  - File A and file B are in Site I
  - File C is in Site II

Site I : A and B
Site II: C



Web pages linking to multiple sites

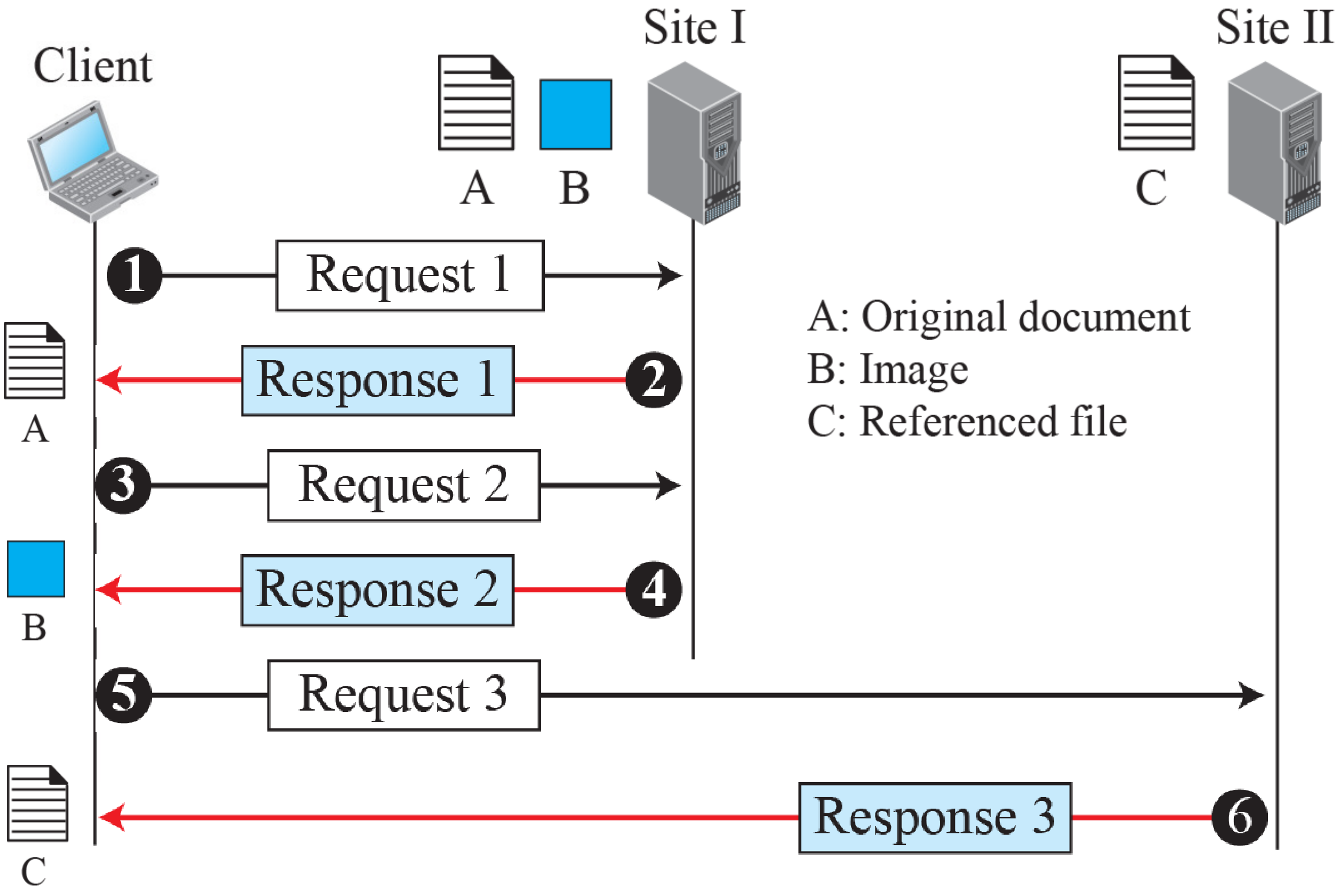


Figure 26.1: Example 26.1

Browser

- It allows them to view content via the web in its graphic form rather than HTML code, the primary language used by a website's designers to place the varying elements of a website

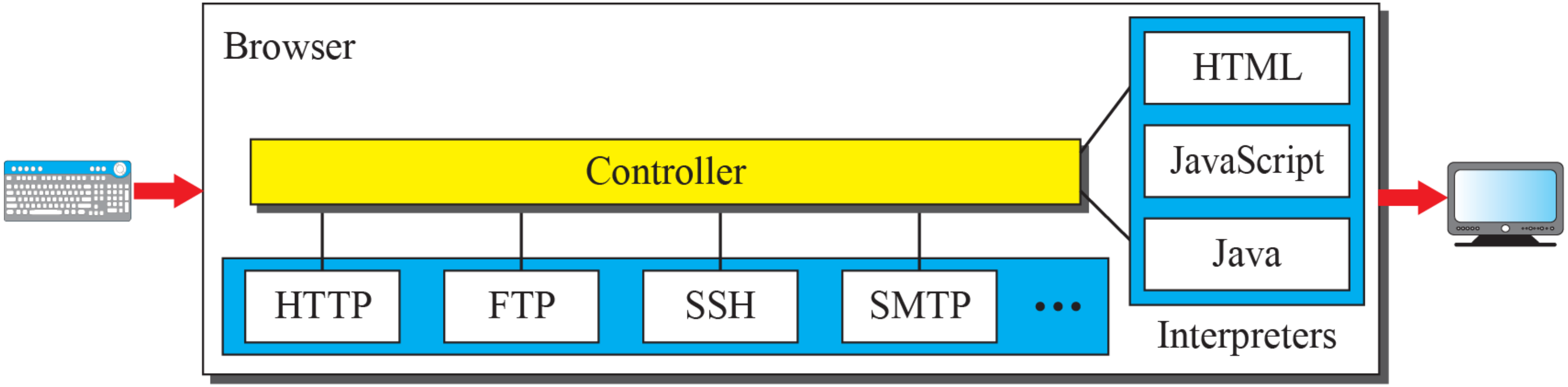


Figure 26.2: Browser

Uniform Resource Identifier (URL)

- URL format
  - protocol://host/path used most of the time
  - protocol://host:port/path used when port number is needed

- The URL http://www.mhhe.com/compsci/forouzan/ defines the web page related to one of the computer in the McGraw-Hill company
  - The computer (host) name is www.mhhe.com
    - The three letters www are part of the host name.
  - The path is compsci/forouzan/, which defines Forouzan's web page under the directory compsci.

HyperText Transfer Protocol

- The HyperText Transfer Protocol (HTTP) is used to define how the client-server programs can be written to retrieve web pages from the Web.
  - An HTTP client sends a request; an HTTP server returns a response.
  - The server uses the port number 80; the client uses a temporary port number.
  - HTTP uses the services of TCP.

Connection Persistence

- *Non-persistent* connection
  - For example:
    - The client needs to access a file that contains one link to an image. The text file and image are located on the same server. Here we need two connections.
    - For each connection, TCP requires at least three handshake messages to establish the connection, but the request can be sent with the third one.
    - After the connection is established, the object can be transferred.
    - After receiving an object, another three handshake messages are needed to terminate the connection
  - Used in HTTP 1.0

Non-persistent connection

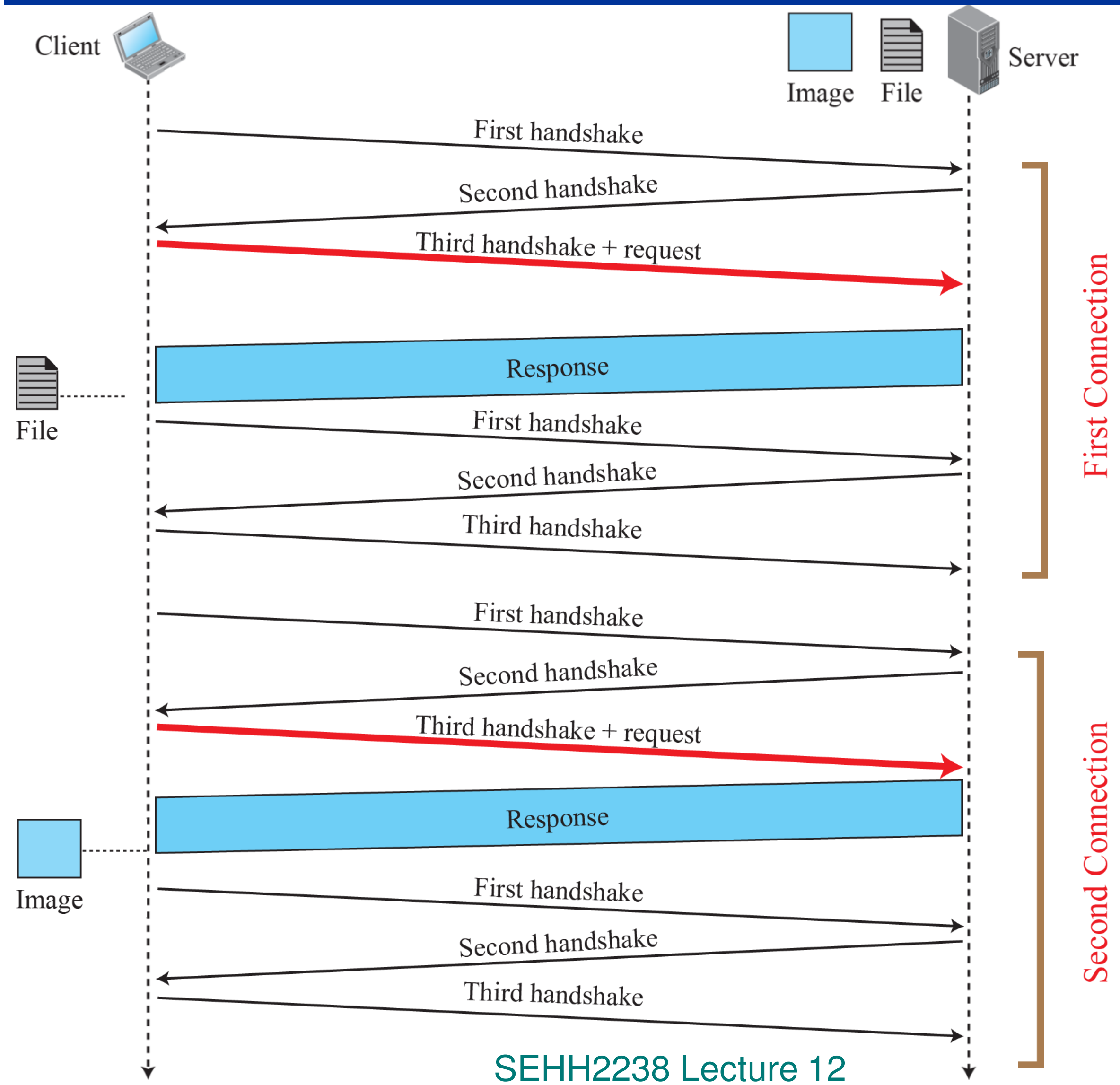


Figure 26.3:

Persistent connection

- Only one connection establishment and connection termination is used, but the request for the image is sent separately.
  - Used in HTTP 1.1

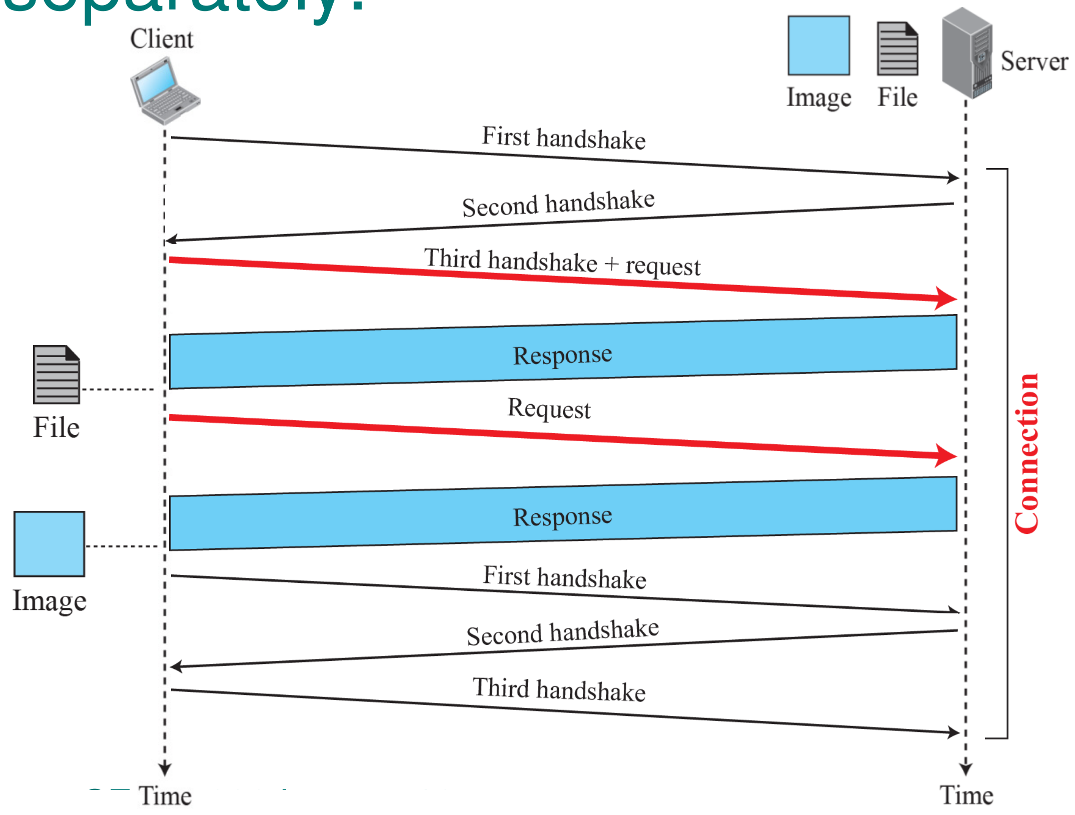
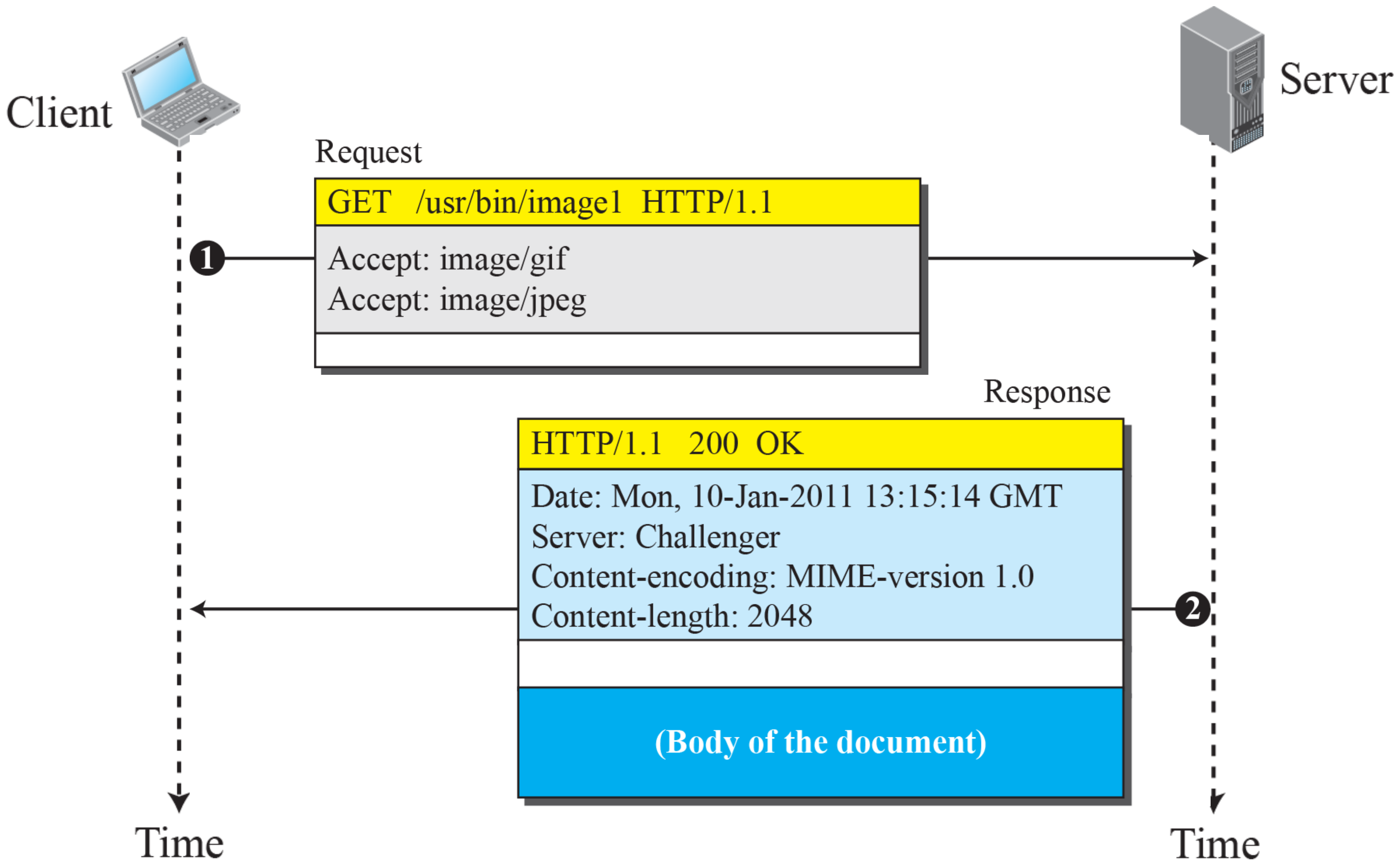


Figure 26.4:



```
GET   /usr/bin/image1  HTTP/1.1
Accept: image/gif
Accept: image/jpeg
```

```
HTTP/1.1   200  OK
Date: Mon, 10-Jan-2011 13:15:14 GMT
Server: Challenger
Content-encoding: MIME-version 1.0
Content-length: 2048

(Body of the document)
```

Figure 26.6

Example 26.6

HTTP Get

This example retrieves a document (see Figure 26.6). We use the GET method to retrieve an image with the path **/usr/bin/image1**.

- 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, content encoding (MIME version, which will be described in electronic mail), and length of the document.
- The body of the document follows the header.

Common HTTP Methods

Method	Action
GET	Requests a document from the server
HEAD	Requests information about a document but not the document itself
PUT	Sends a document from the client to the server
POST	Sends some information from the client to the server
DELETE	Removes a document from the server

B. FTP

File Transfer Protocol (FTP) is the standard protocol provided by TCP/IP for copying a file from one host to another.

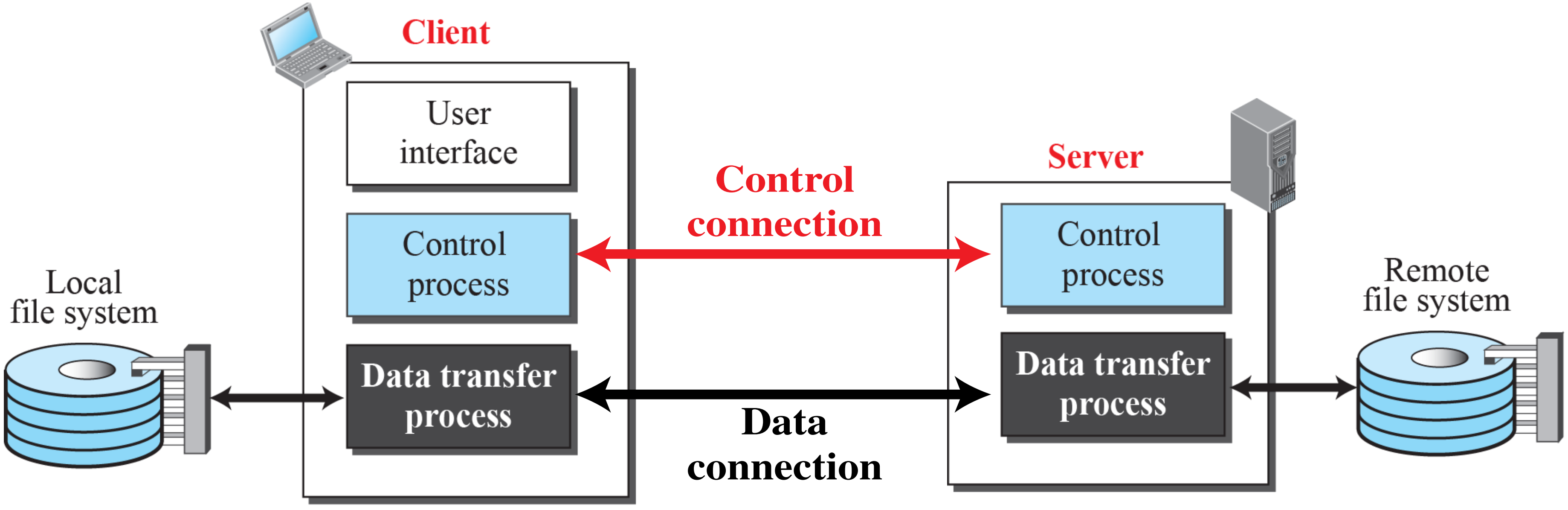


Figure 26.10: FTP

Two Connections

- Two connections in FTP
  - The control connection (port 21)
    - remains connected during the entire interactive FTP session.
  - The data connection (port 20)
    - is opened and then closed for each file transfer activity.
    - It opens each time commands that involve transferring files are used, and it closes when the file is transferred.

Data Connection

The data connection uses the well-known port 20 at the server site. However, the creation of a data connection is different from the control connection. The following shows the steps:

1. The client, not the server, issues a passive open using an ephemeral port.
2. Using the PORT command the client sends this port number to the server.
3. The server receives the port number and issues an active open using the well-known port 20 and the received ephemeral port number.

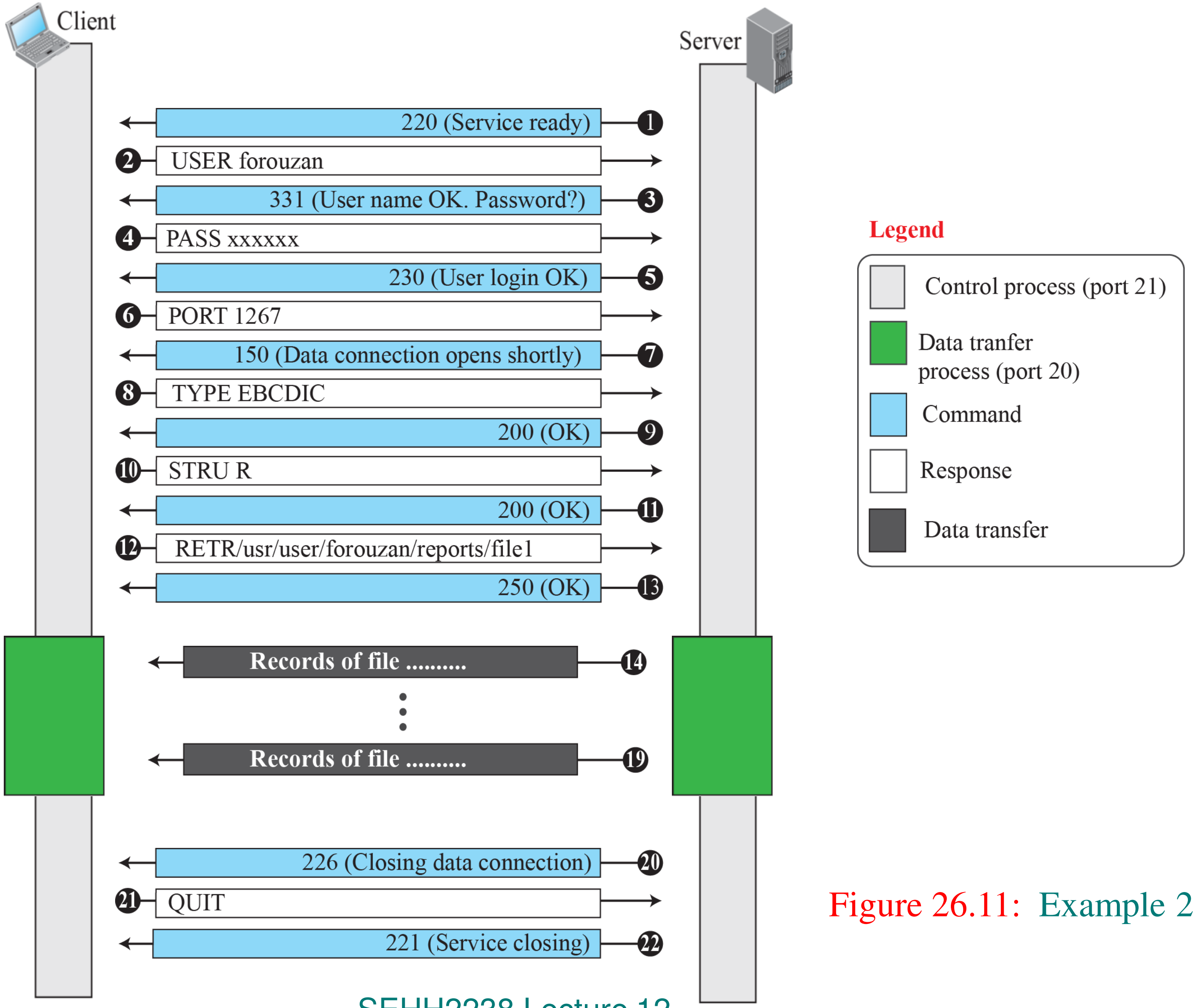

Client
Server
1 220 (Service ready)
2 USER forouzan
3 331 (User name OK. Password?)
4 PASS xxxxxx
5 230 (User login OK)
6 PORT 1267
7 150 (Data connection opens shortly)
8 TYPE EBCDIC
9 200 (OK)
10 STRU R
11 200 (OK)
12 RETR/usr/user/forouzan/reports/file1
13 250 (OK)
14 Records of file ....
19 Records of file ....
20 226 (Closing data connection)
21 QUIT
22 221 (Service closing)
Legend
Control process (port 21)
Data tranfer process (port 20)
Command
Response
Data transfer

Figure 26.11: Example 26.12

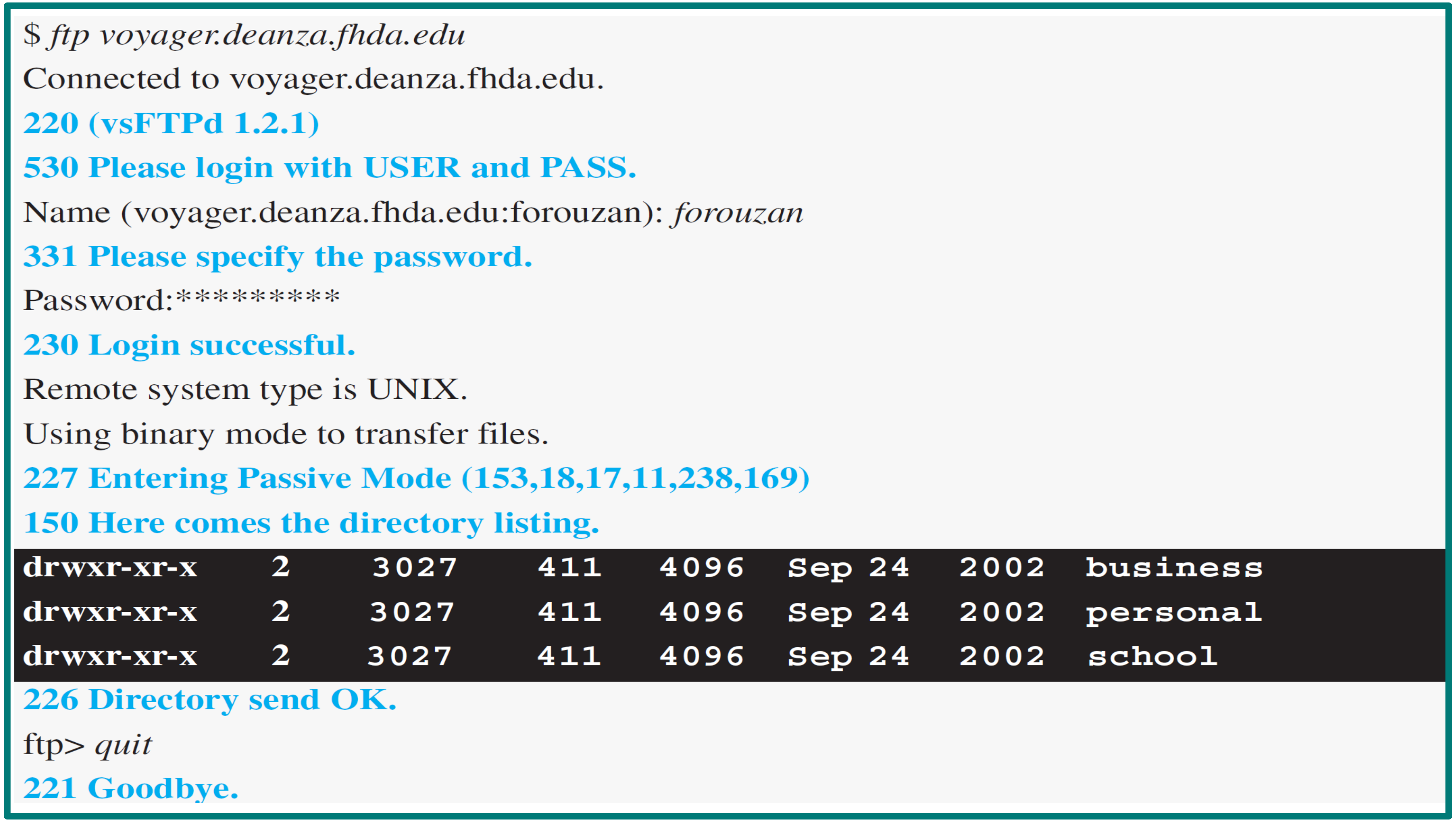
Example 26.10

Figure 26.11 shows an example of using FTP for retrieving only one file.

- The control connection remains open all the time, but the data connection is opened and closed repeatedly.
- After all records have been transferred, the server control process announces that the file transfer is done.
- Since the client control process has no file to retrieve, it issues the QUIT command, which causes the service connection to be closed.

Example 26.11

The following shows an actual FTP session that lists the directories.



```
$ ftp voyager.deanza.fhda.edu
Connected to voyager.deanza.fhda.edu.
220 (vsFTPd 1.2.1)
530 Please login with USER and PASS.
Name (voyager.deanza.fhda.edu:forouzan): forouzan
331 Please specify the password.
Password:*********
230 Login successful.
Remote system type is UNIX.
Using binary mode to transfer files.
227 Entering Passive Mode (153,18,17,11,238,169)
150 Here comes the directory listing.
drwxr-xr-x    2    3027    411    4096   Sep 24   2002   business
drwxr-xr-x    2    3027    411    4096   Sep 24   2002   personal
drwxr-xr-x    2    3027    411    4096   Sep 24   2002   school
226 Directory send OK.
ftp> quit
221 Goodbye.
```

C. ELECTRONIC MAIL

- ***Electronic mail (or e-mail) allows users to exchange messages.***
- **E-mail is a one-way transaction**
- The email system needs two user agents (UA), two pairs of Mail Transfer Agent (MTAs) (client and server), and a pair of Mail Access Agent (MAAs) (client and server).

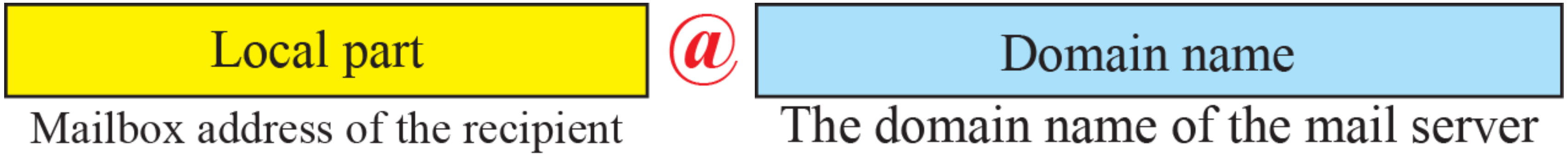

Local part
@
Domain name
Mailbox address of the recipient
The domain name of the mail server

Figure 26.14: E-mail address

Email Architecture

UA: user agent
MTA: message transfer agent
MAA: message access agent

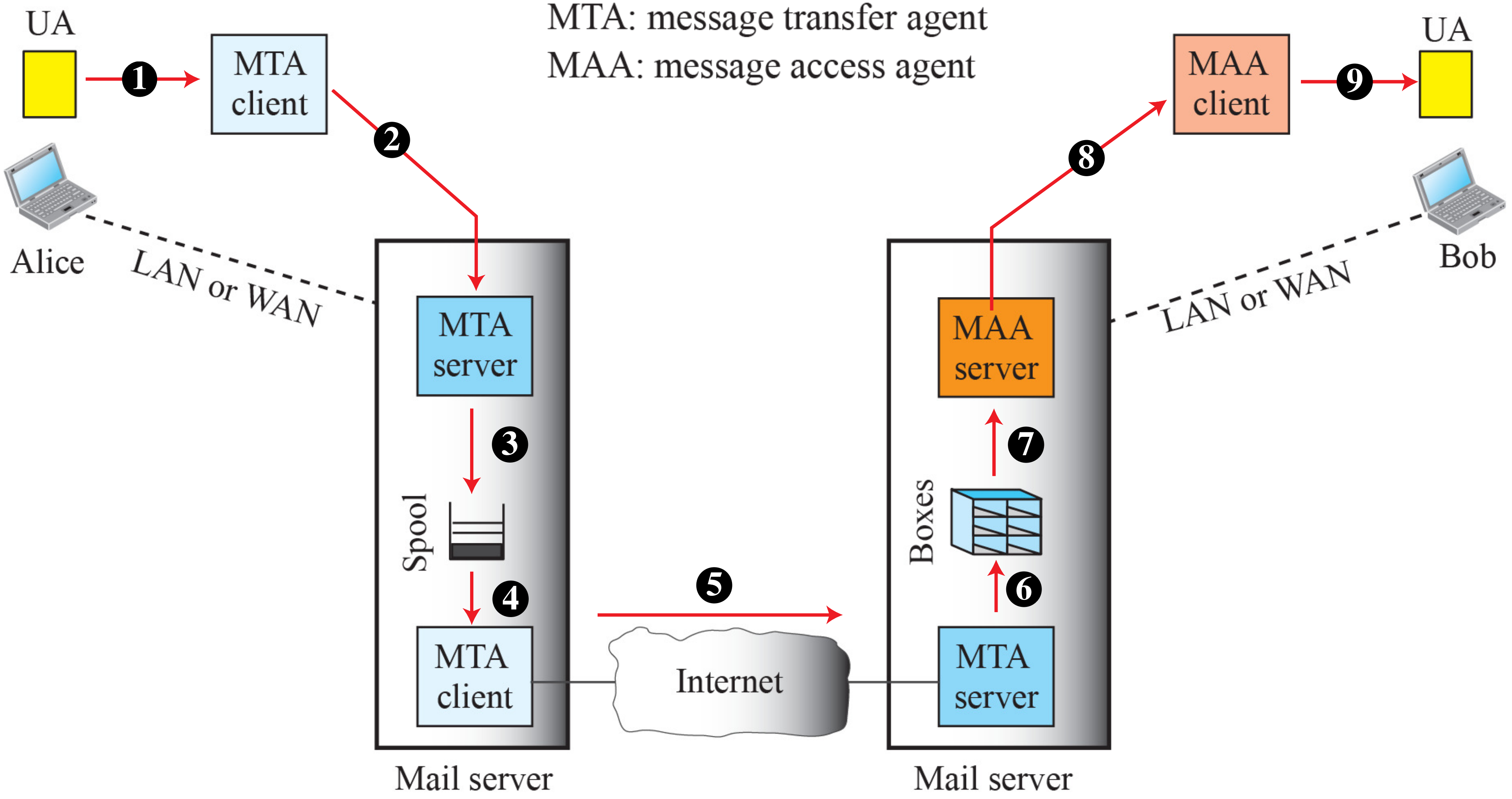


Figure 26.12: Common scenario

Email Sending

1. User Agent (UA) provides service to the user to create email.
2. UA sends the mail to the mail server by Simple mail transfer protocol (SMTP).
3. The mail server at sending site use a queue (spool) to store messages
4. The message is waiting to be sent.
5. Mail Transfer Agent (MTA) client in the sending site sends the mail to receiver’s mail server, by SMTP.

Email Reading

6. MTA server in the receiving site store the mail in the reserving users’ mailbox.
7. Receiving user connects to the mail server (login)
8. Then, the mail is delivered by POP or IMAP protocol by Mail Access Agent (MAA).

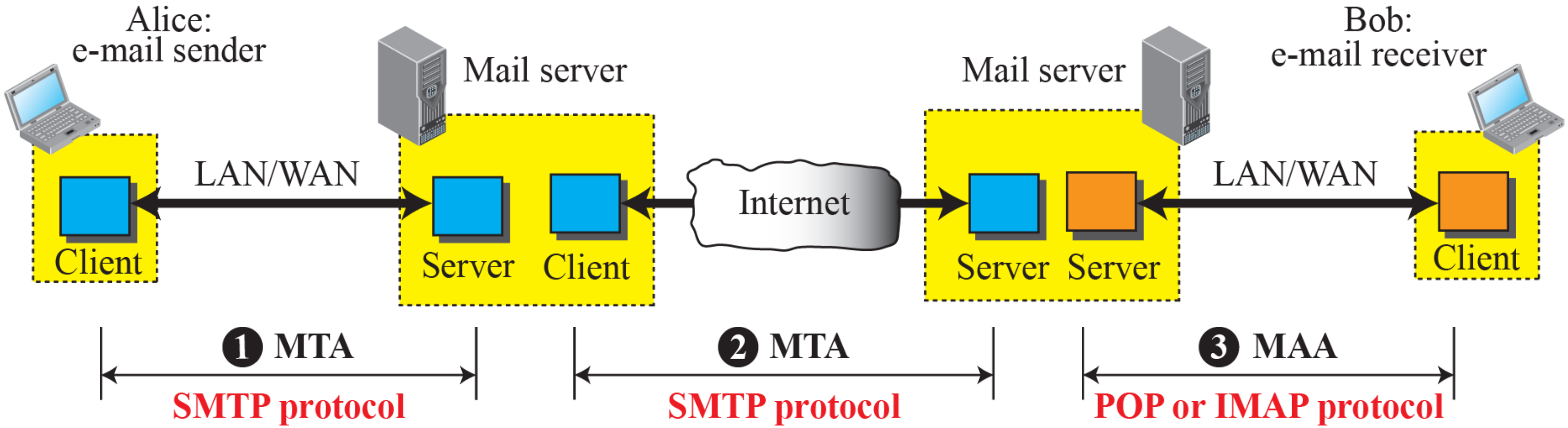


Figure 26.15: Protocols used in electronic mail

D. DOMAIN NAME SYSTEM (DNS)

- The Internet needs to have a directory system that can map a name to an address.

- The names must be unique because the addresses are unique.
  - A name space that maps each address to a unique name.

Flow of Domain Name to IP

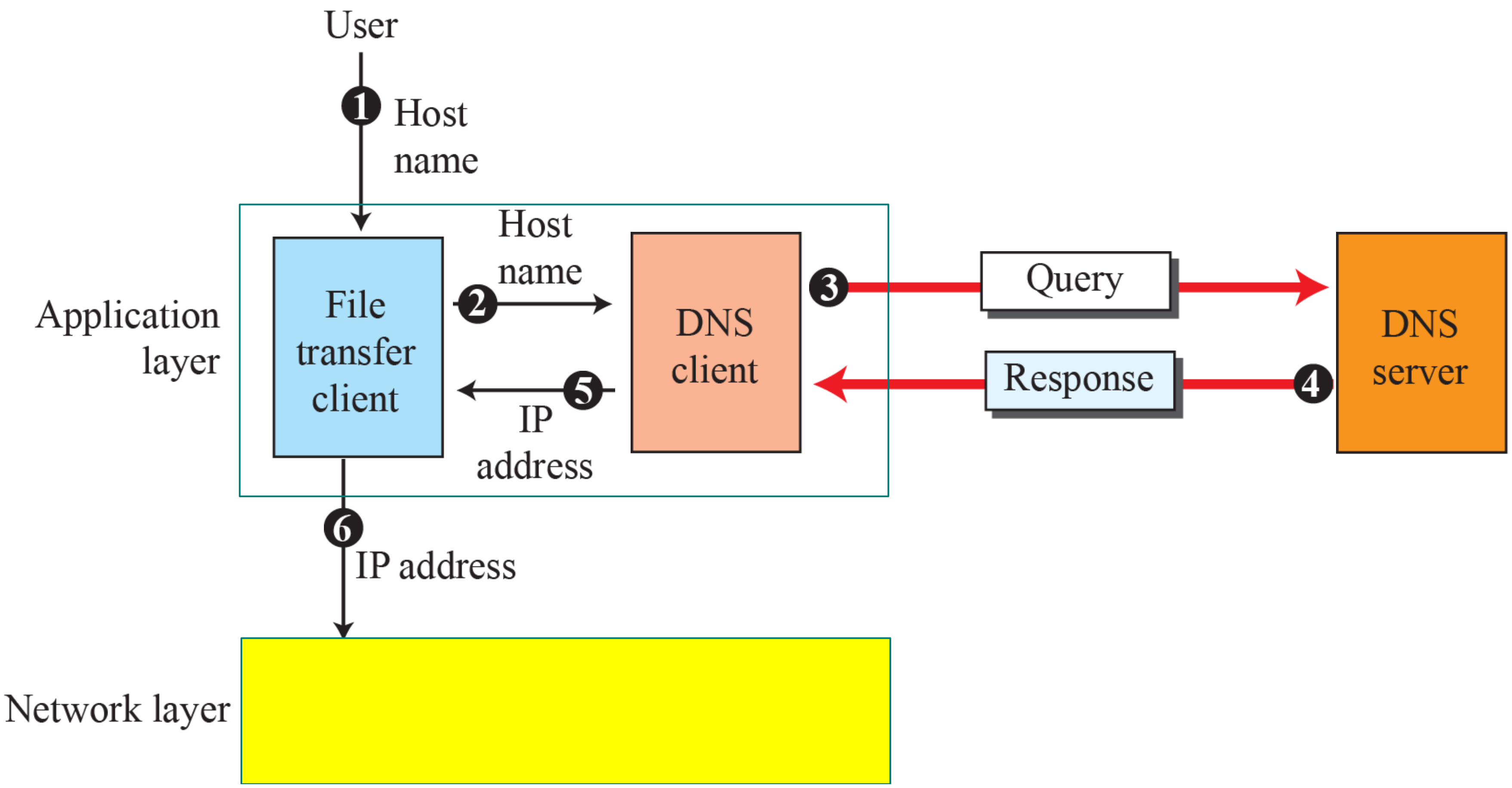


Figure 26.28: Purpose of DNS

Domain names and labels

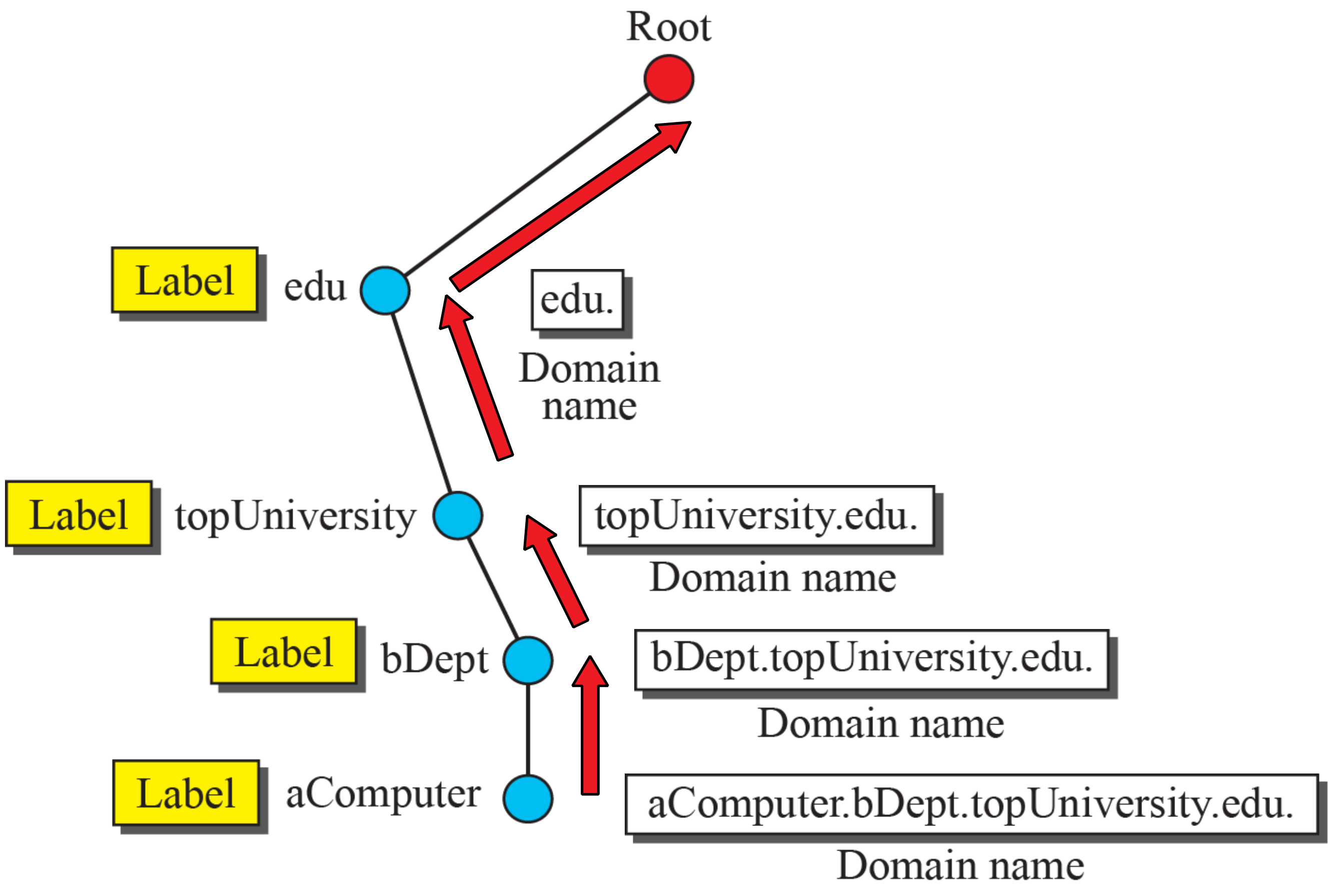


Figure 26.30: Domain names and labels

Resolution

- Mapping a name to an address is called name-address resolution.
- DNS is designed as a client-server application.
- The resolver accesses the closest DNS server with a mapping request.
  - If the server has the information, it satisfies the resolver;
  - otherwise, it either refers the resolver to other servers or asks other servers to provide the information.

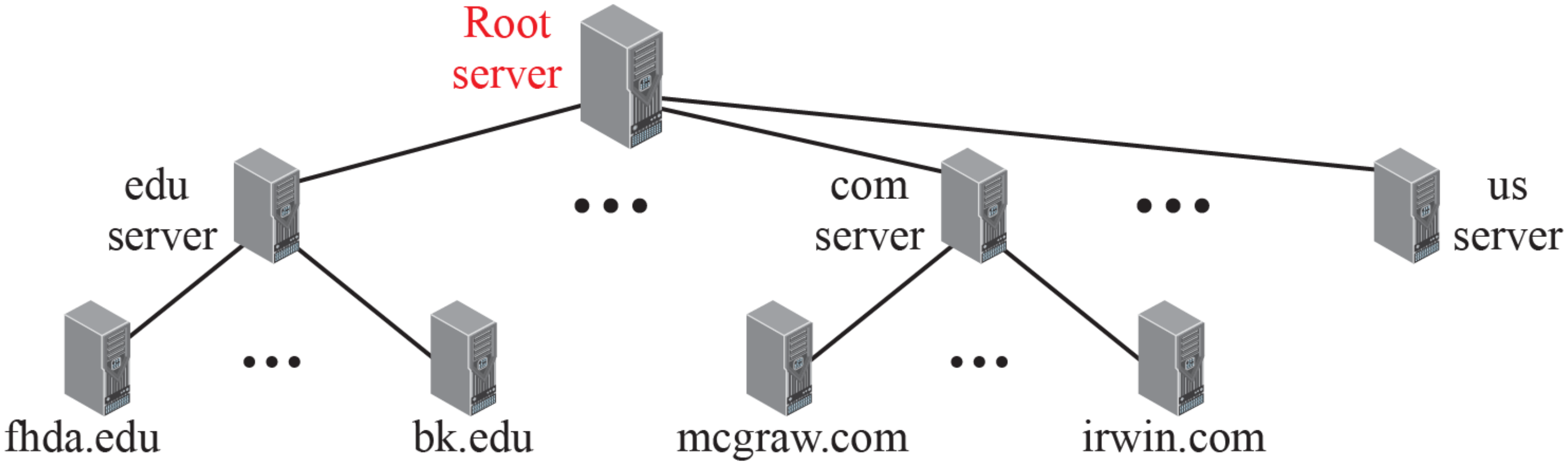


Figure 26.32: Hierarchy of name servers

Recursive resolution

Query for the IP address of engineering.mcgraw-hill.com

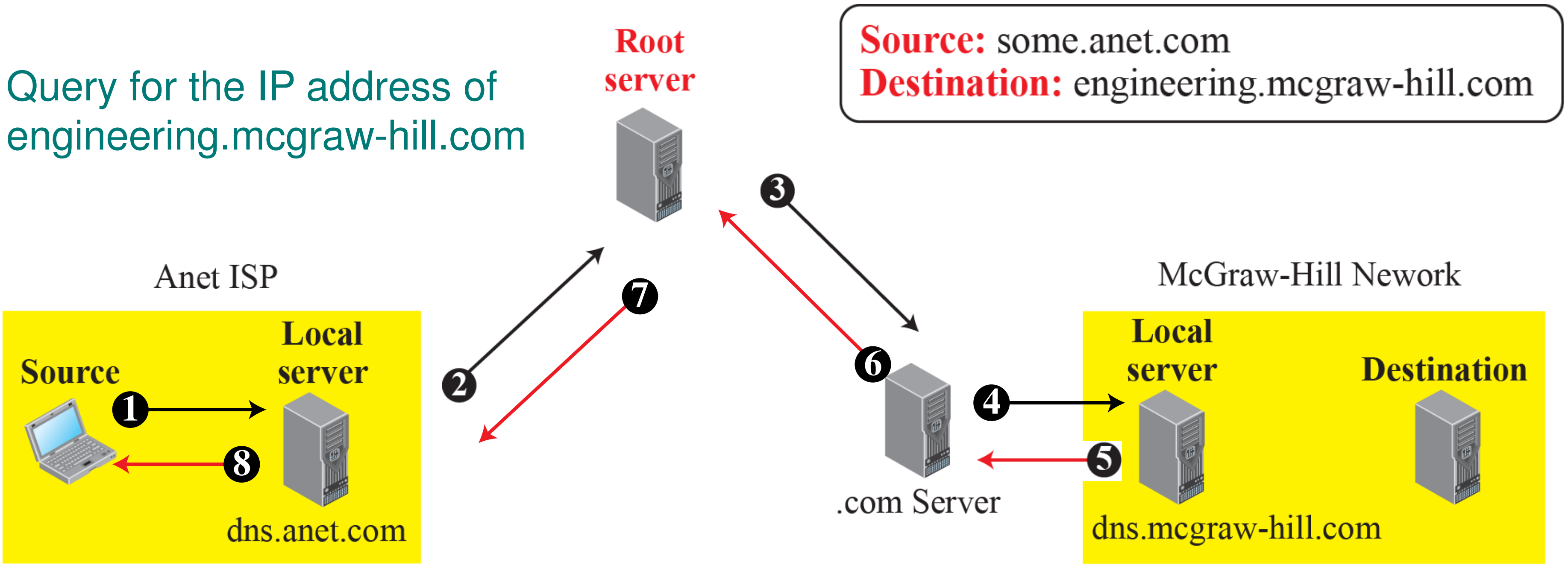


Figure 26.36: Recursive resolution

Iterative resolution

Query for the IP address of engineering.mcgraw-hill.com

Source: some.anet.com
Destination: engineering.mcgraw-hill.com

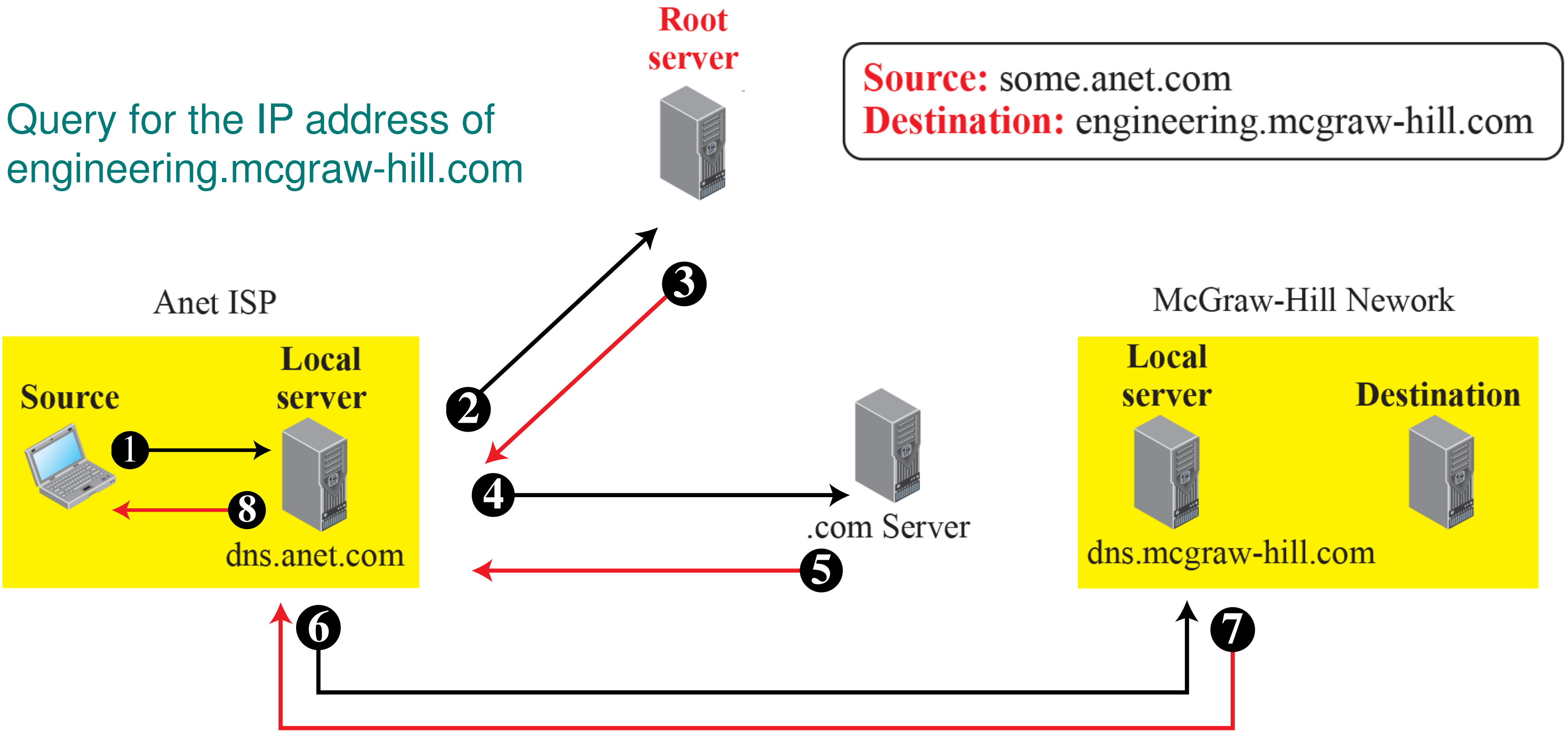
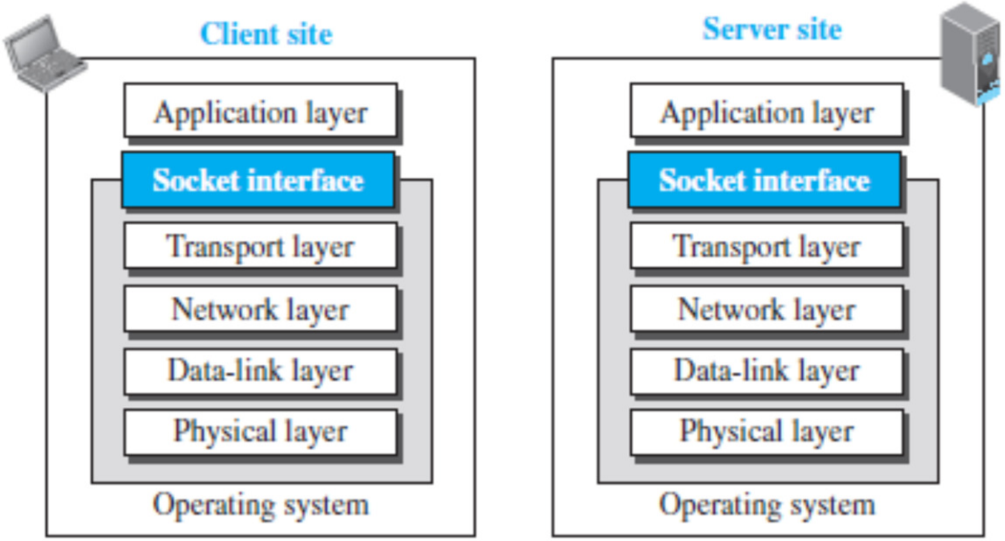


Figure 26.37: Iterative resolution

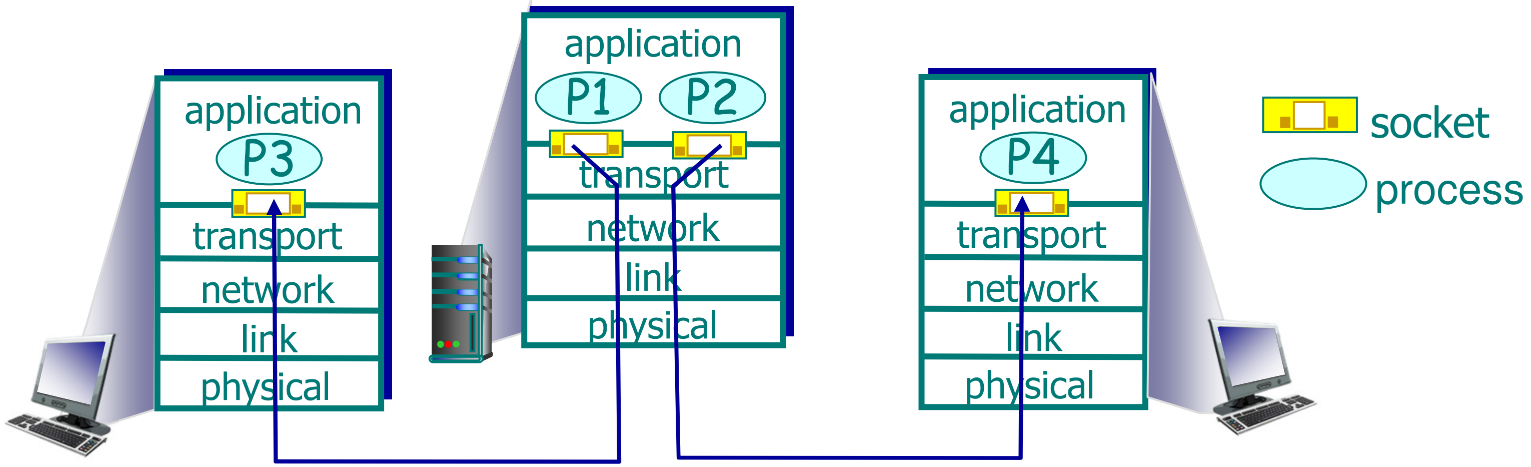
E. Sockets

- There are different types of application programs
- Using a common set of lower layer protocols in TCP/IP protocol suite, usually provided by OS
- Need a socket for such interaction
  - Analogy: Different electric appliances use the same electricity supply network via electric socket

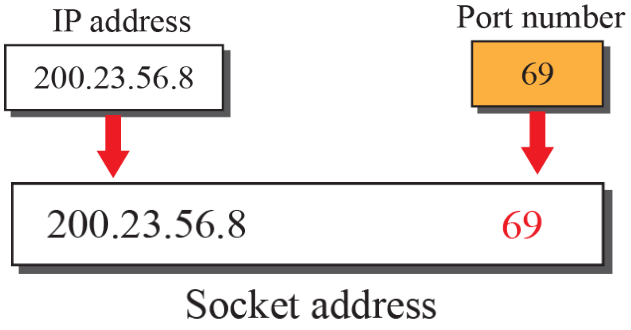


Socket Address

- A host can run multiple applications, each has a socket for communication.

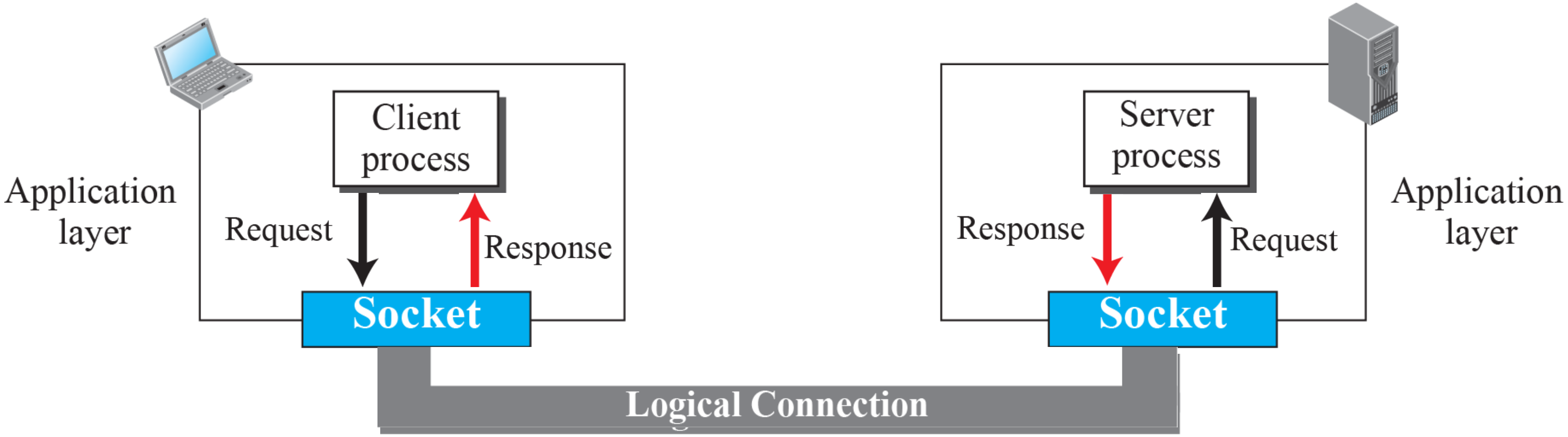


- The combination of an IP address and a port number is called a socket address.



Application programming interface (API)

- How can a client process communicate with a server process?
  - We need a set of instructions to tell the lowest four layers of the TCP/IP suite to
    - open the connection,
    - send and receive data from the other end, and
    - close the connection.
  - A set of instructions of this kind is normally referred to as an application programming interface (API).



Socket Programming

- A component of application design that involves network connection.
- Write programs to… *(refer to appendix for details)*
  - create socket depends on TCP or UDP is used
  - read and write data from the socket
  - perform necessary processing on the data
- Client initiates data transmission to a server.
- For server, the socket is always waiting (listening) for incoming data.

Summary

- Web: HTTP
  - Non-persistent (1.0) vs. persistent (1.1)
- File Transfer Protocol: FTP
  - Control and Data connection separated
- Email: SMTP, POP, IMAP
- Domain Name: DNS
  - Recursive vs. iterative resolution
- Sockets: Address, API

References

- Video on DNS
  - http://www.youtube.com/watch?v=ZBi8GCxk7NQ
- Video on IMAP vs POP
  - http://www.youtube.com/watch?v=BK4ng6Gcits
- Revision Quiz
  - http://highered.mheducation.com/sites/0073376221/student_view0/chapter26/quizzes.html