

- The semantics of the fields, that is, the meaning of the information in the fields
- Rules for determining when and how a process sends messages and responds to messages

Some application-layer protocols are specified in RFCs and are therefore in the public domain. For example, the Web's application-layer protocol, HTTP (the HyperText Transfer Protocol [RFC 2616]), is available as an RFC. If a browser developer follows the rules of the HTTP RFC, the browser will be able to retrieve Web pages from any Web server that has also followed the rules of the HTTP RFC. Many other application-layer protocols are proprietary and intentionally not available in the public domain. For example, Skype uses proprietary application-layer protocols.

It is important to distinguish between network applications and application-layer protocols. An application-layer protocol is only one piece of a network application (albeit, a very important piece of the application from our point of view!). Let's look at a couple of examples. The Web is a client-server application that allows users to obtain documents from Web servers on demand. The Web application consists of many components, including a standard for document formats (that is, HTML), Web browsers (for example, Firefox and Microsoft Internet Explorer), Web servers (for example, Apache and Microsoft servers), and an application-layer protocol. The Web's application-layer protocol, HTTP, defines the format and sequence of messages exchanged between browser and Web server. Thus, HTTP is only one piece (albeit, an important piece) of the Web application. As another example, an Internet e-mail application also has many components, including mail servers that house user mailboxes; mail clients (such as Microsoft Outlook) that allow users to read and create messages; a standard for defining the structure of an e-mail message; and application-layer protocols that define how messages are passed between servers, how messages are passed between servers and mail clients, and how the contents of message headers are to be interpreted. The principal application-layer protocol for electronic mail is SMTP (Simple Mail Transfer Protocol) [RFC 5321]. Thus, e-mail's principal application-layer protocol, SMTP, is only one piece (albeit, an important piece) of the e-mail application.

### 2.1.6 Network Applications Covered in This Book

New public domain and proprietary Internet applications are being developed every day. Rather than covering a large number of Internet applications in an encyclopedic manner, we have chosen to focus on a small number of applications that are both pervasive and important. In this chapter we discuss five important applications: the Web, file transfer, electronic mail, directory service, and P2P applications. We first discuss the Web, not only because it is an enormously popular application, but also because its application-layer protocol, HTTP, is straightforward and easy to understand. After covering the Web, we briefly examine FTP, because it provides a nice contrast to HTTP. We then discuss electronic mail, the Internet's first killer application. E-mail is more complex than the Web in the sense that it makes use of not one