Web-Based Projects that Rock the Class

Build Fully-Functional Web Apps and Learn Through Doing

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Christos Karayiannis

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For my children, Vasilis and Stamatia.

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About the Author

Christos Karayiannis has taught web development courses for more than 20 years in high schools and institutes of technology in Greece. He holds an MSc in computer science from the University of Wales and a physics degree from Aristotle University. His main interests are networking, operating systems, and programming. Christos has contributed to open source projects by documenting source code.

About the Technical Reviewer

François-Denis Gonthier is a graduate of the Université de Sherbrooke computer science program. He first worked for a startup company delivering cryptographic software using open source technologies. Since then, he has never strayed far from the Linux and open source world. He went from programming front ends in JavaScript and HTML 5.0 to coding back ends using Java, J2EE, JSF, or plain old Unix daemons. The cool Web 2.0 kids would call this being a *full-stack developer*. Nowadays, he mostly works on embedded Android projects and writes JavaScript running on Node.js in his spare time.

Acknowledgments

Writing this book would not have been possible without the contribution of the people of Apress. I would like to specially thank Louise Corrigan for entrusting me to turn an idea into this book, Nancy Chen and James Markham for their valuable advice and support, Francois-Denis Gonthier for providing his insightful comments, and finally Sathyamurthy Krishnan and Arockia Rajan for the proofreading of this book.

Introduction

This book includes several web-based projects. With each project you'll create a complete client-server application while learning about different aspects of web development. Each project includes detailed steps to build the software that executes on both the client and server sides. Introductory examples are also provided to highlight the techniques and programming concepts that are then used in the projects.

The projects are real-world web services that you would typically find on the Internet today. Here are a few examples:

- A site that pinpoints a visitor's location on a map and greets them in that country's native language
- An online WHOIS service
- A remote TCP port scan service
- A test service for displaying how a site is viewed remotely
- A dynamic content site where users can search with keywords and read online scientific papers, with a database automatically updated when new documents are inserted into a directory
- A project that implements web scraping techniques
- A site that use cookies to remember a visitor
- A site that uses sockets to connect to other Internet services, like QOTD
- A site that implements PHP sessions, where visitors log in with an encrypted password and while connected browse the site with access only to their own personal details

The techniques you'll learn while creating these services can be applied to your own future projects.

About the Tools and Source Code

Each chapter contains all the steps for installing and setting up the required software tools for the project being discussed. For instance, two different web servers are used in the book, along with a PHP interpreter and the MySQL database server. The book also explains how to set up a router, and it contains a DDNS guide that explains how to configure the projects for the Internet.

The software tools used in this book are free and don't require you to purchase API keys, such as when using a static map. The only exceptions are the steps for purchasing a second-level domain name and an SSL certificate; however, obtaining these is optional for running the corresponding projects.

I've tried to keep the source code to a minimum so that the projects can be completed within a time-constrained web development course. All the projects are original in that they were designed just for this book. You will not find the source code used anywhere on the Web or in other textbooks.

However, just because these projects were designed for a classroom setting does not mean they are not professional-grade quality. Anyone interested in the underlying mechanisms of modern web development can also use this book.

Let's get started with the projects so you can design and build your first online service, used in the classroom or in the real world!

CHAPTER 1

The Apache Web Server

Most people are familiar with using a web browser. Even when they use a new browser for the first time, they are capable of visiting a web page and navigating to other sites immediately. This is because browsers usually encompass all the same handy functionalities. For example, all browsers include an address bar at the top of the window, a history option, a favorites folder, and some navigation buttons.

Web servers, on the other hand, rarely look similar to each other. However, servers do share some common ground. In this book, you'll be using two different web servers, and you'll learn about the common features of both as well as the differences. In this chapter, you'll use the Apache web server, and in Chapter 5 you'll use another popular web server, Lighttpd.

Getting Started with Apache

The Apache web server is one of the most popular web servers today. This is because of how easy the administrative features are to use and because of its flexibility based on its modular design. Apache got its name in 1995 when the Apache Project started. The Apache Project was a collaboration of many programmers, and hence the source code required many *patches* (software fixes). Through software modules, Apache offers additional functionality that administrators can install. Because of these added components, Apache isn't by default a huge, monolithic piece of software.

Apache was one of the first servers to support virtual hosts (*vhosts*). This notion—also referred as *virtual servers* on other web servers like Cherokee—denotes the capability of a single web server to run multiple sites simultaneously that are differentiated either by the IP address, by the port number, or by the domain name used in the client request.

C. Karayiannis, *Web-Based Projects that Rock the Class*, https://doi.org/10.1007/978-1-4842-4463-0_1

Installing and Testing Apache

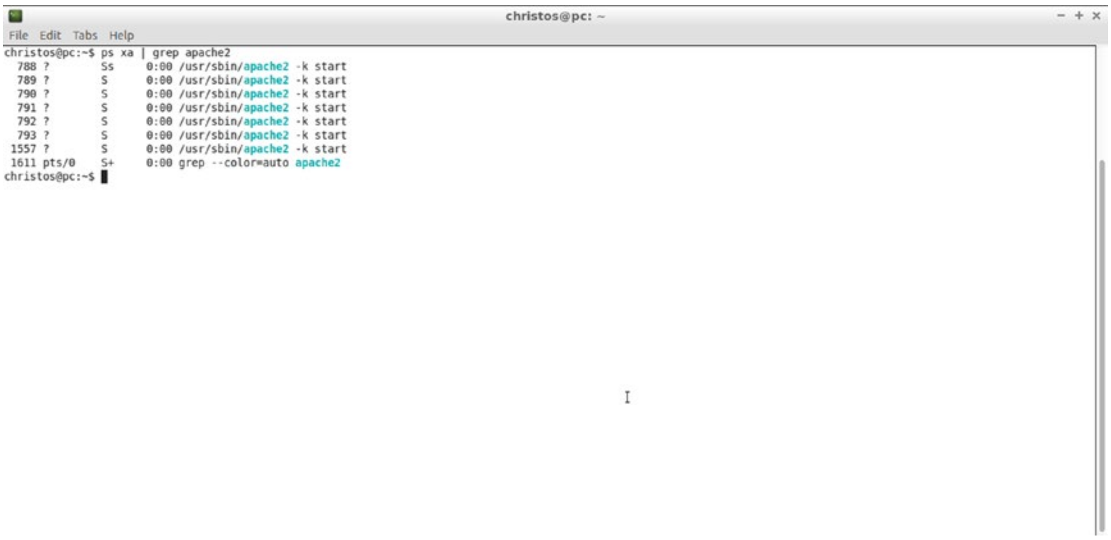
The Apache program is currently known as apache2, and you can download and install it from the Linux terminal using the following command:

```
$ sudo apt-get install apache2
```

The apache2 process starts running. Use the ps (process status) command from the Linux terminal to view the apache2 processes.

```
$ ps xa | grep apache2
```

More than one apache2 process is created instantly to be ready to serve further client requests. Figure 1-1 displays the process IDs (PIDs) for the Apache processes returned at this time by the command ps.



```
christos@pc:~$ ps xa | grep apache2
  788 ?        Ss     0:00 /usr/sbin/apache2 -k start
  789 ?        S      0:00 /usr/sbin/apache2 -k start
  790 ?        S      0:00 /usr/sbin/apache2 -k start
  791 ?        S      0:00 /usr/sbin/apache2 -k start
  792 ?        S      0:00 /usr/sbin/apache2 -k start
  793 ?        S      0:00 /usr/sbin/apache2 -k start
 1557 ?        S      0:00 /usr/sbin/apache2 -k start
 1611 pts/0    S+     0:00 grep --color=auto apache2
christos@pc:~$ 
```

Figure 1-1. *The command ps output lists the apache2 PIDs*

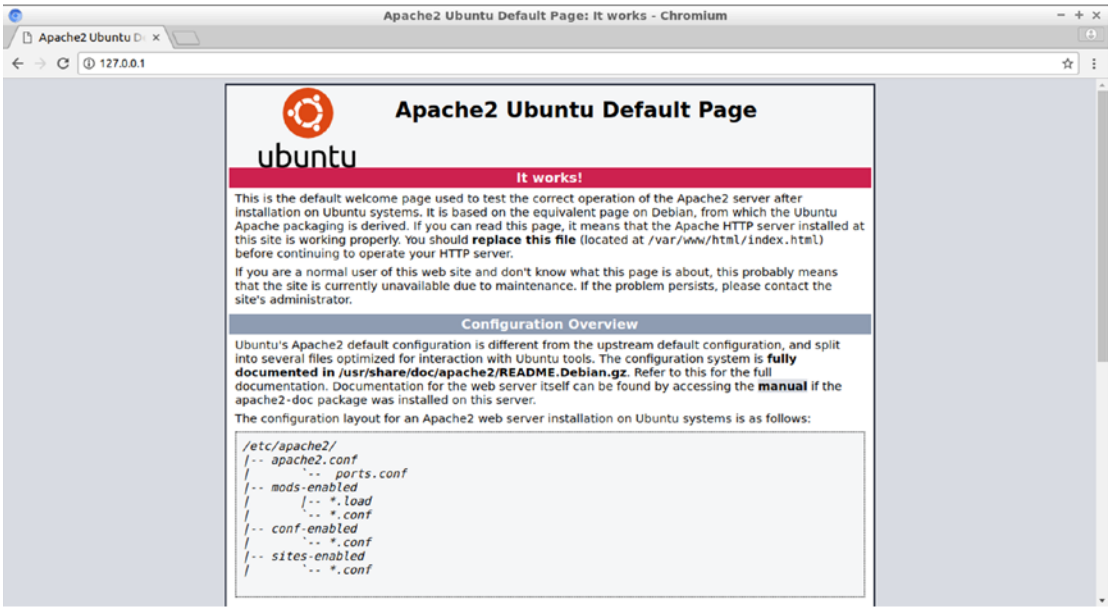
The web server is up and running and ready to dispatch the first page. In the address bar of your browser, enter the loopback IP address, which is the IP address your PC owns even if no network card is installed, or its corresponding host name. Here are some examples:

```
127.0.0.1
http://127.0.0.1
localhost
```

Apache responds by providing the directory index since no actual web page was specified in the URL.

Hint! A default page set for a specific directory is called the *directory index* for this directory. Also, the directory index for the document root (i.e., the base directory for a website) is the directory index of the site.

The directory index contents include a short introduction to the Apache configuration options. Figure 1-2 displays the Apache default page for Ubuntu.



Apache2 Ubuntu Default Page

It works!

This is the default welcome page used to test the correct operation of the Apache2 server after installation on Ubuntu systems. It is based on the equivalent page on Debian, from which the Ubuntu Apache packaging is derived. If you can read this page, it means that the Apache HTTP server installed at this site is working properly. You should **replace this file** (located at `/var/www/html/index.html`) before continuing to operate your HTTP server.

If you are a normal user of this web site and don't know what this page is about, this probably means that the site is currently unavailable due to maintenance. If the problem persists, please contact the site's administrator.

Configuration Overview

Ubuntu's Apache2 default configuration is different from the upstream default configuration, and split into several files optimized for interaction with Ubuntu tools. The configuration system is **fully documented in /usr/share/doc/apache2/README.Debian.gz**. Refer to this for the full documentation. Documentation for the web server itself can be found by accessing the **manual** if the apache2-doc package was installed on this server.

The configuration layout for an Apache2 web server installation on Ubuntu systems is as follows:

```
/etc/apache2/
|-- apache2.conf
|       `--  ports.conf
|-- mods-enabled
|       |-- *.load
|       `-- *.conf
|-- conf-enabled
|       `-- *.conf
|-- sites-enabled
|       `-- *.conf
```

Figure 1-2. *The Apache directory index for Ubuntu*

As the first section's title states, "It works!" The bad news is that so far it works only for users who use their own PC and are interested in just the Apache configuration. There is good news, though. Following the steps in the book, you can customize your web server with your preferences, and you can make your site available to the whole Internet.

Adding New Directories and Web Pages

By reading the web page's content, you can find out the document root and the file name of the directory index. The following text:

```
"You should replace this file (located at /var/www/html/index.html)"
```

indicates that this path is the document root:

```
/var/www/html/
```

and indicates that this file is the directory index:

```
index.html
```

From the Linux terminal, change the current working directory to `/var/www/html`, as shown here:

```
$ cd /var/www/html
```

Create a copy of `index.html` to use your own directory index.

```
$ sudo cp index.html index_OLD.html
```

Use a Linux text editor such as gedit to edit the original `index.html`, as shown here:

```
$ sudo gedit index.html
```

In the gedit window, enter your own HTML source code, for instance:

```
<!DOCTYPE html>
<html>
<head>
<title>Testing Apache</title>
</head>
<style>
p {
   font-size:24px;
   text-align:center;
   color:blue;
}
```

```
body{
background-color:yellow;
}
</style>
</head>
<body>
<p>Hello World!</p>
</body>
</html>
```

Click the Save button in the gedit window. Next enter the loopback IP address in the browser's address bar. As displayed in Figure 1-3, the Apache server displays your own web page.

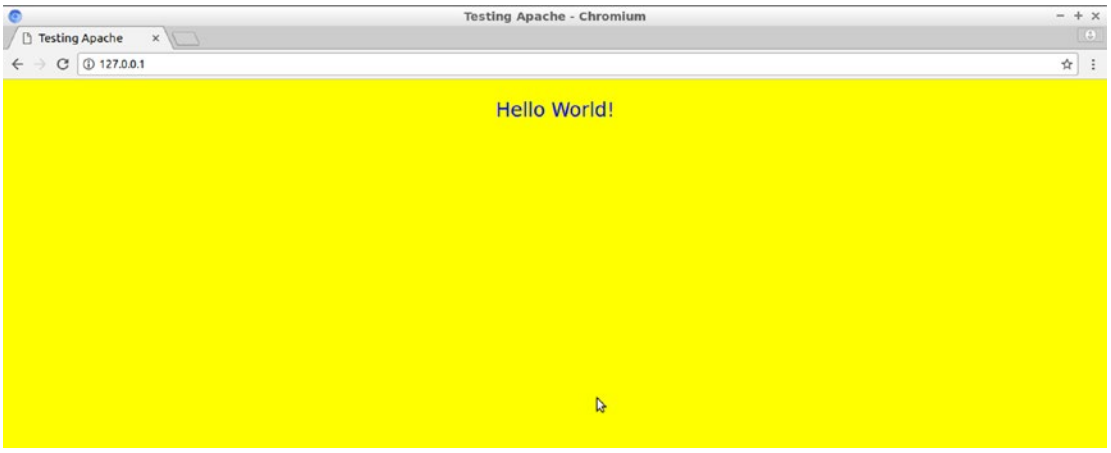
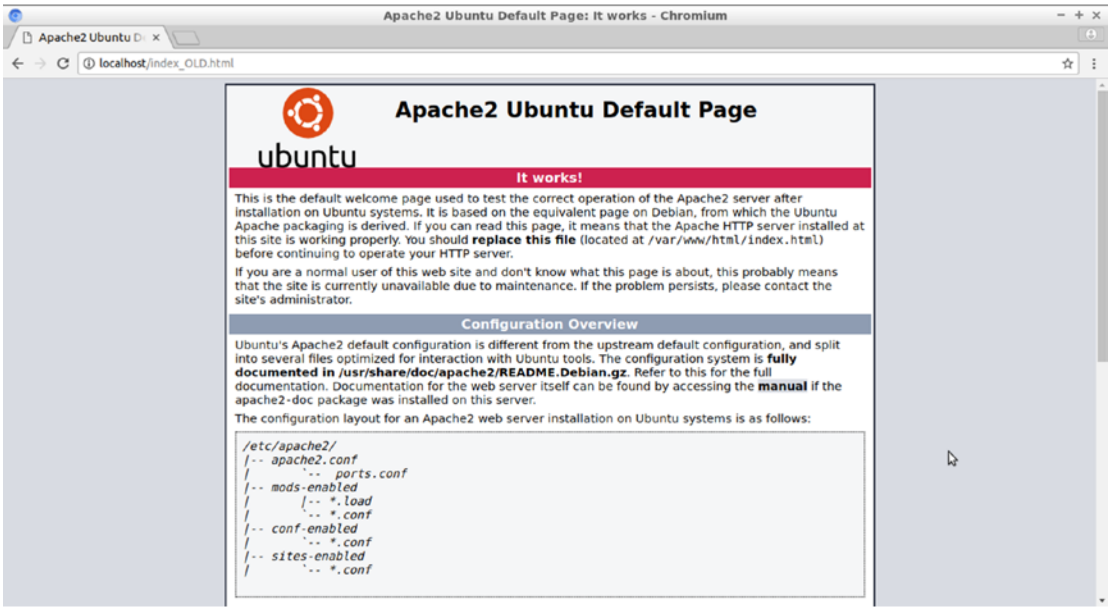


Figure 1-3. A customized directory index printing "Hello World!"

To request another web page, for instance `index_OLD.html`, you can provide the URL for the web page file by including the web page path starting from the document root. For instance, enter one of the following in the address bar of your browser:

```
127.0.0.1/index_OLD.html
localhost/index_OLD.html
```

Because `index_OLD.html` is in the document root, the path includes only the file name of the web page. By using this URL, the default web page of Apache for Ubuntu is displayed again, as shown in Figure 1-4.



Apache2 Ubuntu Default Page

It works!

This is the default welcome page used to test the correct operation of the Apache2 server after installation on Ubuntu systems. It is based on the equivalent page on Debian, from which the Ubuntu Apache packaging is derived. If you can read this page, it means that the Apache HTTP server installed at this site is working properly. You should **replace this file** (located at `/var/www/html/index.html`) before continuing to operate your HTTP server.

If you are a normal user of this web site and don't know what this page is about, this probably means that the site is currently unavailable due to maintenance. If the problem persists, please contact the site's administrator.

Configuration Overview

Ubuntu's Apache2 default configuration is different from the upstream default configuration, and split into several files optimized for interaction with Ubuntu tools. The configuration system is **fully documented in /usr/share/doc/apache2/README.Debian.gz**. Refer to this for the full documentation. Documentation for the web server itself can be found by accessing the **manual** if the apache2-doc package was installed on this server.

The configuration layout for an Apache2 web server installation on Ubuntu systems is as follows:

```
/etc/apache2/
|-- apache2.conf
|       `--  ports.conf
|-- mods-enabled
|       |-- *.load
|       `-- *.conf
|-- conf-enabled
|       `-- *.conf
|-- sites-enabled
|       `-- *.conf
```

Figure 1-4. *Downloading a specific web page by including its path in the URL*

Start including subdirectories in the document root to better organize your web site. At the Linux terminal, change the working directory to the document root.

```
$ cd /var/www/html/
```

Create a new `test` directory. In the new directory, create `test.html`, another HTML file.

```
$ sudo mkdir test
$ sudo gedit test/test.html
```

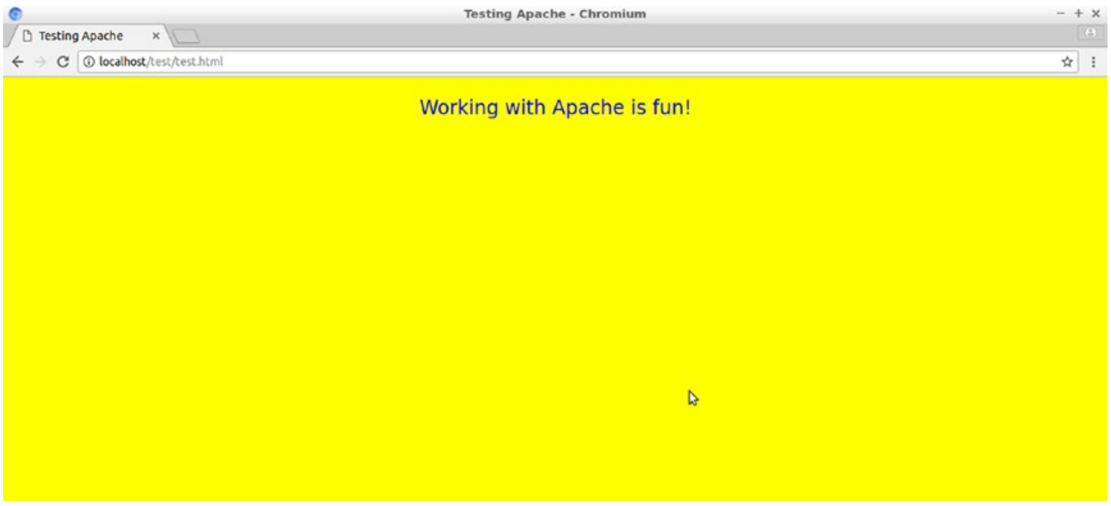
In the gedit window, enter some HTML source code for `test.html` and click the Save button. Then enter the file name path of the web page, excluding the document root, in the address bar of your browser. The file name path for `test.html` is as follows:

```
/var/www/html/test/test.html
```

You can omit the document root part since on the web server any file reference starts from the document root; therefore, the URL of `test.html` is as follows:

```
localhost/test/test.html
or 127.0.0.1/test/test.html
```

The web page is loaded in your browser, as displayed in Figure 1-5.



Working with Apache is fun!

Figure 1-5. *Testing a web page located in the document root subdirectory*

Testing Your Web Site from Another Computer of Your LAN

As another test, you can see whether Apache connects to other computers on the same local area network (LAN) as your PC. A connection between two workstations on the same LAN happens via the Internet layer of the TCP/IP protocol between their private IP addresses. The private IP addresses are valid only internally to the LAN. This is in contrast to public IP addresses that are globally accessible to the whole Internet. Put simply, all workstations in a LAN possess private IP addresses and are represented to the Internet with the public IP address of the LAN router (which also includes a private IP address for internal communication with the LAN workstations).

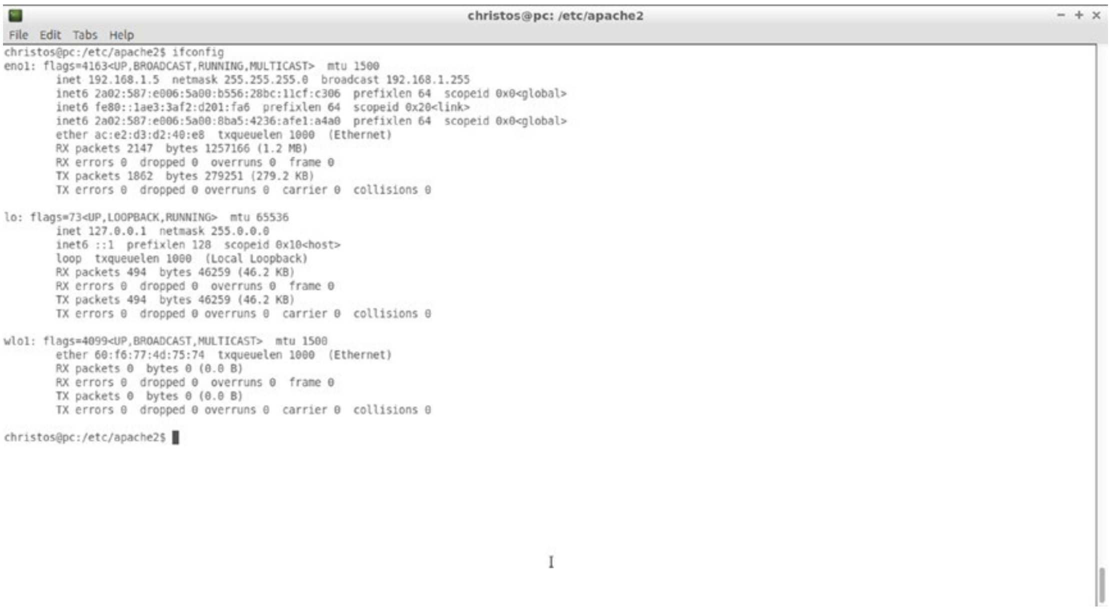
At the Linux terminal, use the `ifconfig` command to find out the private IP address of your computer.

```
$ ifconfig
```

You can also use the `hostname` command.

```
$ hostname -I
```

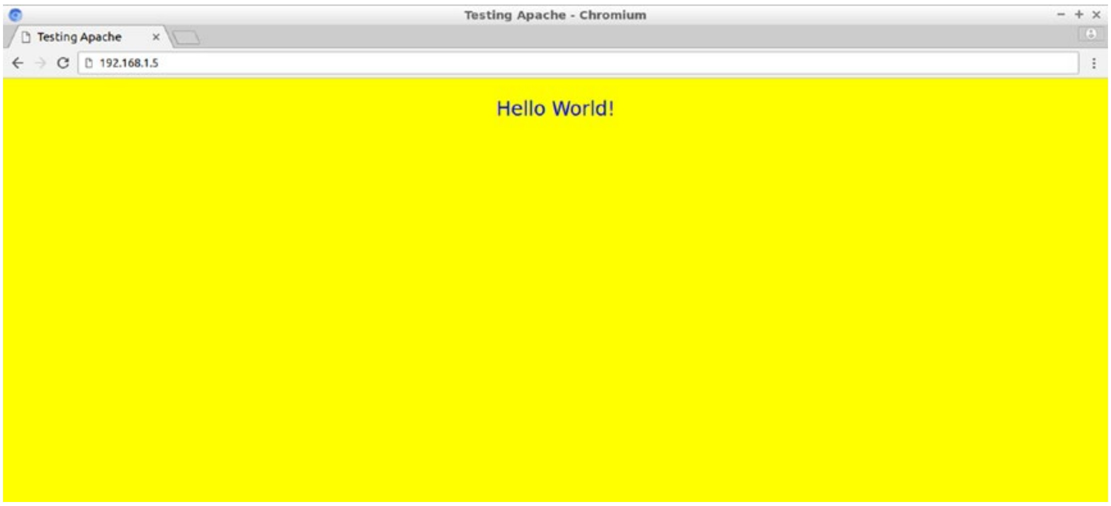
The private IP address of my computer used at the given time was 192.168.1.5, as shown in Figure 1-6.



```
christos@pc:/etc/apache2$ ifconfig
eno1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.1.5  netmask 255.255.255.0  broadcast 192.168.1.255
        inet6 2a02:587:e006:5a00:b556:28bc:11cf:c306  prefixlen 64  scopeid 0x0<global>
        inet6 fe80::1ae3:3af2:d201:fa6  prefixlen 64  scopeid 0x20<link>
        inet6 2a02:587:e006:5a00:8ba5:4236:afe1:a4a0  prefixlen 64  scopeid 0x0<global>
        ether ac:e2:d3:d2:40:e8  txqueuelen 1000  (Ethernet)
        RX packets 2147  bytes 1257166 (1.2 MB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 1862  bytes 279251 (279.2 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 494  bytes 46259 (46.2 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 494  bytes 46259 (46.2 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

wlo1: flags=4099<UP,BROADCAST,MULTICAST>  mtu 1500
        ether 60:f6:77:4d:75:74  txqueuelen 1000  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

christos@pc:/etc/apache2$ 
```

Figure 1-6. *ifconfig returning the private IP address*

Use the private IP address returned by `ifconfig` in the address bar of the local browser. The web page loads just like previously (with the loopback address), as shown in Figure 1-7.



Hello World!

Figure 1-7. *Testing the web server using a private IP address*

Next try the same IP address from another computer of your LAN. Figure 1-8 displays the browser used on a Windows 7 system in the same LAN.

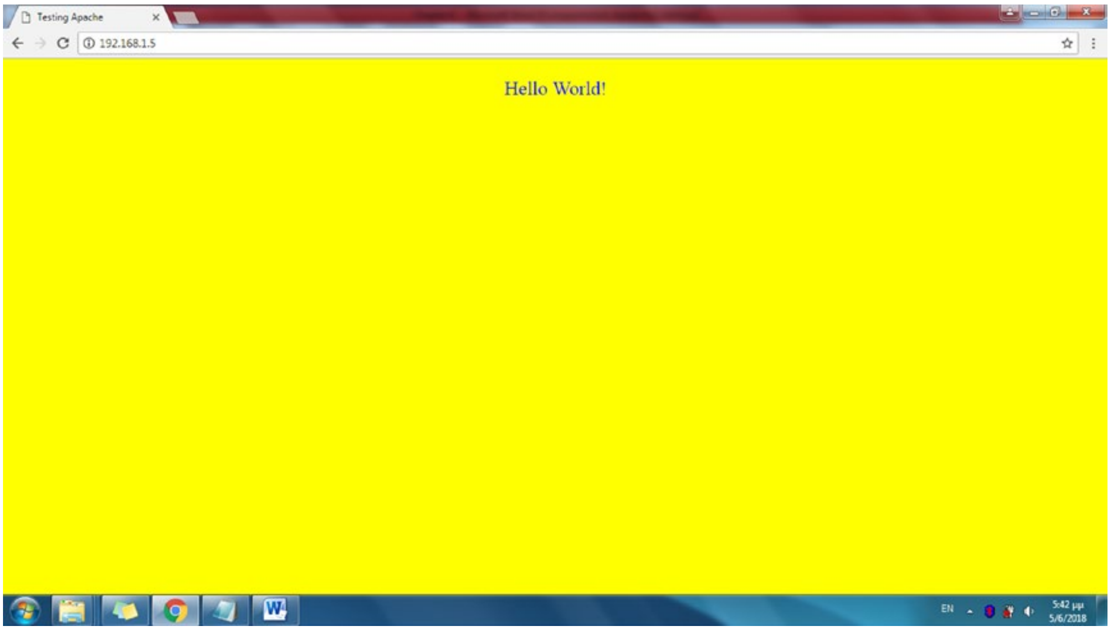


Figure 1-8. *Testing the web server from another PC of your LAN*

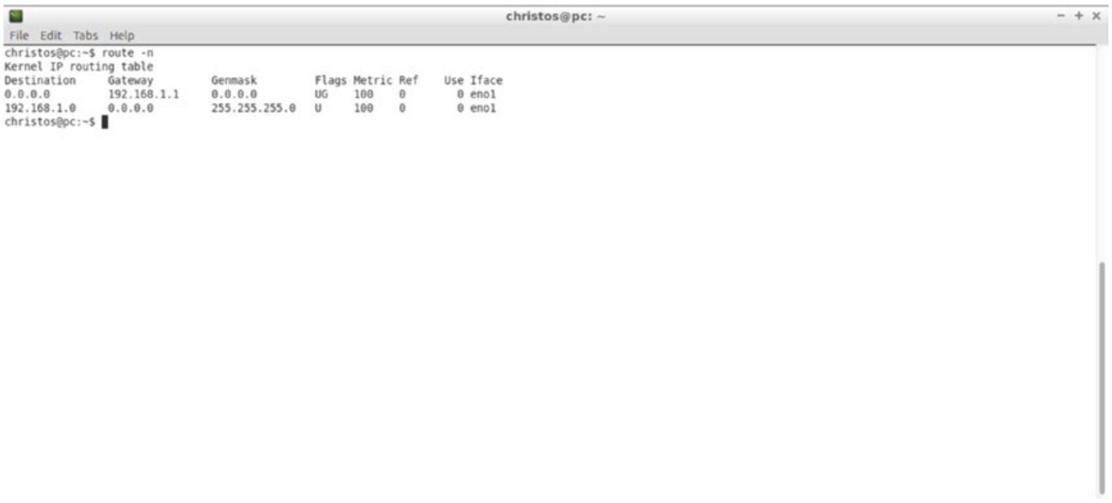
Providing a Static Private IP Address to the Web Server

The next step for the web server configuration is to set up a static private IP address. This is a private IP address that remains the same each time the computer that hosts your web server restarts. This step is optional to test your server from your LAN, but it is essential for making the server available to the whole Internet. To provide a static private IP address, the network connection of the computer that hosts the web server has to properly configured.

The most straightforward configuration for a workstation in a LAN is to obtain its IP address with the Dynamic Host Configuration Protocol (DHCP). When a PC is configured with the DHCP option, on startup it is assigned by the router with an IP address, a network mask, the IP address of the default gateway (the router itself), and the DNS server used for performing the translations between domain names and IP addresses. The drawback with DHCP is that your PC gets the next available IP address from an IP address pool, which may be a different address from the one obtained the previous time (a dynamic address).

Your other option is to use a static private IP address. Each time you start your PC, its IP address remains the same. A static IP address is mandatory for a server required to be available for connections across the Internet. To implement a static IP address, you have to configure manually the information previously retrieved by DHCP. Run first the `route` command from your terminal to find the default gateway (the router) in your LAN, as shown in Figure 1-9.

```
$ route -n
```



```
christos@pc:~$ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         192.168.1.1     0.0.0.0         UG    100    0        0 eno1
192.168.1.0     0.0.0.0         255.255.255.0   U     100    0        0 eno1
christos@pc:~$
```

Figure 1-9. *The route command returns the default gateway IP address*

The IP address for the gateway (the router) is therefore 192.168.1.1.

Run `ifconfig` again to gather information about the current IP address and the mask.

As you saw in Figure 1-6 earlier in the chapter, the IP address for the web server is currently 192.168.1.5 with a netmask of 255.255.255.0. The nonzero part of the netmask describes the part of the IP address that corresponds to the network, while the zero describes the part that corresponds to the computer in that network. By logical ANDing the IP address and its netmask, you get the network address.

The LAN in this example therefore has the IP address 192.168.1.0. This leaves the last byte to represent the computer in the network. This is therefore the byte that you will change to choose the static IP address for the web server. You can select any unused value from 1 to 254. For instance, for the value 100, you get the IP address 192.168.1.100.

With the information collected, click the Wired Network icon on your desktop and then click Next. Alternatively, select System Settings ➤ Network ➤ Wired or Settings ➤ Preferences ➤ Network Connections depending on your Ubuntu version. In the Network Connections window that appears, as shown in Figure 1-10, double-click "Wired connection 1" (or the option with a similar name in the Ethernet list).

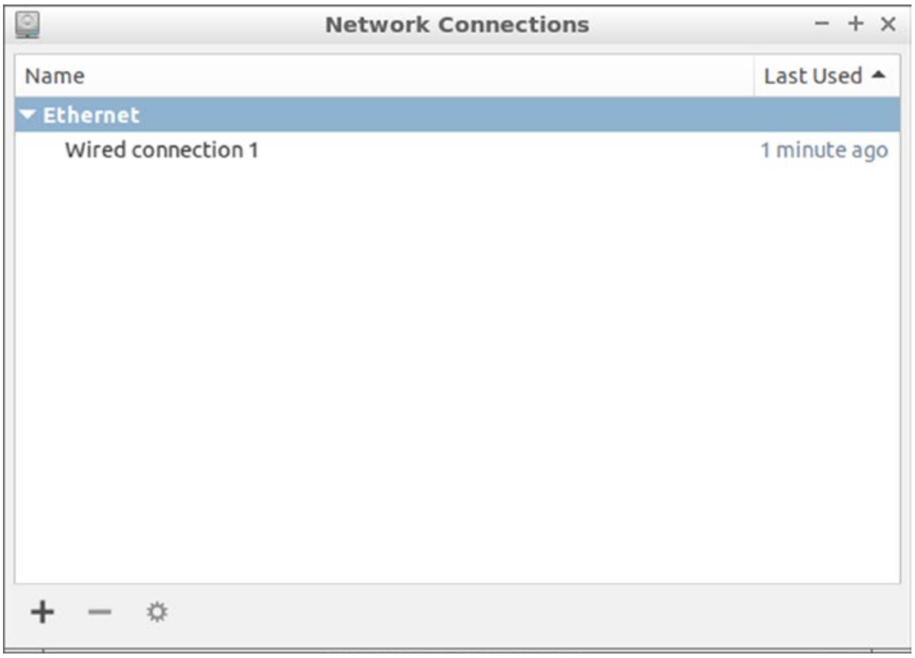


Figure 1-10. *The Network Connections window*

The "Editing Wired connection 1" window that appears next provides the IPv4 Settings and IPv6 Settings tabs for configuring IPv4 and IPv6 addresses, respectively (Figure 1-11).

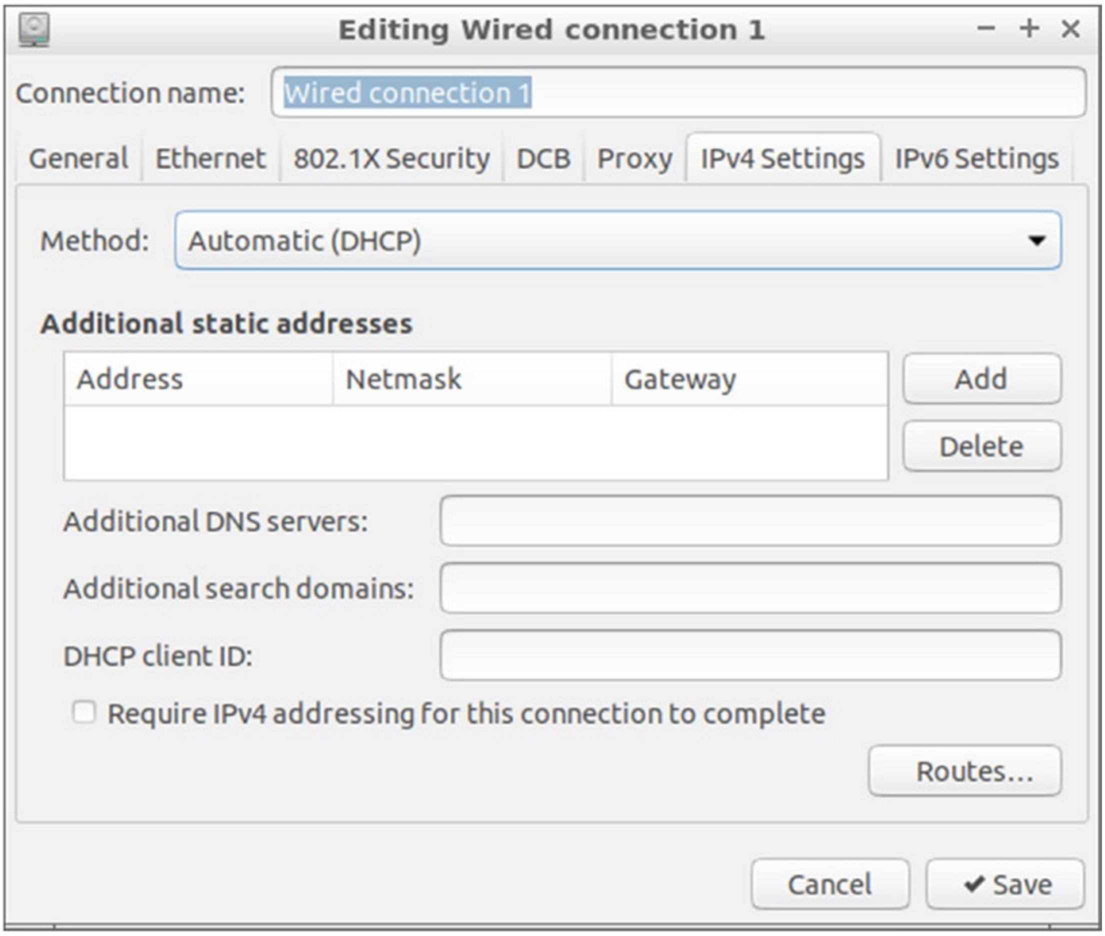
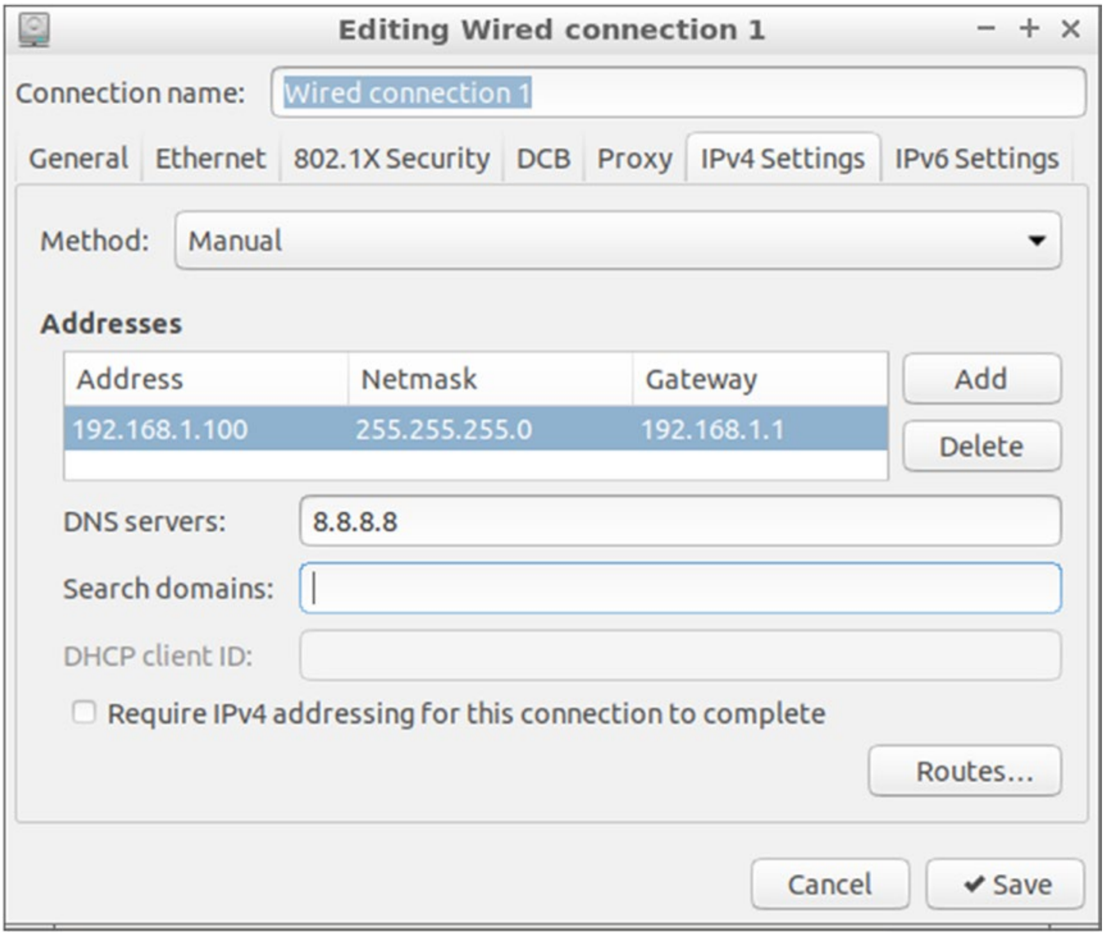


Figure 1-11. *The "Editing Wired connection 1" window*

On the IPv4 Settings tab, the method currently selected is Automatic (DHCP). Deselect this option and select instead Manual from the Method list (Figure 1-12).


Editing Wired connection 1

Connection name: Wired connection 1

Method: Manual

Addresses

Address	Netmask	Gateway
192.168.1.100	255.255.255.0	192.168.1.1

DNS servers: 8.8.8.8

Search domains:

DHCP client ID:

☐ Require IPv4 addressing for this connection to complete

Figure 1-12. *Applying the Manual method for configuring the IPv4 settings*

Click the Add button to complete the required fields for manually setting the connection parameters. Under Address, enter your preferred IP address. For the given LAN with the IP address 192.168.1.0, you could enter, for instance, **192.168.1.100** as the new static IP address for the web server. Enter also the value for the netmask, **255.255.255.0**, for the Netmask option, and enter the IP address of the router, **192.168.1.1** in this example, for the Gateway option. You need also to provide the IP address (or addresses) for a DNS server in the "DNS servers" field. If you enter more than one IP address, separate them using commas. For the DNS server, you can use the IP address of the DNS server suggested by your Internet service provider (ISP) or use the IP address of a freely available DNS server like Google's 8.8.8.8.

Click the Save button to confirm the new settings. To activate the new IP address, click the Network Manager icon and select Disconnect; then click again and select "Wired connection 1" or enter the following at the Linux terminal:

```
$ sudo service network-manager restart
```

You can try now the static IP address of your web server by entering it in the address bar of a browser and running it from another PC in your LAN, as indicated in Figure 1-13.

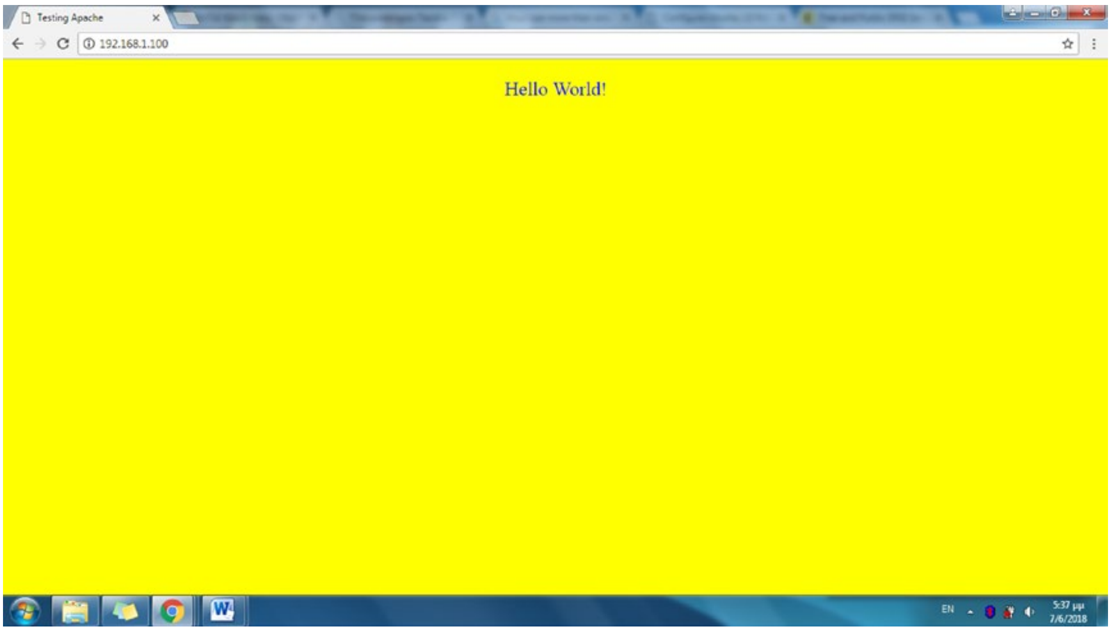


Figure 1-13. *Testing the web server by using its static IP address*

In the following section, you can configure your Linux firewall to block connections for all port numbers except the ones set by you.

Using the Linux Firewall

You should be able to view your web page on another PC in your LAN without a problem. However, if a firewall is enabled in your system, you will get the error message "This site can't be reached" or a similar one in your browser. (A *firewall* is an application that checks the connections to your system and permits or bans them according to the rules that you set.)

In the system I used in the previous section, the pre-installed Ubuntu Linux firewall (ufw) was disabled by default. To disable it, you can use this command:

```
$ sudo ufw disable
```

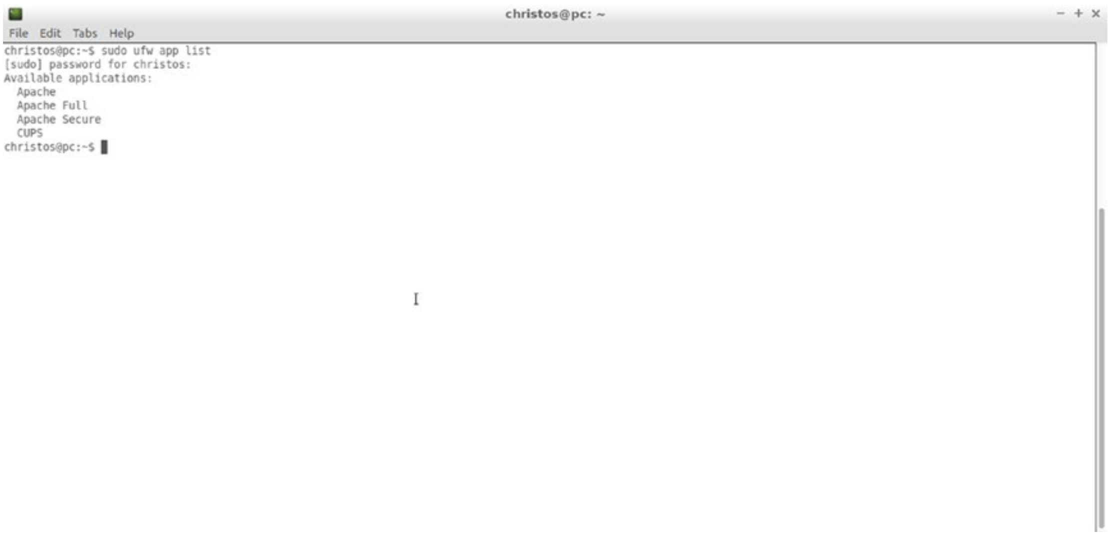
Now try to connect and see if you get the error message. You can then restore it using the following command:

```
$ sudo ufw enable
```

To allow the Apache server to receive connections while a firewall is on, you can specify the appropriate rules. Apache, trying to make your work easy, has already set the basic rules for you when it was installed on your system. At the command line, enter the following:

```
$ sudo ufw app list
```

The command's output includes the ufw profiles for Apache shown in Figure 1-14.



```
christos@pc:~$ sudo ufw app list
[sudo] password for christos:
Available applications:
  Apache
  Apache Full
  Apache Secure
  CUPS
christos@pc:~$
```

Figure 1-14. *Listing the ufw profiles*

- Profile Apache is for the default HTTP port 80.
- Profile Apache Full is for both ports80 and 443.
- Profile Apache Secure is for the default HTTPS port 443.

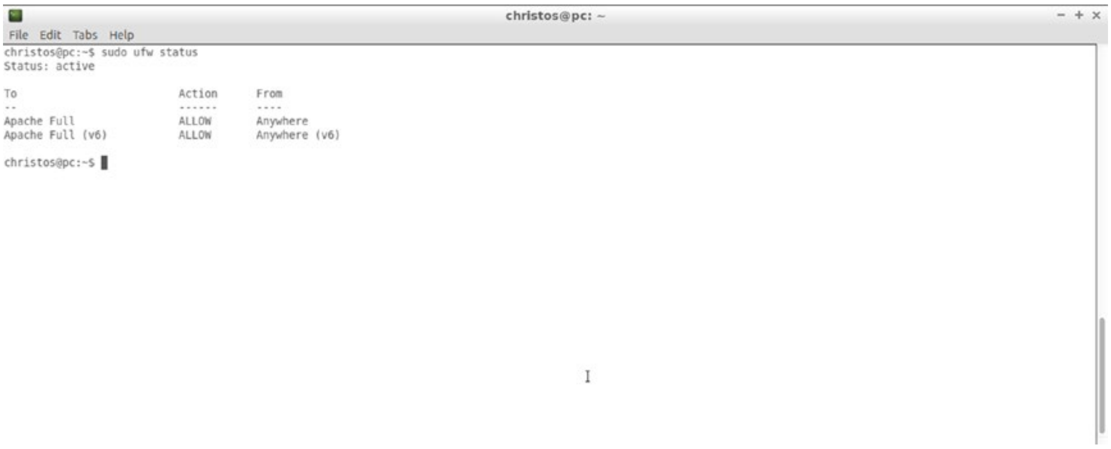
To allow incoming traffic for the Apache Full profile, enter the following at the Linux terminal:

```
$ sudo ufw allow 'Apache Full'
```

To verify this, enter the following:

```
$ sudo ufw status
```

The command's output is shown in Figure 1-15.



```
christos@pc:~$ sudo ufw status
Status: active

To                         Action      From
--                         ------      ----
Apache Full                ALLOW       Anywhere
Apache Full (v6)           ALLOW       Anywhere (v6)

christos@pc:~$
```

Figure 1-15. *Displaying the status of the ufw firewall with the Apache Full profile set*

An even better way to verify this is to connect to the Apache web server from another PC in your LAN. The web page should load as usual.

Managing the Apache Process

To apply new configuration rules while Apache runs and also to start and stop the Apache process (required, for instance, when you want to try other web servers), you need to run a few commands from the Linux terminal.

To stop your web server, enter the following at the command line:

```
$ sudo systemctl stop apache2
Or use:
$ sudo service apache2 stop
```

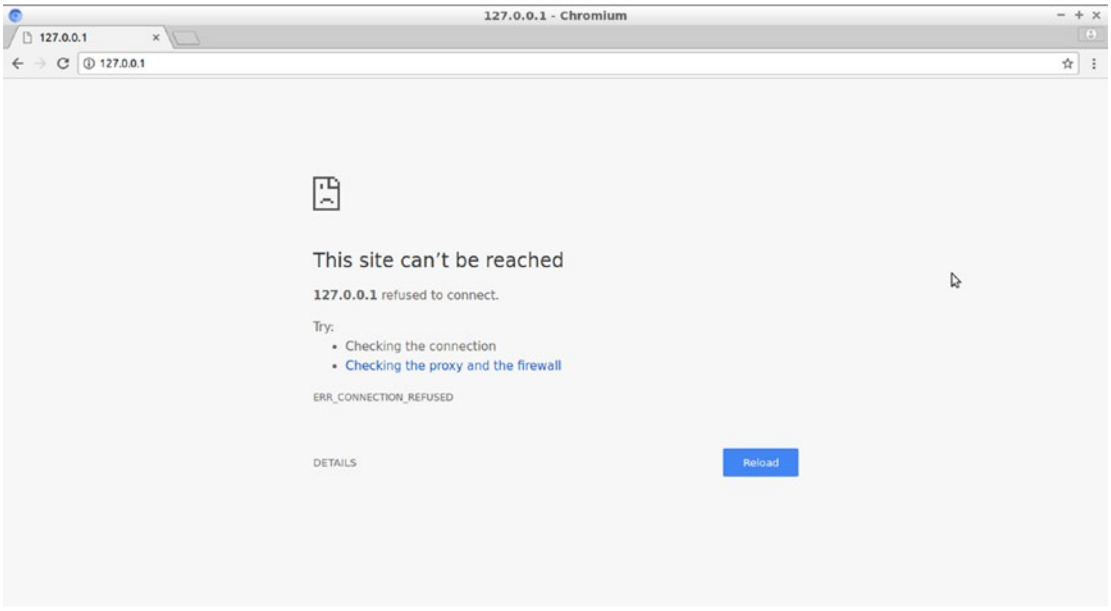
To start the Apache web server when it is already stopped, enter the following:

```
$sudo systemctl start apache2
Or use:
$ sudo service apache2 start
```

Do the following experiment to implement the previous commands. First run the following to view the apache2 processes:

```
$ ps xa | grep apache2
```

Then use the `systemctl stop` command and run the `ps` command again. You'll find that the apache2 processes have been "killed." You can also try a request from your browser. You'll find that the message "The site can't be reached" appears, as viewed in Figure 1-16.



This site can't be reached

127.0.0.1 refused to connect.

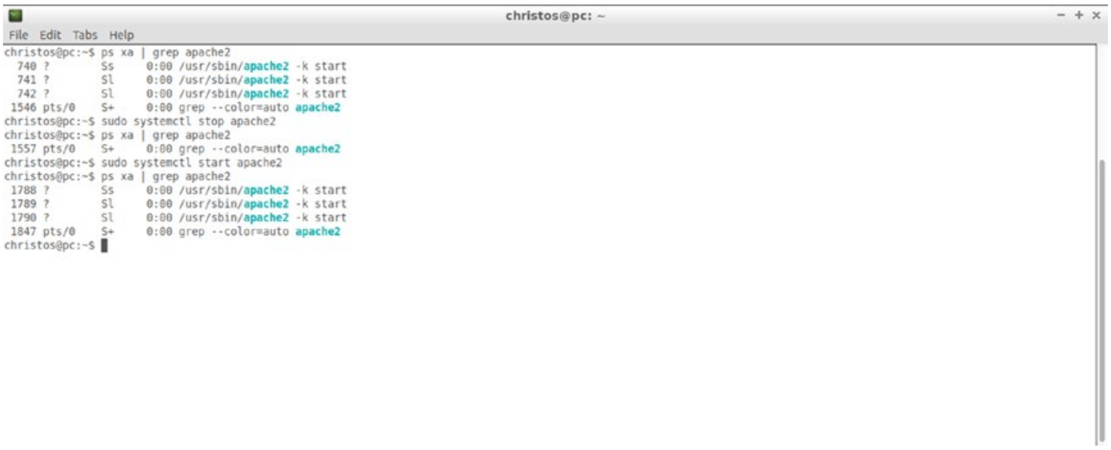
Try:
- Checking the connection
- Checking the proxy and the firewall

ERR_CONNECTION_REFUSED

***Figure 1-16.** Trying to download a web page with the Apache server stopped*

Use the `systemctl start` command to restore the Apache server.

Figure 1-17 shows the previous commands.



```
christos@pc:~$ ps xa | grep apache2
  740 ?        Ss     0:00 /usr/sbin/apache2 -k start
  741 ?        Sl     0:00 /usr/sbin/apache2 -k start
  742 ?        Sl     0:00 /usr/sbin/apache2 -k start
 1546 pts/0    S+     0:00 grep --color=auto apache2
christos@pc:~$ sudo systemctl stop apache2
christos@pc:~$ ps xa | grep apache2
 1557 pts/0    S+     0:00 grep --color=auto apache2
christos@pc:~$ sudo systemctl start apache2
christos@pc:~$ ps xa | grep apache2
 1788 ?        Ss     0:00 /usr/sbin/apache2 -k start
 1789 ?        Sl     0:00 /usr/sbin/apache2 -k start
 1790 ?        Sl     0:00 /usr/sbin/apache2 -k start
 1847 pts/0    S+     0:00 grep --color=auto apache2
christos@pc:~$ 
```

Figure 1-17. *Displaying the Apache PIDs when the server runs and the absence of Apache PIDs when the server stops*

To stop and then start the Apache server again, enter the following:

```
$ sudo systemctl restart apache2
```

To reload Apache (that is, to retain the process running and just update the configuration), enter the following:

```
$ sudo systemctl reload apache2
```

or you can enter the following:

```
$ sudo service apache2 force-reload
which is equal to the the following:
$ sudo service apache2 reload
```

The Apache server starts by default when the system boots. To disable that configuration, enter the following:

```
$ sudo systemctl disable apache2
```

To make Apache start on system boot, enter the following:

```
$ sudo systemctl enable apache2
```

Working with Virtual Hosts

Virtual hosts (vhosts) or virtual servers enable a web server to host multiple sites simultaneously. Vhosts fall into one of the following categories:

- IP-based virtual hosts, where each vhost is dedicated to a site that makes use of a specific IP address from the web server IP addresses
- Port-based virtual hosts, where each vhost listens on a different port number for each site it hosts
- Name-based virtual hosts, where each vhost is dedicated to a site with a specific domain name

An Apache configuration can mix all these categories and also include a default host.

The initial Apache configuration file is called `000-default.conf` and is found in the `/etc/apache2/sites-available` directory. Apache requires a new configuration file to have a `.conf` file extension. At the Linux terminal, change the working directory to `sites-available`, which is the Apache directory that contains the configuration files.

```
$ cd /etc/apache2/sites-available
```

Open the default configuration file `000-default.conf` with the command `cat`, as shown here:

```
$ cat 000-default.conf
```

The file opens in a new window. The file contents are as follows:

```
<VirtualHost *:80>
      # The ServerName directive sets the request scheme, hostname and port
        that
      # the server uses to identify itself. This is used when creating
      # redirection URLs. In the context of virtual hosts, the ServerName
      # specifies what hostname must appear in the request's Host: header
        to match this virtual host. For the default virtual host (this
        file) this value is not decisive as it is used as a last resort
        host regardless.
        # However, you must set it for any further virtual host explicitly.
        #ServerName www.example.com

        ServerAdmin webmaster@localhost
        DocumentRoot /var/www/html

        # Available loglevels: trace8, ..., trace1, debug, info, notice, warn,
        # error, crit, alert, emerg.
        # It is also possible to configure the loglevel for particular
        # modules, e.g.
        #LogLevel info ssl:warn

        ErrorLog ${APACHE_LOG_DIR}/error.log
        CustomLog ${APACHE_LOG_DIR}/access.log combined

        # For most configuration files from conf-available/, which are
        # enabled or disabled at a global level, it is possible to
        # include a line for only one particular virtual host. For example the
        # following line enables the CGI configuration for this host only
        # after it has been globally disabled with "a2disconf".
        #Include conf-available/serve-cgi-bin.conf
</VirtualHost>

# vim: syntax=apache ts=4 sw=4 sts=4 sr noet
```

Each Apache configuration file includes three kinds of entries.

- Directives that define the behavior of the web server
- Containers, such as `VirtualHost`, that define blocks of directives for a vhost
- Comments, starting with a hash (#), that provide some aid in the usage of the directives

Container `<VirtualHost *:80>` pairs with `</VirtualHost>` just like an HTML start and end tag. The `VirtualHost` pair encloses all directives for the specific vhost and also defines the IP address and port number to which the given vhost should respond. In this configuration file, the asterisk (*) corresponds to any IP address, and 80 corresponds to port 80, which is the default port for the HTTP protocol. You already tested this configuration in the previous sections when one of the following IP addresses was used in the address bar of your browser to download the directory index:

```
127.0.0.1
192.168.1.100
```

Both addresses succeeded because the configuration accepted any valid IP address for this server. In the following section, you will create two different vhosts, each one serving a different IP address.

Using IP-Based Virtual Hosts

In this section, you'll create a new configuration file with gedit to implement two IP-based vhosts using the directives contained between the start/end `VirtualHost` containers. One vhost will be responsible for the loopback IP address, 127.0.0.1, and the other will be responsible for the private IP address of the web server, 192.168.1.100, both listening on port 80. The pair of IP address and port number for each vhost is indicated in the `VirtualHost` container. For instance, `<VirtualHost 127.0.0.1:80>` indicates the loopback IP address 127.0.0.1, and 80 is the default port number for the HTTP protocol. You can provide a different directory index to each vhost, such as `index1.html` for the first and `index2.html` for the second, using the `DirectoryIndex` directive. You can leave the other directives with their default values from the `000-default.conf` file.

At the Linux terminal, change the working directory to `sites-available` and use gedit to create the file `example1.conf`.

```
$ cd /etc/apache2/sites-available
$ sudo gedit example1.conf
```

Enter the following configuration rules and save the file:

```
# 1st vhost
<VirtualHost 127.0.0.1:80>
      ServerAdmin webmaster@localhost
      DocumentRoot /var/www/html
      DirectoryIndex index1.html
      ErrorLog ${APACHE_LOG_DIR}/error.log
      CustomLog ${APACHE_LOG_DIR}/access.log combined
</VirtualHost>

# 2nd vhost
<VirtualHost 192.168.1.100:80>
      ServerAdmin webmaster@localhost
      DocumentRoot /var/www/html
      DirectoryIndex index2.html
      ErrorLog ${APACHE_LOG_DIR}/error.log
      CustomLog ${APACHE_LOG_DIR}/access.log combined
</VirtualHost>
```

Next you need to enable the new configuration using the `a2ensite` (apache2 enable site) command. At the Linux terminal, enter the following:

```
$ sudo a2ensite example1.conf
```

Or simply enter this:

```
$ sudo a2ensite example1
```

To enable the new Apache configuration, you need also to reload the web server.

```
$ sudo service apache2 force-reload
```

Create two web pages in the document root directory that will serve as the directory indexes for the two vhosts.

```
$ cd /var/www/html
$ sudo gedit index1.html
```

Enter the following HTML source code:

```
<!DOCTYPE html>
<html>
<head>
<title>Testing the Apache Web Server</title>
```

```
<style>
   body {
        background-color:lightblue;
        }
   p {
   background-color:red;
   font-size:20px;
   }
</style>
</head>
<body>
<p>Hello from 127.0.0.1</p>
</body>
</html>
```

In `/var/www/html`, create a web page called `index2.html` to be used as the directory index for the second vhost. Use the following HTML source code:

```
<!DOCTYPE html>
<html>
<head>
<title>Testing the Apache Web Server</title>
<style>
   body {
        background-color:red;
        }
   p {
   background-color:lightblue;
   font-size:20px;
   }
</style>
</head>
<body>
<p>Hello from 192.168.1.100</p>
</body>
</html>
```

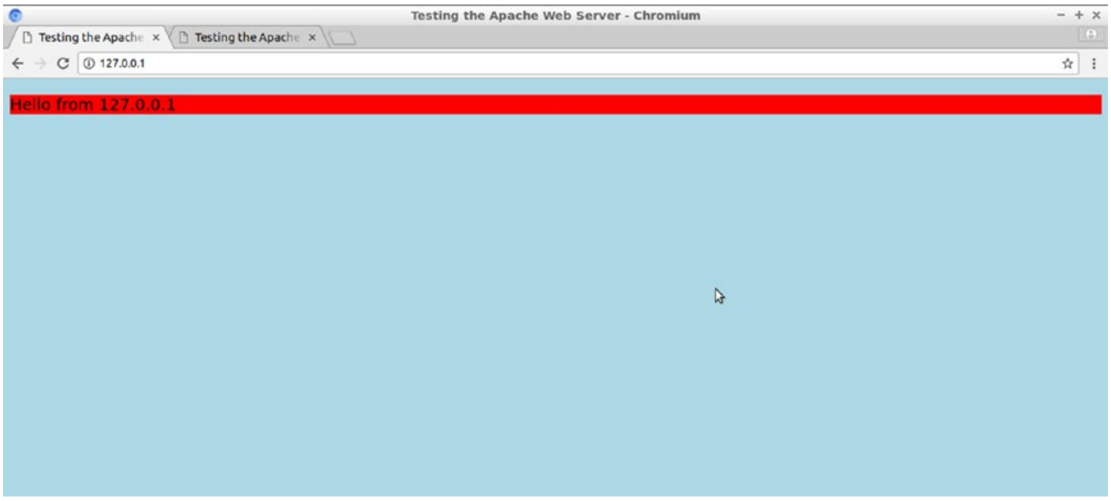
Open two tabs in your browser. On the first, enter the following address in the address bar:

```
127.0.0.1
```

On the second tab, enter the following address in the address bar:

```
192.168.1.100
```

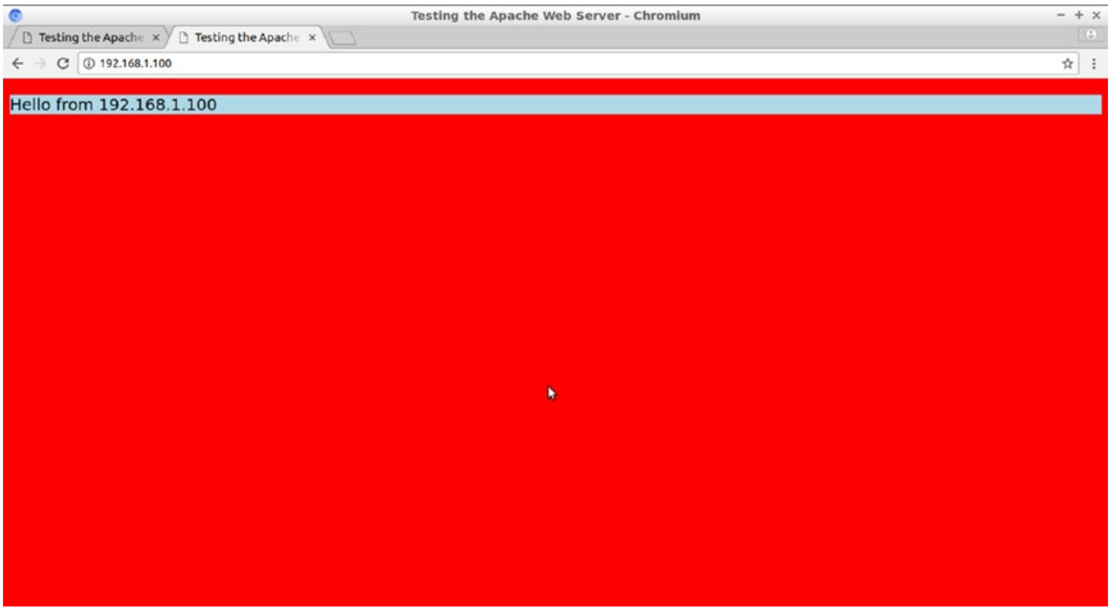
With the current configuration, Apache displays different content for each request. The first request, with the IP address 127.0.0.1, resolves to `index1.html` (Figure 1-18).



Hello from 127.0.0.1

Figure 1-18. *Testing the first IP-based vhost*

The second request with IP address 192.168.1.100 resolves to `index2.html` (Figure 1-19).



Hello from 192.168.1.100

Figure 1-19. *Testing the second IP-based vhost*

Next you'll look at a similar example, this time using port-based virtual hosts.

Using Port-Based Virtual Hosts

The configuration used next will create two virtual hosts that listen on different ports, for instance port 8080 and port 8181. When anything other than the default port number for the HTTP protocol, port 80, is used, the port is required to be appended to the URL with a colon (:). Here's an instance:

```
192.168.1.100:8080
```

Using a different port than the default one makes the URL a bit more complicated, but that is not really a problem when you implement a DDNS service (see Chapter 4) that hides this complexity from the user.

In the `sites-available` directory, create a new configuration file.

```
$ cd /etc/apache2/sites-available
$ sudo gedit example2.conf
```

In the file `example2.conf`, enter the following directives to direct the server to include port numbers 8080 and 8181 in the list of the listening ports:

```
Listen 8080
Listen 8181
```

To create a vhost that listens on port 8080 on any IP address of the server, you can use the asterisk notation in the `VirtualHost` container as `<VirtualHost *:8080>`. Similarly, for the vhost that listens on port 8181, also on any IP address of the server, use the `<VirtualHost *:8181>` container. The complete listing of `example2.conf` is as follows:

```
Listen 8080
Listen 8181
# 1st vhost
<VirtualHost *:8080>
      ServerAdmin webmaster@localhost
      DocumentRoot /var/www/html
      DirectoryIndex index3.html
      ErrorLog ${APACHE_LOG_DIR}/error.log
      CustomLog ${APACHE_LOG_DIR}/access.log combined
</VirtualHost>

# 2nd vhost
<VirtualHost *:8181>
      ServerAdmin webmaster@localhost
      DocumentRoot /var/www/html
      DirectoryIndex index4.html
      ErrorLog ${APACHE_LOG_DIR}/error.log
      CustomLog ${APACHE_LOG_DIR}/access.log combined
</VirtualHost>
```

Save the new configuration file and enable it using the `a2ensite` command. Type the following:

```
$ sudo a2ensite example2.conf
```

or simply type the following:

```
$ sudo a2ensite example2
```

To enable the new Apache configuration, you also need to reload the web server.

```
$ sudo service apache2 force-reload
```

Sometimes the same configuration rules apply to different sites, causing unpredictable results. If you have to work on sites with conflicting rules, then you have to disable one of the sites. To disable, for instance, `example1`, use the `a2dissite` (apache2 disable site) command, as shown here:

```
$ sudo a2dissite example1
```

To have two new port numbers that the server will listen to, you need to set up ufw to permit connections for those port numbers. At the Linux command line, type the following:

```
$ sudo ufw allow 8080
$ sudo ufw allow 8181
```

Create at the document root the two directory indexes, `index3.html` and `index4.html`, and refer to them in the `example2.conf` file. These indexes are for the vhosts that listen on port 8080 and on port 8181, respectively.

```
$ cd /var/www/html
$ sudo gedit index3.html
```

In the gedit window that appears, enter the following HTML source code:

```
<!DOCTYPE html>
<html>
<head>
<title>Testing the Apache Web Server</title>
<style>
   body {
        background-color:red;
        }
   p {
   background-color:lightblue;
   font-size:20px;
   }
</style>
</head>
```

```
<body>
<p>Hello from 8080</p>
</body>
</html>
```

Next, in the document root directory, add the following HTML source code to `index4.html`:

```
<!DOCTYPE html>
<html>
<head>
<title>Testing the Apache Web Server</title>
<style>
   body {
        background-color:lightblue;
        }
   p {
   background-color:red;
   font-size:20px;
   }
</style>
</head>
<body>
<p>Hello from 8181</p>
</body>
</html>
```

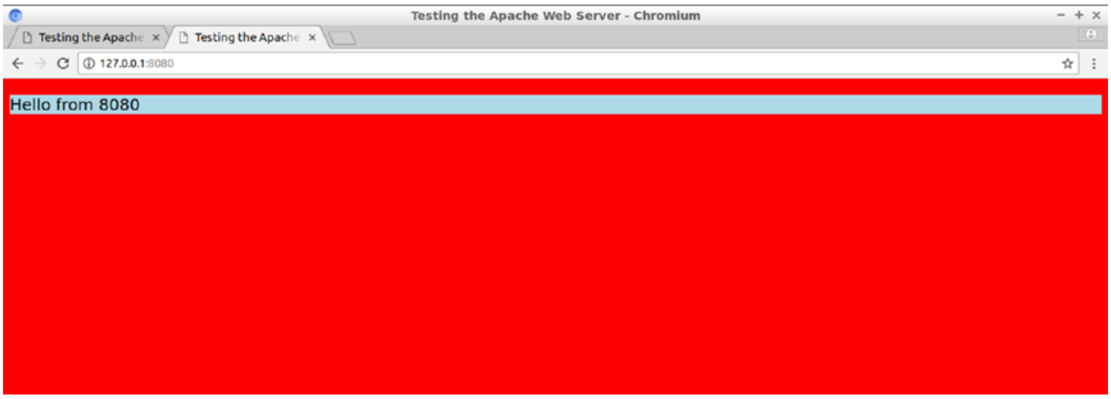
To test the new vhosts, open two tabs in your browser. On the first tab, enter the following in the address bar:

```
127.0.0.1:8080
```

or enter the following:

```
192.168.1.100:8080
```

The directory index `index3.html` is displayed (Figure 1-20).



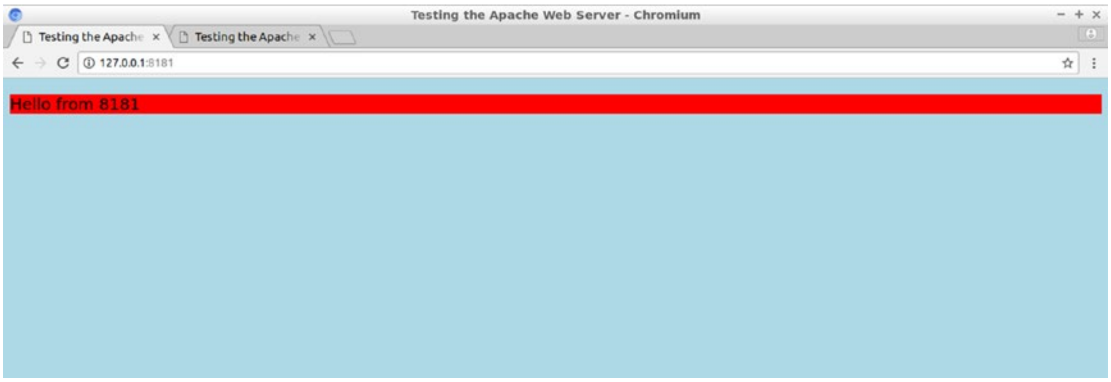
Hello from 8080

Figure 1-20. *Testing the first port-based vhost*

On the second tab, enter one of the following in the address bar:

```
127.0.0.1:8181
192.168.1.100:8181
```

The directory index `index4.html` is displayed (Figure 1-21).



Hello from 8181

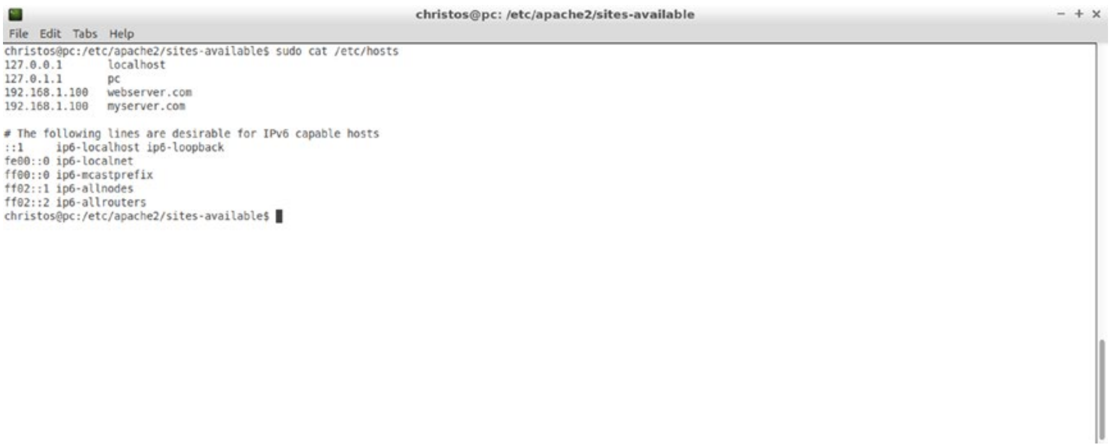
Figure 1-21. *Testing the second port-based vhost*

In the following section, you will create another pair of vhosts that serve requests for specific domain names in the Host field of the client's HTTP request.

Using Name-Based Virtual Hosts

The third approach for running multiple sites is to use name-based vhosts, where each vhost responds to the client's request if the client provides a host HTTP header value that matches its `ServerName` directive. You will not use the Domain Name System for your web server until Chapter 4, so for now you can only try the name-based virtual hosts locally, from the same computer as the server. To provide names to your computer, edit the `/etc/hosts` file as indicated in Figure 1-22. Use the following command at the terminal:

```
$ sudo gedit /etc/hosts
```



```
christos@pc:/etc/apache2/sites-available$ sudo cat /etc/hosts
127.0.0.1       localhost
127.0.1.1       pc
192.168.1.100   webserver.com
192.168.1.100   myserver.com

# The following lines are desirable for IPv6 capable hosts
::1     ip6-localhost ip6-loopback
fe00::0 ip6-localnet
ff00::0 ip6-mcastprefix
ff02::1 ip6-allnodes
ff02::2 ip6-allrouters
christos@pc:/etc/apache2/sites-available$ 
```

Figure 1-22. *Adding two more host names to /etc/hosts*

As you can see, you have already used one entry from this file, `localhost`, which corresponds to IP address 127.0.0.1. Enter two more entries in `/etc/hosts`, both resolving to the web server's static private IP address.

```
192.168.1.100       webserver.com
192.168.1.100       myserver.com
```

Save the `/etc/hosts` file and try one of those names, for instance `webserver.com`, in your browser's address bar. The domain name resolves to the IP address 192.168.1.100, and with `sites` of the `example1` configuration disabled, the vhost that dispatches this request is the default one, `000-default.conf`. The web page downloaded is therefore the one indicated in Figure 1-23.

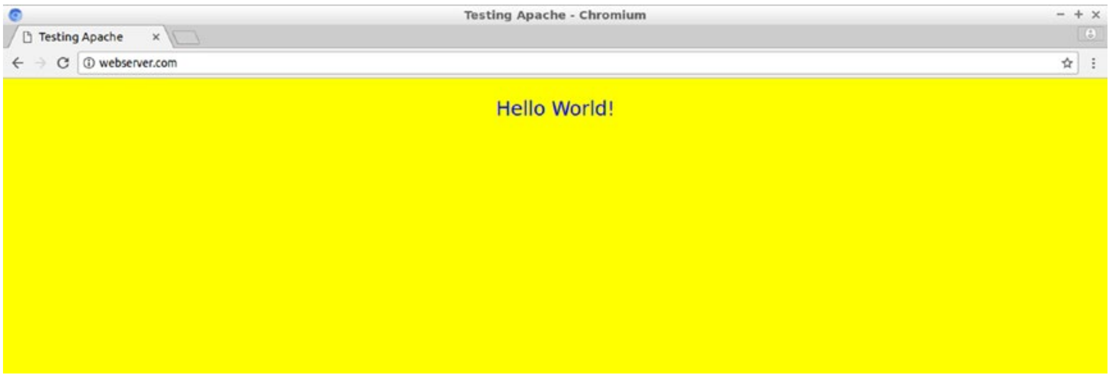


Figure 1-23. *With no name-based vhost configured so far, the default vhost serves the webserver.com request*

Create two name-based vhosts, each one responsible for one of the previous names. Use gedit to create the configuration file of the two vhosts.

```
$ sudo gedit example3.conf
```

In `example3.conf`, enter the following directives:

```
<VirtualHost *:80>
    ServerName webserver.com
    DocumentRoot "/var/www/html/test1"
</VirtualHost>

<VirtualHost *:80>
    ServerName myserver.com
    DocumentRoot "/var/www/html/test2"
</VirtualHost>
```

The first vhost listens to the default HTTP port, which is port 80. It is triggered when it receives an HTTP request with the value of the Host header set to `webserver.com`. The second vhost also listens to port 80. It waits for HTTP requests with the value of the Host header set to `myserver.com`.

The two sites use two different document roots, `/var/www/html/test1` and `/var/www/html/test2`, and since no directory indexes are defined with the `DirectoryIndex` directive, the default one for Apache, `index.html`, will be used. Create next a file named `index.html` in each directory root. At the Linux terminal, enter the following:

```
$ cd /var/www/html/test1
$ sudo gedit index.html
```

In the gedit window, insert the following HTML code and save the file:

```
<!DOCTYPE html>
<html>
<head>
<title>Testing the Apache Web Server</title>
<style>
   body {
        background-color:red;
        }

   p {
   background-color:lightblue;
   font-size:20px;
   }
</style>
</head>
<body>
<p>Hello from webserver.com</p>
</body>
</html>
```

Create a file called `index.html` in the second document root. At the Linux terminal, enter the following:

```
$ cd /var/www/html/test2
$ sudo gedit index.html
```

In the gedit window, enter the following source code and save the file:

```
<!DOCTYPE html>
<html>
<head>
<title>Testing the Apache Web Server</title>
<style>
   body {
        background-color:lightblue;
        }
   p {
   background-color:red;
   font-size:20px;
   }
</style>
</head>
<body>
<p>Hello from myserver.com</p>
</body>
</html>
```

Enable the new configuration using the following:

```
$ sudo a2ensite example3
```

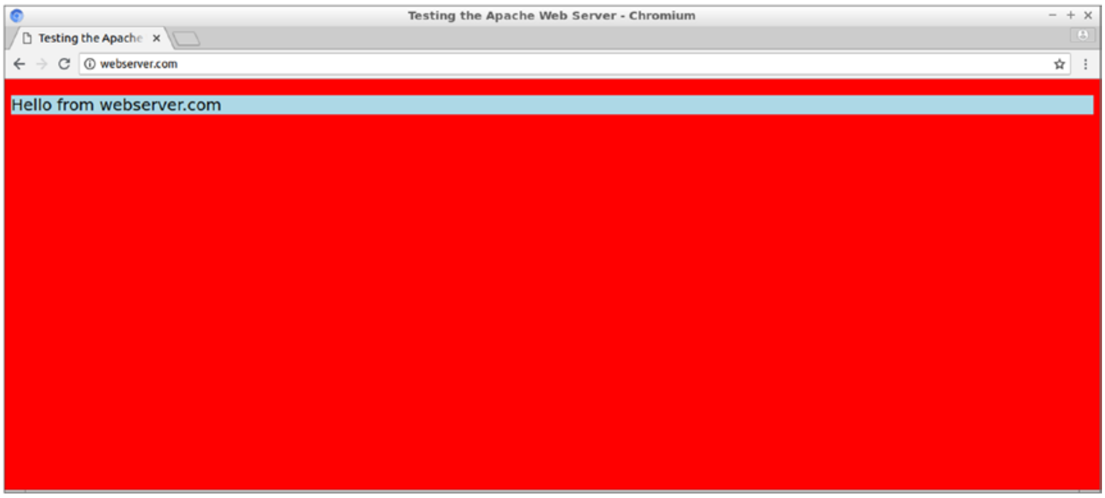
You also have to reload the web server to enable the new sites.

```
$ sudo service apache2 force-reload
```

In a browser on the computer that hosts the web server, open two tabs. In the first tab, enter the following in the address bar:

```
webserver.com
```

The web page `index.html`, located in `/var/www/html/test1`, is displayed in the browser's window, as displayed in Figure 1-24.



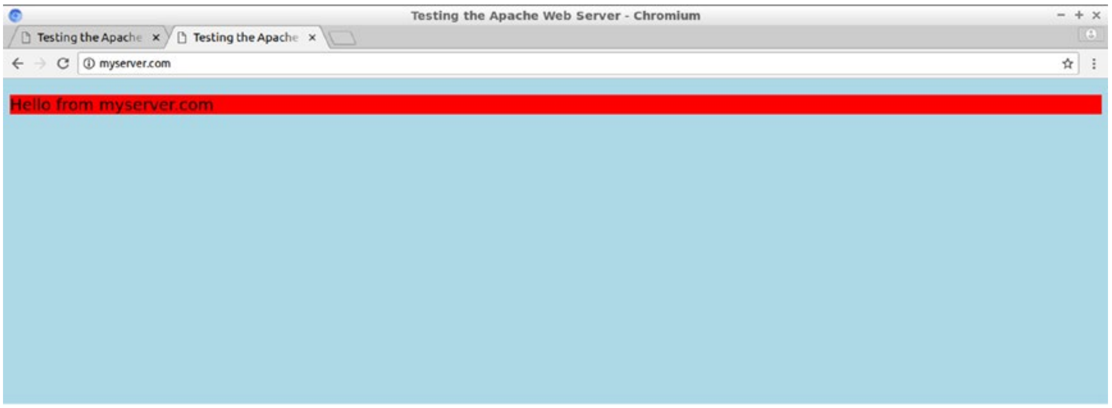
Hello from webserver.com

Figure 1-24. *Testing the first name-based vhost*

Use the following URL on the second tab:

```
myserver.com
```

The web page `index.html`, located in document root `/var/www/html/test1`, is displayed in the browser's window, as viewed in Figure 1-25.



Hello from myserver.com

Figure 1-25. *Testing the second name-based vhost*

In Chapter 9 you'll test the `ServerName` directive with a globally valid domain name like `httpsserver.eu` and see how to obtain and apply such a domain name.

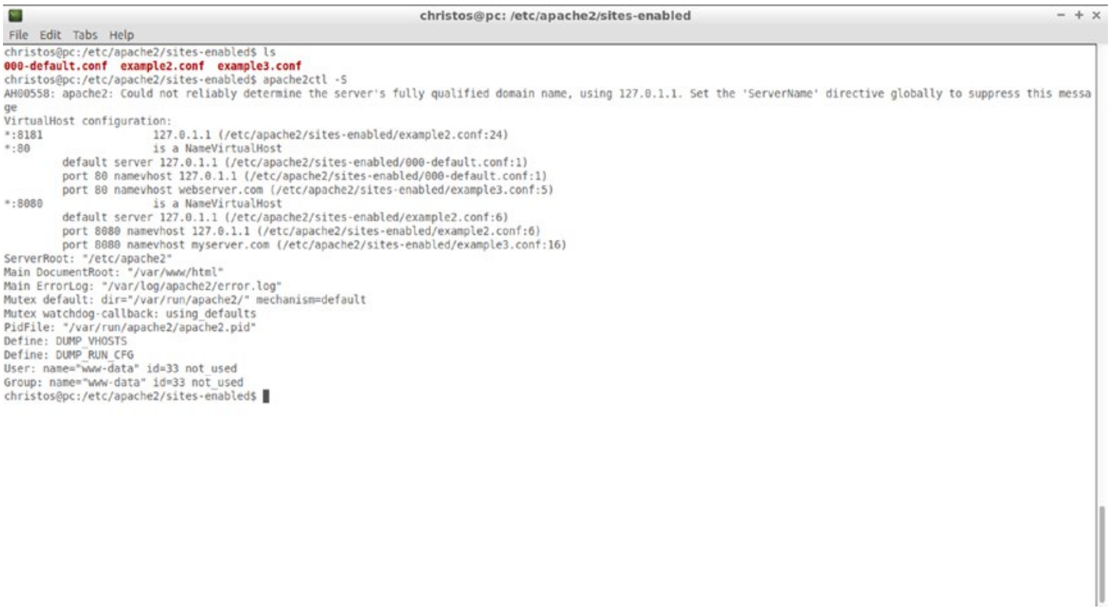
Inspecting the Overall Virtual Host Configuration

Each configuration enabled with the `a2ensite` command adds a symbolic link of itself to the directory `/etc/apache2/sites-enabled`. Use the following:

```
$ ls /etc/apache2/sites-enabled
```

As displayed in Figure 1-26, the `ls` command lists three configuration files: `000-default.conf`, `example2.conf`, and `example3.conf`. The configuration `example1.conf` is not included in this directory because it was disabled with the `a2dissite` command. Use the following to view the details of the overall configuration:

```
$ sudo apachectl -S
```



```
christos@pc:/etc/apache2/sites-enabled$ ls
000-default.conf  example2.conf  example3.conf
christos@pc:/etc/apache2/sites-enabled$ apache2ctl -S
AH00558: apache2: Could not reliably determine the server's fully qualified domain name, using 127.0.1.1. Set the 'ServerName' directive globally to suppress this messa
ge
VirtualHost configuration:
*:8181                 127.0.1.1 (/etc/apache2/sites-enabled/example2.conf:24)
*:80                   is a NameVirtualHost
         default server 127.0.1.1 (/etc/apache2/sites-enabled/000-default.conf:1)
         port 80 namevhost 127.0.1.1 (/etc/apache2/sites-enabled/000-default.conf:1)
         port 80 namevhost webserver.com (/etc/apache2/sites-enabled/example3.conf:5)
*:8080                 is a NameVirtualHost
         default server 127.0.1.1 (/etc/apache2/sites-enabled/example2.conf:6)
         port 8080 namevhost 127.0.1.1 (/etc/apache2/sites-enabled/example2.conf:6)
         port 8080 namevhost myserver.com (/etc/apache2/sites-enabled/example3.conf:16)
ServerRoot: "/etc/apache2"
Main DocumentRoot: "/var/www/html"
Main ErrorLog: "/var/log/apache2/error.log"
Mutex default: dir="/var/run/apache2/" mechanism=default
Mutex watchdog-callback: using_defaults
PidFile: "/var/run/apache2/apache2.pid"
Define: DUMP_VHOSTS
Define: DUMP_RUN_CFG
User: name="www-data" id=33 not_used
Group: name="www-data" id=33 not_used
christos@pc:/etc/apache2/sites-enabled$
```

Figure 1-26. *Listing the enabled sites and details of the Apache configuration*

Figure 1-26 displays also the output of the `apachectl -S` command, which provides an overview of the vhost configuration.

Reading Apache Log Files

To get an idea of the number of visitors and see some of the connection details, such as the client IP address and the time, you can read the log files of Apache. For the vhosts examples of this chapter, the directives related to log files are used in the configuration files as follows:

```
ErrorLog ${APACHE_LOG_DIR}/error.log
CustomLog ${APACHE_LOG_DIR}/access.log combined
```

To locate `APACHE_LOG_DIR`, use the following at the Linux terminal:

```
$ grep APACHE_LOG_DIR /etc/apache2/envvars
```

The Linux terminal responds with the following output:

```
export APACHE_LOG_DIR=/var/log/apache2$SUFFIX
```

With an empty value assigned for the variable `$SUFFIX` in the file `envvars`, the Apache log directory resolves to `/var/log/apache2`.

Change the working directory to `/var/log/apache2`, where the file `access.log` is used to list the visitor details and the file `error.log` is used to report any errors.

```
$ cd /var/log/apache2
```

Move to another computer of your LAN and make an HTTP request to the Apache server. For instance, at the browser's address bar, type the following:

```
192.168.1.100
```

Read the `access.log` file using `more`, `less`, `tail`, or a similar command:

```
$ tail -n 1 access.log
```

The previous Linux shell command prints one line from the end, which corresponds to the last record of the access log. You can also use the `-f` argument to continuously print the last visitor's details of the access log:

```
$ tail -fn 1 access.log
```

The details about the new connection are displayed next, including the IP address of the computer used by the client, the date and time the request was issued, the URL used, the operating system, and the browser:

```
192.168.1.2 - - [14/Jun/2018:16:09:23 +0300] "GET /favicon.ico
HTTP/1.1" 404 504 "http://192.168.1.100/" "Mozilla/5.0 (Windows NT 6.1)
AppleWebKit/537.36 (KHTML, like Gecko) Chrome/66.0.3359.181 Safari/537.36”
```

Summary

In this chapter, you set up and ran Apache, the first of two web servers used in this book. You created a number of virtual hosts (vhosts), each one corresponding to a different site. Two test sites were then run to display how Apache can discriminate between multiple sites belonging to each of the three main vhost categories: IP-based vhost, port-based vhost, and name-based vhost.

In the next chapter, you'll set up the PHP engine, namely, the interpreter that cooperates with Apache to create web pages with PHP source code that executes on the web server before the web page is dispatched to the client. With PHP, you enable sites to dispatch different content according to the client request and also to interface with other programs to work with the server, thus providing dynamic content to the visitors of the site.

CHAPTER 2

Server-Side Programming with PHP

In the beginning of the Internet, web servers dispatched only static content to the client. Soon, though, web servers became capable of dispatching dynamic content as well. To do this, a mechanism was needed that offered programming capabilities as well as the possibility of interfacing the terminal with other programs. Popular mechanisms for this purpose were the Common Gateway Interface (CGI) and later the PHP language. PHP is a recursive acronym for PHP: Hypertext Preprocessor. PHP is a general-purpose open source language that can be embedded in an HTML file or be included in its own stand-alone PHP file.

In this chapter, you will connect the Apache server to a PHP engine to create sites that accept client-specific data from HTML forms, which are processed, and then the results are dispatched back to the client's browser, thus serving dynamic content. You will be introduced to PHP, and then you will compare client-side programming in JavaScript to server-side programming in PHP. Last, you'll build a PHP-based site that validates the feature codes that can be entered online at a website in exchange for prizes.

The PHP Engine

A PHP-enabled web server can receive a request for a PHP file mainly in two ways.

- By using the URL of the PHP file in the web browser's address bar
- By submitting an HTML form, where the `action` attribute is set to the URL of the PHP file

On receiving the request for a PHP file, the web server locates the file and passes it to the PHP engine for processing. The PHP engine is a PHP interpreter that the web server is currently assigned. What the user actually views in the browser is not the

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PHP file itself but rather the output of all the PHP commands, sent back by the web server. For instance, the `echo` PHP command is the one used to output messages. Here's an example:

```
echo "Hello world!";
```

The start/end PHP tags (`<?php` and `?>`) are used as the delimiters for a PHP program.

```
<?php
echo "Hello world!";
?>
```

The PHP engine evaluates the previous program to a string, which is what the user actually sees when requesting `hello.php`.

```
Hello world!
```

Other than PHP commands, the PHP engine accepts HTML tags, for instance:

```
<?php

echo "<b>Hello <br>world!</b>";
?>
```

The user views the following message in bold:

Hello
world!

This capability makes PHP an ideal language for use on the Web.

PHP is a full-fledged programming language that you can use to make programs that run on the server side, limited only by your creativity. Here are a few epigrammatic uses for PHP:

- Interfacing with the operating system's shell, for instance the Linux terminal, and running terminal commands
- Interfacing with user programs, most commonly databases, and thus allowing the user to conduct a search and have the web server offer dynamic content

- Interfacing with the filesystem and allowing for reading and writing files on the server side
- Interfacing with remote servers by establishing network connections

You'll see examples of all these uses for PHP in the following chapters.

Installing and Testing PHP

In this book, PHP version 7.0 is used. To install PHP 7.0, follow the steps in this section.

Add the `ondrej/php` personal package archive (PPA).

```
$ sudo add-apt-repository ppa:ondrej/php
```

Run the update.

```
$ sudo apt-get update
```

Install PHP 7.

```
$ sudo apt-get install php7.0
```

Enable the Apache module `php7.0`, also installed with the previous command.

```
$ sudo a2enmod php7.0
```

Ensure that the `mpm_prefork` (prefork multiprocessing) Apache module is enabled and the `mpm_event` module is disabled.

```
$ sudo a2dismod mpm_event && sudo a2enmod mpm_prefork
Install also the CLI (Command Line Interface) PHP:
$ sudo apt-get install php7.0-cli
```

Restart Apache.

```
$ sudo systemctl restart apache2
```

To test your newly installed PHP engine, create a PHP file, named `info.php`, at the document root directory. Enter the following PHP source code:

```
<?php
phpinfo();
?>
```

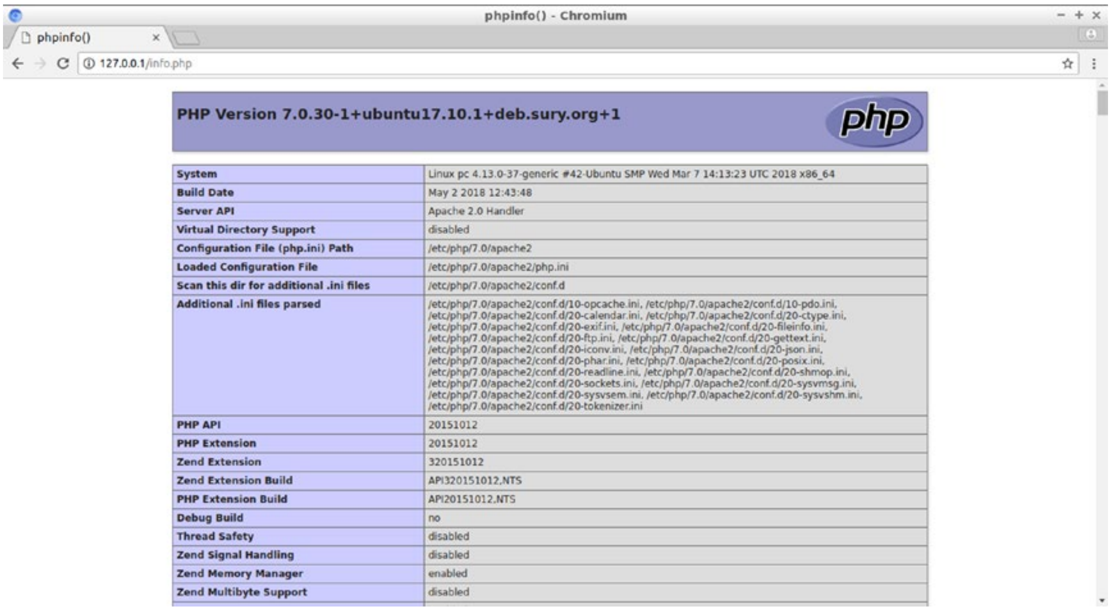
The previous code snippet includes just one command, the `phpinfo()` function call. As with each PHP command, it ends with a semicolon. The function `phpinfo()` returns a plethora of information about the PHP version, the operating system, the web server, etc., that spans multiple screens.

In your browser's address bar, type the URL that leads to `info.php`, for instance:

```
192.168.1.100/info.php
```

192.168.1.100 in this example is the private IP address of the web server.

Figure 2-1 shows the info page.



PHP Version 7.0.30-1+ubuntu17.10.1+deb.sury.org+1

System	Linux pc 4.13.0-37-generic #42-Ubuntu SMP Wed Mar 7 14:13:23 UTC 2018 x86_64
Build Date	May 2 2018 12:43:48
Server API	Apache 2.0 Handler
Virtual Directory Support	disabled
Configuration File (php.ini) Path	/etc/php/7.0/apache2
Loaded Configuration File	/etc/php/7.0/apache2/php.ini
Scan this dir for additional .ini files	/etc/php/7.0/apache2/conf.d
Additional .ini files parsed	/etc/php/7.0/apache2/conf.d/10-opcache.ini, /etc/php/7.0/apache2/conf.d/10-pdo.ini, /etc/php/7.0/apache2/conf.d/20-calendar.ini, /etc/php/7.0/apache2/conf.d/20-ctype.ini, /etc/php/7.0/apache2/conf.d/20-exif.ini, /etc/php/7.0/apache2/conf.d/20-fileinfo.ini, /etc/php/7.0/apache2/conf.d/20-ftp.ini, /etc/php/7.0/apache2/conf.d/20-gettext.ini, /etc/php/7.0/apache2/conf.d/20-iconv.ini, /etc/php/7.0/apache2/conf.d/20-json.ini, /etc/php/7.0/apache2/conf.d/20-phar.ini, /etc/php/7.0/apache2/conf.d/20-posix.ini, /etc/php/7.0/apache2/conf.d/20-readline.ini, /etc/php/7.0/apache2/conf.d/20-shmop.ini, /etc/php/7.0/apache2/conf.d/20-sockets.ini, /etc/php/7.0/apache2/conf.d/20-sysvmsg.ini, /etc/php/7.0/apache2/conf.d/20-sysvsem.ini, /etc/php/7.0/apache2/conf.d/20-sysvshm.ini, /etc/php/7.0/apache2/conf.d/20-tokenizer.ini
PHP API	20151012
PHP Extension	20151012
Zend Extension	320151012
Zend Extension Build	API320151012,NTS
PHP Extension Build	API20151012,NTS
Debug Build	no
Thread Safety	disabled
Zend Signal Handling	disabled
Zend Memory Manager	enabled
Zend Multibyte Support	disabled

Figure 2-1. *The info.php web page displayed in a browser*

The information on the `info.php` web page will be used in the following examples. In the following section, you will try PHP independently from a web server; you'll use the command line to simulate the process followed by a web server equipped with a PHP engine.

Testing PHP Without a Web Server

Sometimes it is useful to run and test PHP source code and view the result as it would appear in the user's browser without requiring a web server. There are PHP interpreters, like CLI PHP, that run from the command line of your operating system; however, they do not deliver the exact effect because they do not process HTML tags. There are also online PHP editors, some of which like phptester.net process HTML tags, but you can't combine them with the software of your computer. For this purpose, the following example can be used, which relies on CLI PHP.

To test whether you have already installed PHP CLI installed, enter the following at the command line:

```
$ php -v
```

The output on my system is as follows:

```
PHP 7.1.17-0ubuntu0.17.10.1 (cli) (built: May  9 2018 17:28:01) ( NTS )
Copyright (c) 1997-2018 The PHP Group
Zend Engine v3.1.0, Copyright (c) 1998-2018 Zend Technologies
    with Zend OPcache v7.1.17-0ubuntu0.17.10.1, Copyright (c) 1999-2018, by
    Zend Technologies
```

To view the available options, use the `-h` (help) switch.

To simulate the process of using PHP code inside a web page and viewing the result with a browser, without requiring a web server, use the following steps. First create a PHP file that uses HTML tags and also PHP source code. Specifically, create a file called `a.php` in your home directory using these commands:

```
$ cd ~
$ gedit a.php
```

Enter the following source code and save the file:

```
<html>
<head>
<title>Testing PHP without a web server</title>
</head>
<body>
<b>
```

```
<?php
$command =  "users";
$output = shell_exec($command);
echo $output;
?>
</b>
</body>
</html>
```

Three PHP commands are included between the start (`<?php`) and the end (`?>`) PHP tags. The first one sets the `$command` variable to the value of the command name that will be executed by the operating system. In this example, the shell command `users` was used, which lists the logged-in users. The second command uses `shell_exec()`, which is the PHP function that interfaces with the shell and executes the command given in the argument, in this case `users`, which is the value of `$command`. As a result, the `users` command is executed, and its output is stored to the `$output` variable. The third command prints the contents of the variable `$output` in bold since the PHP block is included between the `<b>` start and end tags.

The file `a.php` is the original PHP file that will be evaluated and viewed from a browser; however, for this file, the auxiliary file `c.php` is required to run. Create the file `c.php` next.

```
$ gedit c.php
```

Enter the following source code and save the file:

```
<?php
shell_exec("php a.php > b.html");
shell_exec("firefox b.html");
?>
```

What the program `c.php` does is run the code of file `a.php` with PHP CLI and then redirect (>) the output to the HTML file `b.html`.

```
$ php a.php > b.html
```

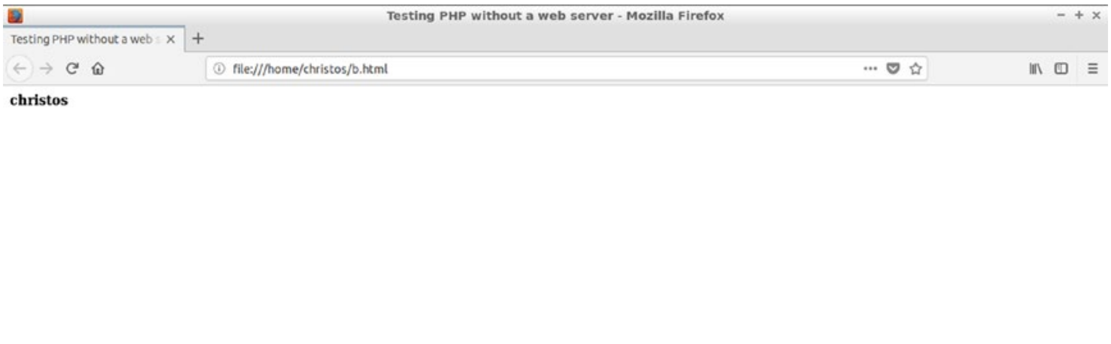
Next the Firefox web browser is invoked from the command line to open the web page `b.html`. This is the equivalent of running the next command from the command line:

```
$ firefox b.html
```

After creating a.php and c.php, the command you issue from the command line that starts everything is as follows:

```
$ php c.php
```

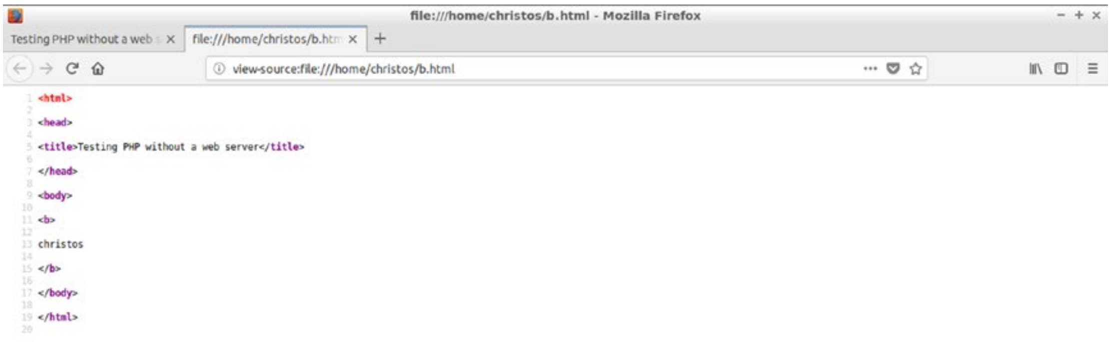
Figure 2-2 displays the result of running the previous command: the Firefox window opens and lists the currently logged-in users.


Testing PHP without a web server - Mozilla Firefox
Testing PHP without a web s
file:///home/christos/b.html

```
christos
```

Figure 2-2. *Running c.php from CLI PHP results in displaying file a.php in a web page*

A simple but efficient way to debug PHP code received from a web server by the user browser is to right-click the web page and select View Page Source (or similar) from the pop-up menu. As shown in Figure 2-3, a new tab opens with the evaluated PHP code.


file:///home/christos/b.html - Mozilla Firefox
Testing PHP without a web s
file:///home/christos/b.htm
view-source:file:///home/christos/b.html

```
<html>

<head>

<title>Testing PHP without a web server</title>

</head>

<body>

<b>

christos

</b>

</body>

</html>
```

Figure 2-3. *The source code of the evaluated PHP code*

As shown in the web page source resulting from the evaluated PHP code, just one user is currently logged in, and the username is included between the start/end bold tags in the body section of the HTML source code. Starting in the next section, all PHP examples will run through the web server. The Apache web server, introduced in the previous chapter, will be used here (starting in Chapter 5 you will use another open source web server, the Lighttpd).

Running Your First PHP Examples from the Web Server

You will now test PHP files evaluated by the PHP engine and dispatched by the Apache web server. The following examples show how variables are combines with strings and the difference between double and single quotes when used with strings. Also, I explain how you can mix JavaScript and PHP in the same command. Understanding those details in the source code is essential for understanding the web-based projects included in the rest of the book.

Working with Variables and Strings

First you'll see how PHP strings and variables can be combined. Create a new file with a `.php` file extension in your document root directory.

```
$ cd /var/www/html
$ sudo gedit test.php
```

Enter the following source code that does not include any strings and save the `test.php` file:

```
<!DOCTYPE html>
<html>
<head>
<title>
Testing PHP
</title>
<style>
p {
```

```
font-size:24px;
color:blue;
</style>
</head>
<body>
<?php
// working with variables
$var1 = 5;
$var2 = 8;
$var3 = $var1 + $var2;
echo $var3;
?>
</body>
</html>
```

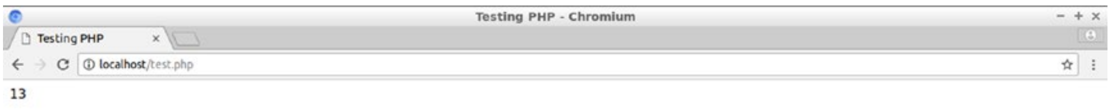
Test the PHP file by entering its URL in the address bar of your browser. If you test from the web server, use the following:

```
localhost/test.php
```

If you also test from the web server or from another computer of your LAN, you can use the following:

```
192.168.1.100/test.php
```

Here, 192.168.1.100 is the private IP address of the computer that hosts the web server. Figure 2-4 shows the web page downloaded to the browser.



```
13
```

Figure 2-4. The evaluated test.php web page

The PHP program uses three variables: `$var1` and `$var2` that are initialized to specific values, and `$var3`, whose value is calculated by the addition of the values of the previous two variables. The `echo` PHP command is used to output the `$var3` variable's value to the web page displayed in your browser. Also, a double forward slash (`//`) is used to mark a line as a comment. To include multiple continuous lines in a comment, use the slash and star notation, that is, `/*` for starting and `*/` for ending.

Notice that a variable name in PHP starts with the dollar sign (`$`). Prepending a variable with the dollar sign may look like overhead, but it is handy when you include the variable in a string. To display this feature, replace the previous PHP code in `test.php` with the following:

```
<?php
// working with variables
$var1 = 5;
$var2 = 8;
$var3 = $var1 + $var2;
echo "The sum of $var1 and $var2 is $var3";
?>
```

Strings in PHP can be included between double (`"`) or single (`'`) quotes. When a variable is inserted in a string with double quote delimiters, it is evaluated to its actual value. The web page in this example displays the following:

```
The sum of 5 and 8 is 13
```

This is not the case, however, when single quotes are used as string delimiters. Replace the previous PHP code in `test.php` with the following:

```
<?php
// working with variables
$var1 = 5;
$var2 = 8;
$var3 = $var1 + $var2;
echo 'The sum of $var1 and $var2 is $var3';
?>
```

The web page displays the following:

```
The sum of $var1 and $var2 is $var3
```

You can also use the concatenation operator (`.`) to concatenate strings and variables. Change the previous PHP code in `test.php` to the following:

```
<?php
// working with variables
$var1 = 5;
$var2 = 8;
$var3 = $var1 + $var2;
echo "The sum of " . $var1 . " and ". $var2 . " is " . $var3;
?>
```

The web page `test.php` evaluates now to the following:

```
The sum of 5 and 8 is 13
```

You can instead use single quotes to have the same effect.

```
<?php
// working with variables
$var1 = 5;
$var2 = 8;
$var3 = $var1 + $var2;
echo 'The sum of ' . $var1 . ' and ' . $var2 . ' is ' . $var3;
?>
```

Escaping Double or Single Quotes in PHP

To include double quotes in a string printed in the `echo` command without getting them mixed up with the message's double quotes used as delimiters, you can prepend them with the backslash (`\`) character. This is referred as *escaping* the double quotes. Another method is to include the message with the double quote characters in single quote delimiters. For instance, the following PHP file source code allows the double quote to be included in the `echo` messages:

```
<?php
echo "This message includes a double quote(\")<br>";
echo 'This message also includes a double quote(")<br>';
?>
```

Similarly, you can include single quotes in a string by escaping them with the backslash character in a single-quoted string or use double quotes as string delimiters. The following PHP example displays this technique:

```
<?php
echo 'This message includes a single quote(\')<br>';
echo "This message also includes a single quote(')";
?>
```

Mixing JavaScript and PHP

While JavaScript is used for the client-side programming language and PHP is used for the server-side language, there are cases where HTML and JavaScript have to be mixed with PHP. This section outlines the general rules for mixing JavaScript, PHP, and HTML tags.

To start with, a PHP file may include HTML tags such as a common HTML file, for instance:

```
<!DOCTYPE html>
<html>
<head>
<style>
p{
font-size:24px;
}
</style>
</head>
<body>
<?php
echo "<p>Hello World!</p>";
?>
</body>
</html>
```

You can instead use a PHP file with HTML-free content like the following:

```
<?php
echo "Hello World!";
?>
```

A PHP file may also include JavaScript source code, as in the following example:

```
<script>
document.write("Hello ");
</script>

<?php
echo "World!";
?>
```

In the previous PHP file, the two source code blocks are not mixed, and both functions individually print their own part on the web page, with JavaScript running when the browser loads the page and PHP running before the web page is submitted to the user's browser. Next you will see some cases where the PHP and JavaScript source code are mixed. As a general rule, HTML tags, like `<script>`, `<style>`, etc., may be included in a PHP file, however, not inside a PHP source code block, defined between the `<php` and `?>` delimiters. Otherwise, the PHP code won't run, and the evaluated web page will display an error message (HTTP error 500). The following example will run because the start and end script tags are outside the PHP block and the JavaScript commands are printed in their place with a PHP `echo` command:

```
<script>
<?php
echo '
alert("Hello World!");
';
?>
</script>
```

Also, the following source code snippet will run because all script tags are included in the `echo` PHP message, and therefore the whole script is printed to the web page when the PHP source code evaluates:

```
<?php
echo '
<script>
alert("Hello World!");
</script>
';
?>
```

In the next example, the source code will not run because the script's start and end tags are included inside the PHP block, however, without being included in the `echo` command:

```
<?php
<script>
echo '
alert("Hello World!");
';
</script>
?>
```

In this book, you will see a lot of cases where you have to use PHP and JavaScript in the same command. For instance, sometimes a PHP variable needs to appear to the user in a pop-up window instead of being typed into the browser's window with the `echo` command. With PHP belonging to the server side, you don't give control to the user's browser to create a pop-up window. You instead include JavaScript in the PHP evaluated page. The following PHP file contains PHP code in two blocks. In the first block, for simplicity, the variable `$name` is hardwired to a specific value, and in the second block, a PHP block is combined with JavaScript code as part of the `alert()` text so that the PHP variable `$name` appears in a pop-up window message:

```
<?php
$name = "Madison";
?>

<script>
alert("Hello <?php echo $name; ?> ");
</script>
```

Consider also the example where the pop-up window appears only if the value of `$name` is `'Jennifer'`. In this case, the whole script needs to be conditionally included in the PHP source code, but it may never run.

```
<?php
$name = 'Susan';
if ($name === Susan) {
echo '
<script>
alert("Hello ' . $name . ' ");
</script>
';
} else {
echo  'Hello';
}
?>
```

In the previous example, for simplicity, the $name variable was hardwired to the source code instead of allowing for multiple values, e.g., values derived from an HTML form. Like with the script tag, PHP code can be mixed with other HTML tags.

Here's an example of source code that won't run:

```
<?php
<b>
echo "Hello World!";
</b>
?>
```

On the other hand, the following example runs as expected:

```
<b>
<?php
echo "Hello World!";
?>
</b>
```

Or you can also use the following:

```
<?php
echo "<b>Hello World!</b>";
?>
```

In the examples used in this section, the PHP program initialized the PHP variables to their values. Next you will use HTML forms that the site visitor uses to submit user-specific data to the web server and then set the PHP variables according to the user preferences.

Setting the PHP Variables with the GET Method

The most common way to allow the user to send data to the web server is to use an HTML form that implements the `GET` or `POST` method and also refers to the URL of the PHP program that receives and processes the user data from the `action` attribute of the form element. In the following example, you will create a web page that includes an HTML form with the `method` attribute set to `GET`. First create the HTML file `get.html` that includes a form to enable the user to insert numbers in two fields and also to select an arithmetic operator with a drop-down list. When the submit button is clicked, the user data is transmitted to the `get.php` program, which is located, as the relative URL of the action attribute indicates, on the web server that dispatched the current web page and in the same directory as the current web page.

Use the following commands to switch to the server's document root and create the file `get.html`:

```
$ cd /var/www/html
$ sudo gedit get.html
```

Insert the following HTML source code:

```
<!DOCTYPE html>
<html>
<head>
<style>
input, select{
font-size:24px;
}
</style>
</head>
<body>
<form method="get" action="get.php">
<input type="number" name="n1">
<select name="operator">
  <option value="add">+</option>
  <option value="subtract">-</option>
  <option value="multiply">*</option>
  <option value="divide">/</option>
</select>
```

```
<input type="number" name="n2">
<input type="submit" value="Calculate">
</form>
</body>
</html>
```

Create the `get.php` file in the same directory.

```
$ sudo gedit get.php
```

Insert the following HTML source code that embeds the PHP source code:

```
<!DOCTYPE html>
<html>
<head>
<style>
p{
font-size:24px;
}
</style>
</head>
<body>
<p>
<?php
$num1 = $_GET["n1"];
$num2 = $_GET["n2"];
$operator = $_GET["operator"];
switch($operator) {
    case "add":
         echo $num1 + $num2;
         break;
    case "subtract":
         echo $num1 - $num2;
         break;
    case "multiply":
         echo $num1 * $num2;
         break;
    case "divide":
         echo $num1 / $num2;
         break;
}
?>
</p>
</body>
</html>
```

With the GET form method array `$_GET`, a global PHP variable is passed by the PHP engine to `get.php`, the PHP action program. The `$_GET` array elements consist of the data sent by the form. By using the name of the form's element with `$_GET` as the index to submit a value, the specific value is returned. For instance, with the following command, the PHP variable `$num1` gets the value submitted by the form's field named `n1`:

```
$num1 = $_GET["n1"];
```

Similarly, the value entered by the user in the second field of the type number is assigned to the PHP variable `$num2`.

```
$num2 = $_GET["n2"];
```

The drop-down list of the form submits also a value that corresponds to one of the following arithmetic operators: addition (+), subtraction (-), multiplication (*), division (/). The user choice for the operator is then accessed with the PHP `$operator` variable as follows:

```
$operator = $_GET["operator"];
```

Next, `$operator` enters a PHP switch command that according to the `$operator` value performs the corresponding arithmetic operation between `$num1` and `$num2`.

To test the client-server interaction of this example, use another computer in your LAN and enter the following in the browser's address bar:

```
192.168.1.100/get.html
```

192.168.1.100 is in this example the private IP address of the computer that hosts your web server. Alternatively, you can test the example from the same computer where your web server resides by entering the following:

```
127.0.0.1/get.html
```

Fill in the fields of the form with numeric values and select an arithmetic operator. Figure 2-5 displays the web page `get.html` with the values 200 and 100 entered in the number fields and also the multiplication sign selected from the drop-down list. Click the Calculate button to submit the form data to `get.php`.

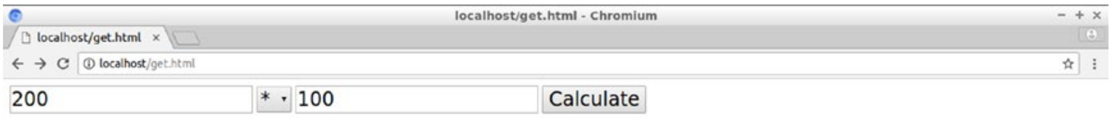
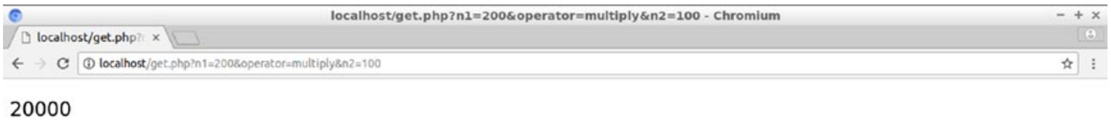


***Figure 2-5.** The web page get.html with the form fields completed*

Figure 2-6 displays the web page resulting from the evaluation of `get.php`, the action program in the web server, that received the data from the `get.html` form. The PHP code multiplies the two numeric variables `$num1` and `$num2`, and the result is printed with the `echo` command to the output returned by the web server to the client browser.


localhost/get.php?n1=200&operator=multiply&n2=100 - Chromium
localhost/get.php?
localhost/get.php?n1=200&operator=multiply&n2=100

```
20000
```

***Figure 2-6.** The evaluated get.php web page as it appears in the user browser*

The data submitted by the user is appended as the query string in the URL. The query string, for this example, is as follows:

```
n1=200&operator=multiply&n2=100
```

This includes the name-value pairs of all form fields submitted to the server and comprises the info received by the PHP program, which is used to fill the `$_GET` array and provide the PHP program with the user-defined variables.

Setting the PHP Variables with the POST Method

Let's now try the POST method of the form element, which is another option for submitting data to the web server. Create the file post.html as follows:

```
$ cd /var/www/html
$ sudo gedit post.html
```

Enter the following HTML source code, which differs from the get.html code only by the values of the form attributes method and action:

```
<!DOCTYPE html>
<html>
<head>
<style>
input, select{
font-size:24px;
}
</style>
</head>
<body>
<form method="post" action="post.php">
<input type="number" name="n1">
<select name="operator">
  <option value="add">+</option>
  <option value="subtract">-</option>
  <option value="multiply">*</option>
  <option value="divide">/</option>
</select>
<input type="number" name="n2">
<input type="submit" value="Calculate">
</form>
</body>
</html>
```

The method used is therefore POST, and the PHP file post.php is used to handle the user request. Create the file post.php also at the document root as follows:

```
$ cd /var/www/html
$ sudo gedit post.php
```

Enter the following source code and save the file:

```
<!DOCTYPE html>
<html>
<head>
<style>
p{
font-size:24px;
}
</style>
</head>
<body>
<p>
<?php
$num1 = $_POST["n1"];
$num2 = $_POST["n2"];
$operator = $_POST["operator"];
switch($operator) {
    case "add":
         echo $num1 + $num2;
         break;
    case "subtract":
         echo $num1 - $num2;
         break;
    case "multiply":
         echo $num1 * $num2;
         break;
    case "divide":
         echo $num1 / $num2;
         break;
}
?>
</p>
</body>
</html>
```

To test the client-server interaction of this example, use another computer in your LAN and in the browser's address bar enter the following:

```
192.168.1.100/post.html
```

Here, 192.168.1.100 is the private IP address of the computer that hosts your web server. Alternatively, you can test the example from the same computer where your web server resides by entering the following:

```
127.0.0.1/post.html
```

Provide a numeric value for each of the two fields and choose also an arithmetic operator from the drop-down list. In Figure 2-7, the two form fields of the web page `post.html` are completed with the numeric values 3000 and 5, respectively, and the division operator is selected from the drop-down list.

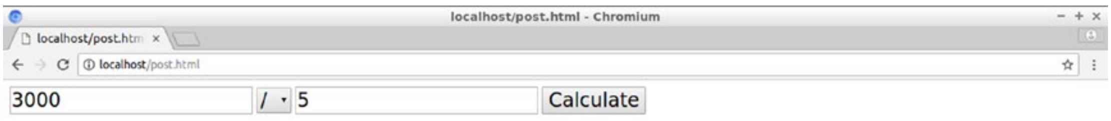
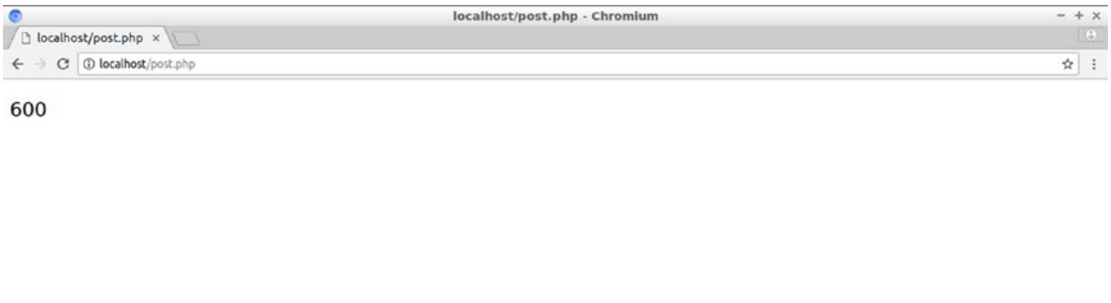


Figure 2-7. *The web page post.html with the form completed*

Click the Calculate button. The form values are submitted to `post.php`. On the web server, the PHP engine is invoked, and the form values are retrieved from the global PHP variable `$_POST`, which is an array similar to `$_GET` with the values submitted from the form elements. The PHP source code performs the division between 3000 and 5. The result is output with the `echo` command to the web page, as displayed in Figure 2-8, and is sent back from the web server to the user.



```
600
```

Figure 2-8. *The evaluated post.php web page as it appears in the user's browser*

Notice that in the address bar of your browser the URL remains the same. With the `POST` method, the data is not included in the URL of the HTTP request line, as with the method `GET`, but is rather appended to the body of the HTTP request sent to the web server. In the following section, another form is used to submit data to a PHP program on the server, and this process is compared with the JavaScript code that performs the corresponding calculation locally.

Running Client-Side vs. Server-Side Programs

You will next compare how server-side programs and client-side programs act, using JavaScript and PHP source code embedded in the same web page. Both languages are used to perform the same operation, specifically an arithmetic addition. JavaScript runs on the client side in the client's browser and displays the web page. PHP runs on the server side since the addition is performed on the web server that provides the specific web page.

A simple pattern for defining the programming process is to input the data to the source code and output the results. With JavaScript, the web server submits the source code via the network, and then the input/output data is used locally on the client's system. With PHP, the contrary applies: the client submits the data to the server, which makes the calculation remotely to the client, and the output is sent back to the client, as shown in Figure 2-9.

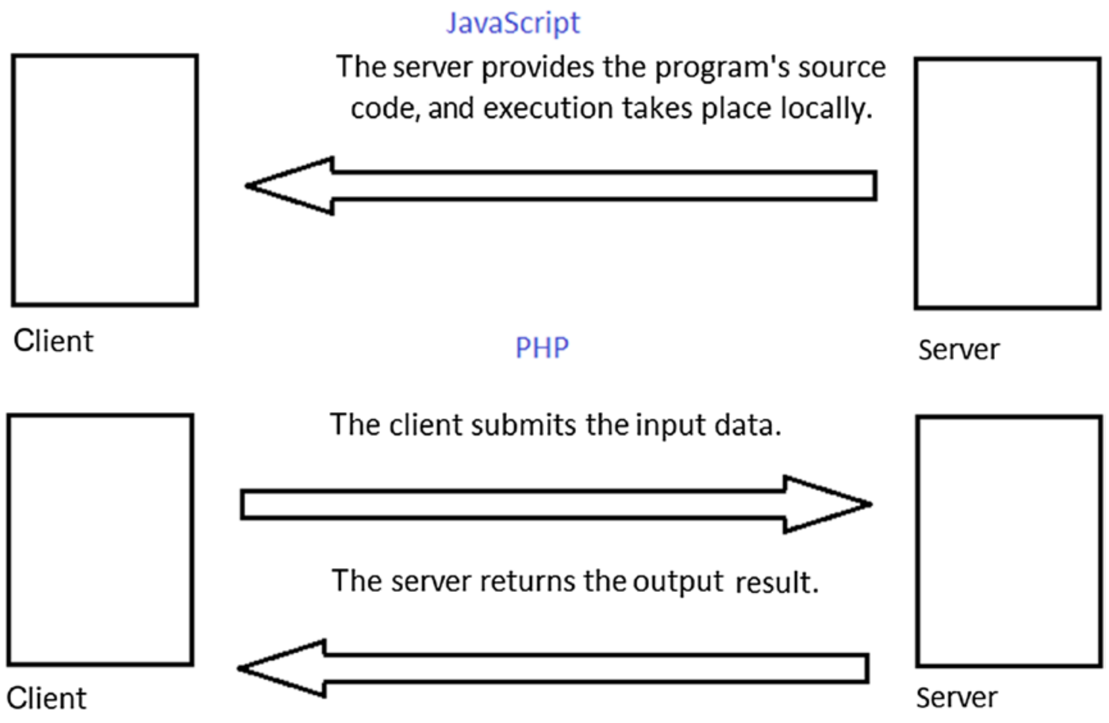

JavaScript
The server provides the program's source code, and execution takes place locally.
Client
Server
PHP
The client submits the input data.
The server returns the output result.
Client
Server

Figure 2-9. *Defining the programming process*

The JavaScript/PHP Addition Web Page

In this section, you'll create two calculators, which for simplicity here only do addition, in the same web page, `program.html`. The first is a client-side calculator that runs JavaScript, and the second is a server-side calculator that runs PHP. At the Linux terminal, create `program.html` in the document root of the web server with the following terminal commands:

```
$ cd /var/www/html
$ sudo gedit program.html
```

In the gedit window, enter the following HTML page that embeds the PHP and JavaScript source code and save the file:

```
<!DOCTYPE html>
<html>
<head>
<title>Client side and Server side programs</title>
```

```
<style>
input{
font-size:24px;
text-align:right;
background-color:lime;
}
input[type="submit"] {
background-color:yellow;
color:lime;
}
button{
font-size:24px;
color:lime;
background-color:yellow;
}
span{
font-size:24px;
color:lime;
}
</style>
</head>
<body>
<div>
<span>Add using JavaScript: </span>
<input type="text" id = "t1" size=5>
<span>+</span>
<input type="text" id = "t2" size=5>
<button onclick="f1()">=</button>
<input type = "text" id = "t3" size=5>
</div>
<div>
<br>
<span>Add using PHP: &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;
</span>
<form method="get" action="addition.php" style="display:inline;">
```

```
<input type="text" name="t4" size=5>
<span>+</span>
<input type="text" name="t5" size=5>
<input type="submit" value="=">
</form>
</span>
</div>
<script>
function f1() {
var x = Number(document.getElementById("t1").value);
if (isNaN(x)) {
alert("Please enter a number");
return false;
}
var y = Number(document.getElementById("t2").value);
if (isNaN(y)) {
alert("Please enter a number");
return false;
}
var z = x + y;
document.getElementById("t3").value = z;
}
</script>
</body>
</html>
```

The HTML file is used to perform addition in two ways: by using JavaScript and by using PHP. For JavaScript, the fields `t1` and `t2` are used to fill the operands and `t3` is used to output the sum. When the button with the equal sign is clicked, the calculation is performed. This button is assigned function `f1()` for handling the `onclick` event. The JavaScript section implements function `f1()`. This routine sets the JavaScript variable `x` to the current value of the element `t1` (the first textbox) and sets the JavaScript variable `y` to the current value of the element `t2` (the second textbox). The JavaScript function `Number()` is then used to convert the textbox value to a numeric value. Without using `Number()`, the value 5 would represent the character 5, and the addition 5+5 would result in 55. Because with JavaScript the calculation is performed locally in the browser, no data is transferred to and from the web server, and therefore when using JavaScript, the URL never changes.

The second way to do the addition is to use PHP. With PHP the values of textboxes t4 and t5 are transferred to the web server via a form submission when the submit button is clicked. The submit button looks like the equal button from the JavaScript technique, but it functions by sending the data to the web server contrary to the JavaScript button that invokes a function to make the calculation locally. The program that receives the data on the web server is determined by the value of the action attribute of the form. This is set to addition.php, which is a PHP file that should be found in the document root of the web server, as indicated by the relative URL that includes only the file name.

Create this program with the following command:

```
$ sudo gedit addition.php
```

In the gedit window, enter the following source code and click the Save button:

```
<!DOCTYPE html>
<html>
<head>
<style>
body{
background-color:lime;
font-size:24px;
}
</style>
</head>
<body>
<?php
$x = $_GET["t4"];
$y = $_GET["t5"];
$z = $x + $y;
echo $z;
?>
</body>
</html>
```

The PHP file `addition.php` includes a PHP block where the value sent by textbox `t4` is retrieved from the `$_GET[]` global PHP array, and it is assigned then to the PHP variable `$x`. Similarly, the value sent by textbox `t5` is stored in the PHP variable `$y`. Next, `$x` and `$y` are added together, and the result is assigned to the variable `$z`. The value of `$z` is printed with the `echo` command to the web page sent back to the browser.

To try the calculators, enter the following URL in your browser's address bar:

```
localhost/program.html
```

On the web page you can test the JavaScript code first. In the example in Figure 2-10, the result of adding 6 and 9 appears when the first equal sign button is clicked.

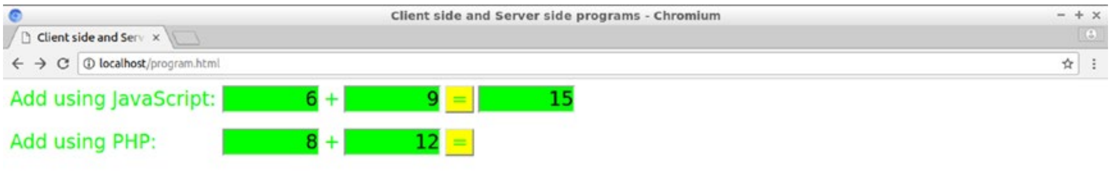

Client side and Server side programs - Chromium
Client side and Serv
localhost/program.html
Add using JavaScript: 6 + 9 = 15
Add using PHP: 8 + 12 =

***Figure 2-10.** Performing the addition locally with the JavaScript calculator*

Test the PHP addition next. Enter two numbers in the PHP fields. In the example in Figure 2-9, the numbers 8 and 12 were entered. Click the button with the equal sign, which is an HTML form submit button. The evaluated source code of the action file, `addition.php`, appears, as shown in Figure 2-11.

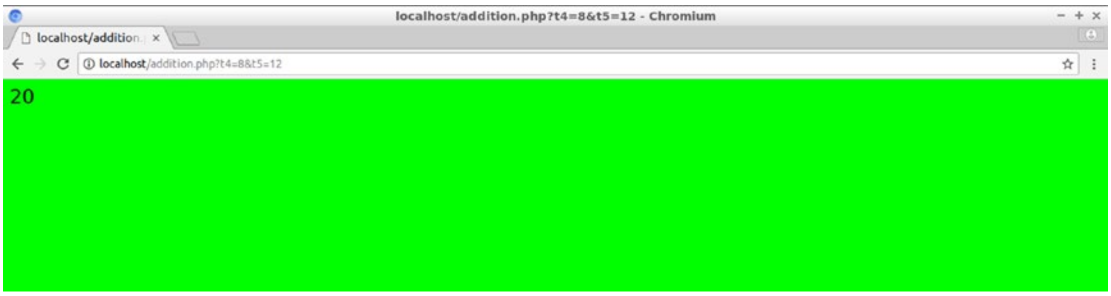

localhost/addition.php?t4=8&t5=12 - Chromium
localhost/addition.
localhost/addition.php?t4=8&t5=12
20

***Figure 2-11.** The result of the PHP addition as returned from the web server*

In the case of JavaScript, the source code is executed locally on the same computer, and the web page remains the same. For the PHP code, the code is executed in the web server, and the reply is submitted to the client with a new page. In the previous example, it may look like an unfair comparison because PHP provides the result in a web page that is not consistent with the initial one. With the next versions of the files `program.html` and `addition.php`, this can be fixed.

The Second Version of the JavaScript/PHP Addition Web Page

Create a file called `program2.html` with gedit or any other text editor. Enter the following source code in `program2.html`:

```
<!DOCTYPE html>
<html>
<head>
<title>Client side and Server side programs</title>
<style>
input{
font-size:24px;
text-align:right;
background-color:lime;
}
input[type="submit"], input[type="button"] {
background-color:yellow;
color:lime;
}
button{
font-size:24px;
color:lime;
background-color:yellow;
}
span{
font-size:24px;
color:lime;
}
```

```
</style>
</head>
<body>
<div>
<span>Add using JavaScript: </span>
<form method="get" action="addition2.php" style="display:inline;">
<input type="text" id = "t1" size=5 name="t1">
<span>+</span>
<input type="text" id = "t2" size=5 name="t2">
<input type="button" onclick="f1()" value="=">
<input type = "text" id = "t3" size=5 name="t3">
</div>
<br>
<div>
<span>Add using PHP: &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;
</span>
<input type="text" name="t4" size=5>
<span>+</span>
<input type="text" name="t5" size=5>
<input type="submit" value="=">
<input type="text" name="t6" size=5>
</form>
</span>
</div>
<script>
function f1() {
var x = Number(document.getElementById("t1").value);
if (isNaN(x)) {
alert("Please enter a number");
return false;
}
var y = Number(document.getElementById("t2").value);
if (isNaN(y)) {
alert("Please enter a number");
return false;
}
var z = x + y;
document.getElementById("t3").value = z;
}
</script>
</body>
</html>
```

The HTML file `program2.html` differs from `program.html` because of the value of the `action` attribute of the form element. Instead of `addition.php`, the program `addition2.php` is used. But there is another difference as well: the first three textboxes, `t1`, `t2`, and `t3`, used for the JavaScript section now use a `name` attribute, which will be used to transfer their values to the web server when the submit button is clicked. Those values will not be used for any calculation by the PHP web server program, `addition2.php`, but the values will be submitted to the `addition2.php` source code to be returned as values in the corresponding textboxes in the evaluated page. Thus, a continuity will be retained with the state of the original page, `program2.html`.

Create a file named `addition2.html` in the document root of your server with the following commands:

```
$ cd /var/www/html
$ sudo gedit addition2.php
```

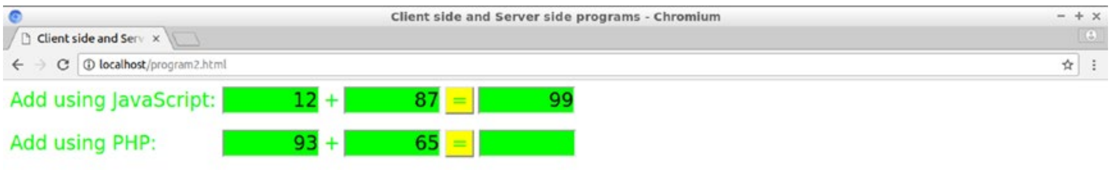
Enter the following code and save the file:

```
<!DOCTYPE html>
<html>
<head>
<title>Client side and Server side programs</title>
<style>
input{
font-size:24px;
text-align:right;
background-color:lime;
}
input[type="submit"], input[type="button"] {
background-color:yellow;
color:lime;
}
```

```
button{
font-size:24px;
color:lime;
background-color:yellow;
}
span{
font-size:24px;
color:lime;
}
</style>
</head>
<body>
<?php
if (isset($_GET["t1"])){
$t1 = $_GET["t1"];
}
if (isset($_GET["t2"])){
$t2 = $_GET["t2"];
}
if (isset($_GET["t3"])){
$t3 = $_GET["t3"];
}
if (isset($_GET["t4"])){
$t4 = $_GET["t4"];
}
if (isset($_GET["t5"])){
$t5 = $_GET["t5"];
}
if (isset($t4) && isset($t5)){
$t6 = $t4 + $t5;
}
?>
<form name="f1" action="addition2.php" method="GET">
<div>
<span>Add using JavaScript: </span>
```

```
<input type = "text" id="t1" name = "t1" size=5 value = "<?php echo $t1 ?>" >
<span>+</span>
<input type = "text" id="t2" name = "t2" size=5 value = "<?php echo $t2 ?>" >
<input type="button" value="=" onclick="function1()">
<input type = "text" id="t3" name = "t3" size=5 value = "<?php echo $t3 ?>" >
</div>
<br>
<div>
<span>Add using PHP: &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;
</span>
<input type = "text" name = "t4" size=5 value = "<?php echo $t4 ?>" >
<span>+</span>
<input type = "text" name = "t5" size=5 value = "<?php echo $t5 ?>" >
<input type="submit" value="=">
<input type = "text" name = "t6" size=5 value = "<?php echo $t6 ?>" >
</div>
</form>
<script>
function function1() {
var x = Number(document.getElementById("t1").value);
if (isNaN(x)) {
alert("Please enter a number");
return false;
}
var y = Number(document.getElementById("t2").value);
if (isNaN(y)) {
alert("Please enter a number");
return false;
}
var z = x + y;
document.getElementById("t3").value = z;
}
</script>
</body>
</html>
```

In this new version of the PHP file, the result of the PHP addition appears as the value of a new textbox, named `t6`, visually simulating the JavaScript calculator. You can test both calculators in this new version. As displayed in Figure 2-12, the fields of the JavaScript calculator reflect the addition previously issued, and in the PHP calculator the operand fields are set for the addition.

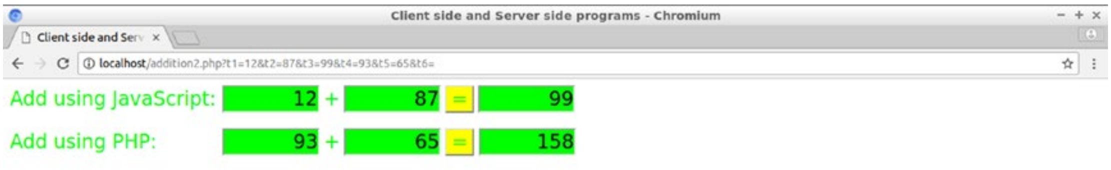


Add using JavaScript: 12 + 87 = 99

Add using PHP: 93 + 65 =

Figure 2-12. *The web page program2.html before submitting the form*

After clicking the submit button, the result appears in the evaluated `addition2.php` web page. As displayed in Figure 2-13, `addition2.php` has the same look and feel as the previous web page, `program2.html`. Moreover, all textbox values from both JavaScript and PHP sections are retained.


Client side and Server side programs - Chromium
Client side and Serv
localhost/addition2.php?t1=12&t2=87&t3=99&t4=93&t5=65&t6=

Add using JavaScript: 12 + 87 = 99

Add using PHP: 93 + 65 = 158

Figure 2-13. *The evaluated web page addition2.php when the form is submitted*

This is achieved with the following PHP block:

```
<?php
if (isset($_GET["t1"])){
$t1 = $_GET["t1"];
}
if (isset($_GET["t2"])){
$t2 = $_GET["t2"];
}
if (isset($_GET["t3"])){
$t3 = $_GET["t3"];
}
if (isset($_GET["t4"])){
$t4 = $_GET["t4"];
}
if (isset($_GET["t5"])){
$t5 = $_GET["t5"];
}
if (isset($t4) && isset($t5)){
$t6 = $t4 + $t5;
}
?>
```

In the previous PHP block, the values of the JavaScript textboxes, `t1`, `t2`, and `t3`, are submitted along with two of the values of the PHP section, `t4` and `t5`. The value for the result of the PHP section, appearing in `t6`, is calculated next from the values of `t4` and `t5`. Function `isset()` is used to check whether a variable is set.

To return the values of `t1` up to `t6` in the corresponding textboxes, an `echo` command is included for each `text` input element in a separate PHP block. For instance, for `t1`, its last value, maintained in the PHP code in variable `$t1`, is printed in the first textbox with the following PHP block contained in the input element:

```
<input type = "text" id="t1" name = "t1" size=5 value = "<?php echo $t1 ?>" >
```

The previous input tag processed by the PHP engine, for instance when `t1` currently has the value 12, is as follows:

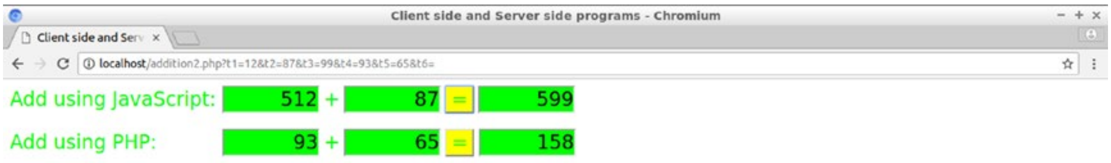
```
<input type = "text" id="t1" name = "t1" size=5 value = "12" >
```

This value, carried to the server side and returned to the client side, is maintained to retain the state of the two calculators.

To enable the evaluated page to use the JavaScript calculator, the script of `program2.html` is also included in `addition2.php`.

```
<script>
function function1() {
var x = Number(document.getElementById("t1").value);
if (isNaN(x)) {
alert("Please enter a number");
return false;
}
var y = Number(document.getElementById("t2").value);
if (isNaN(y)) {
alert("Please enter a number");
return false;
}
var z = x + y;
document.getElementById("t3").value = z;
}
</script>
```

Figure 2-14 shows the results. You can access the JavaScript fields in `addition2.php` to make further local additions.


Client side and Server side programs - Chromium
Client side and Serv
localhost/addition2.php?t1=12&t2=87&t3=99&t4=93&t5=65&t6=

Add using JavaScript: 512 + 87 = 599

Add using PHP: 93 + 65 = 158

***Figure 2-14.** The new version addition2.php enables both remote PHP additions and local JavaScript additions*

Next you'll create the final version of this site.

The Third Version of the JavaScript/PHP Addition Web Page

Since `addition2.php` evaluates to the `program2.php` web page that submits the data, `program2.php` can be completely omitted from the site. Therefore, the only PHP file required, `addition.php`, can replace `program2.php` as the home directory of the site. The following URL will be used:

```
localhost/addition2.php
```

In the following section, you will create a site that validates promotional codes dispatched from an HTML form and uses PHP to validate the data submitted by this form.

Form Validation with PHP

So far you have used HTML and JavaScript to validate a web page. Another option you have is to use PHP. With PHP you validate the web page remotely. To test this scheme, create a new PHP site that simulates a scenario where promotional codes are redeemed so that the user can win free products. At the Linux terminal, create the `validate.php` file in the document root of the web server.

```
$ cd /var/www/html
$ sudo gedit validate.php
```

Enter the following source code and save the file:

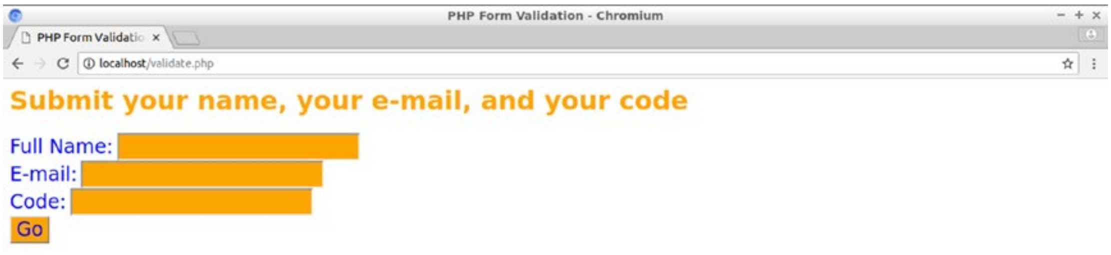
```
<html>
<head>
<title>PHP Form Validation</title>
<style>
h1{
color:orange;
}
.error{
color:red;
font-size:20px;
}
```

```
label{
color:blue;
font-size:24px;
}
input{
color:blue;
font-size:24px;
background-color:orange;
}
</style>
</head>

<body>
<?php
 $errormsg1="";
 $errormsg2="";
 $errormsg3="";
 $valid1=false;
 $valid2=false;
 $valid3=false;

if (isset($_POST['submit']))
{

 $name=$_POST["name"];
 $email=$_POST["email"];
 $code=$_POST["code"];

 if(empty($name) || is_numeric($name))
 {
 $errormsg1.='<p class="error">* Please enter a valid name.</p>';
 $valid1=false;
 }
 else
 {
 if(is_string($name))
 $valid1=true;
```

```
else
{
$errormsg1.='<p class="error">* Please use valid characters.</p>';
$valid1=false;
}
}

if(empty($email) || is_numeric($email))
{
$errormsg2.='<p class="error"> * Please enter your e-mail.</p>';
$valid2=false;
}
else
{
if(is_string($email))
$valid2=true;
else
{
$errormsg2.='<p class="error">* Please use valid characters.</p>';
$valid2=false;
}
}

if(empty($code))
{
$errormsg3.='<p class="error">* Please enter your code number.</p>';
$valid3=false;
}
else
{
$len=strlen($code);

if($len==10)
$valid3=true;
else
{
$errormsg3.='<p class="error">* Code should be in alphabetic letters and
numerical digits format with 10 characters in it.</p>';
```

```
 $valid3=false;
 }
 }

 if($valid1==true && $valid2==true && $valid3==true)
 header("Location:process.php? code=$code&name=$name&email=$email");
}
?>

<h1>Submit your name, your e-mail, and your code</h1>
<form name="form1" method="post" action="<?php echo htmlspecialchars
($_SERVER["PHP_SELF"]);?>">

<label for="name">Full Name:</label>
<input type="text" name="name"><br>
<?php
 if((errormsg1!="") && isset($_POST['submit']))
 echo $errormsg1;
?>
<label for="email">E-mail:</label>
<input type="text" name="email"><br>
<?php
 if((errormsg2!="") && isset($_POST['submit']))
 echo $errormsg2;
?>
<label for="code">Code:</label>
<input type="text" name="code"><br>
<?php
 if((errormsg3!="") && isset($_POST['submit']))
 echo $errormsg3;
?>
<input type="submit" name="submit" value="Go">
</form>

</body>
</html>
```

As displayed in Figure 2-15, `validate.php` creates a web page that includes a form with three fields and a submit button, with the caption Go.

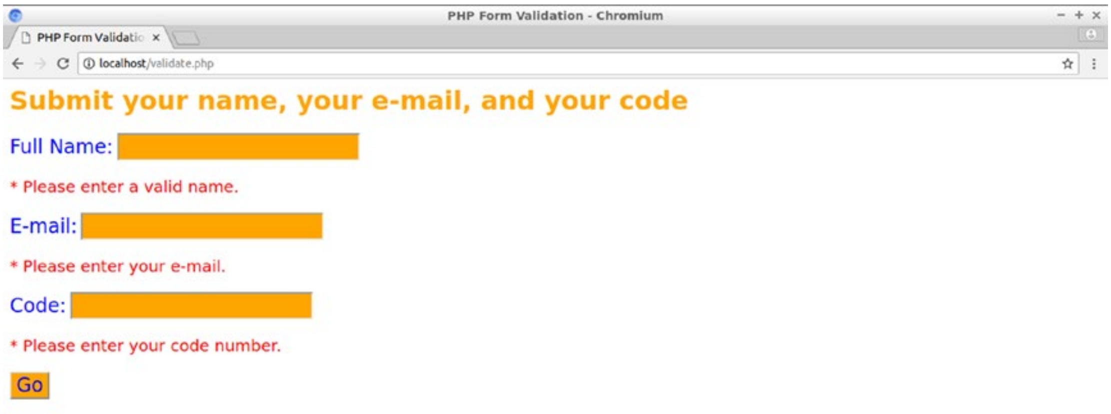


Submit your name, your e-mail, and your code

Full Name:
E-mail:
Code:

Figure 2-15. *The web page created by validate.php*

For this form, all fields are required to be filled in, and the code must be an alphanumeric string of 10 characters. Figure 2-16 displays the error messages generated by the PHP code when the user clicks the Go button without completing all the fields.



Submit your name, your e-mail, and your code

Full Name:

* Please enter a valid name.

E-mail:

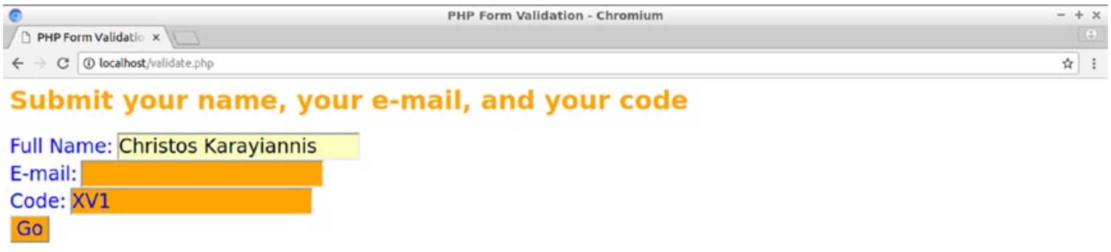
* Please enter your e-mail.

Code:

* Please enter your code number.

Figure 2-16. *The error messages displayed in the web page when fields are incomplete*

Test the form by completing just two of the fields, e.g., Full Name and Code, with the latter including only three characters. Figure 2-17 displays an example. Click the Go button.

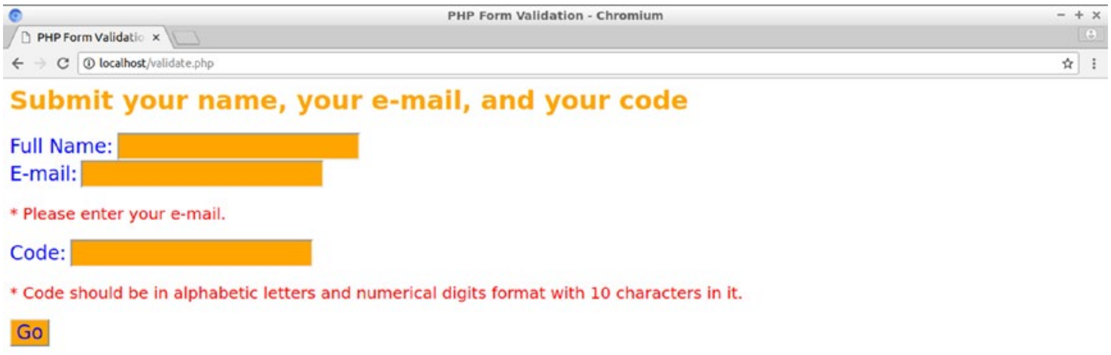


Submit your name, your e-mail, and your code

Full Name: Christos Karayiannis
E-mail:
Code: XV1
Go

Figure 2-17. *Testing the form with only two fields completed*

The PHP source code validates the form according to the rule set and displays two warnings, one for the empty field and one for the length of the string entered in the Code textbox. Figure 2-18 displays the warnings.



Submit your name, your e-mail, and your code

Full Name:
E-mail:

* Please enter your e-mail.

Code:

* Code should be in alphabetic letters and numerical digits format with 10 characters in it.

Go

Figure 2-18. *The warnings displayed for the entries of Figure 2-16*

In the following section, I'll discuss the PHP source code for the form validation.

The validate.php Source Code Commentary

The Go button of the form, which is of type `submit`, relays the data to the PHP file indicated by the value of the form's `action` attribute. This is set to `$_SERVER["PHP_SELF"]`, which is another variable of the global PHP `$_SERVER[]` array. This value is filled by the PHP engine on the fly relative to the document root path of the current file, for this example /validate.php. Notice that the action attribute of the form is set as follows:

```
action="<?php echo htmlspecialchars($_SERVER["PHP_SELF"]);?>
```

The value of the action is enclosed in the PHP tags so that the value of

```
htmlspecialchars($_SERVER["PHP_SELF"])
```

is actually printed as the action's value. Function htmlspecialchars() is used to sanitize the file's pathname so that symbols like the double quote (") is converted to &quot;, which is the equivalent HTML entity. The purpose of this is to avoid a possible $_SERVER["PHP_SELF"] exploit, which is a cross-site scripting (XSS) exploit, where a hacker injects JavaScript code into web pages viewed by other users.

At the beginning of the PHP source code, three fields are evaluated. For instance, consider the following validation code for the value of the first field sent as $_POST["name"]:

```
if (isset($_POST['submit']))
{
 $name=$_POST["name"];
 $email=$_POST["email"];
 $code=$_POST["code"];

 if(empty($name) || is_numeric($name))
 {
 $errormsg1.='<p class="error">* Please enter a valid name.</p>';
 $valid1=false;
 }
 else
 {
 if(is_string($name))
 $valid1=true;
 else
 {
 $errormsg1.='<p class="error">* Please use valid characters.</p>';
 $valid1=false;
 }
 }
```

With function `isset()`, it is ensured that the evaluation takes place only when the submit button is clicked and the submit method is `POST`. Otherwise, the fields would get evaluated even before the user had the chance to fill them.

```
if (isset($_POST['submit']))
```

The variables `$valid1`, `$valid2`, and `$valid3` are used as flags to signal a valid (true) or an invalid (false) value for the first, second, and third fields, respectively. Also, the variables `$errormsg1`, `$errormsg2`, and `$errormsg3` are used to specify the appropriate error message for the first, second, and third fields, respectively. For instance, with the following commands, `errormsg3` appears when the value of the code does not have a length of ten characters:

```
if($len==10)
 $valid3=true;
 else
 {
 $errormsg3.='<p class="error">* Code should be in alphabetic letters and
numerical digits format with 10 characters in it.</p>';
```

The concatenating assignment operator (`.=`) is a PHP string operator that appends the argument on the right side to the argument on the left side.

The form submits to the same PHP file, where it is included, while the user does not provide the expected values, thus allowing for validating the form. When all three fields are filled with valid values, the following `if` condition holds true and the `header()` function runs:

```
if($valid1==true && $valid2==true && $valid3==true)
 header("Location:process.php? code=$code&name=$name&email=$email");
```

The `header()` function, which sends raw HTTP headers, is used here with the `Location` HTTP header. This function redirects the browser to the URL indicated by the `Location` value. In this example, the value includes the attached query string with the variable-value pairs required to be forwarded to the destination file, `process.php`. Thus, the function `header()` provides the escape mechanism to `validate.php` to break out of the loop of continuously submitting data to itself.

Create the file process.php in the document root with the following commands:

```
$ cd /var/www/html
$ sudo gedit process.php
```

Enter the following source code and save the file:

```
<html>
<head>
<title>Code evaluation</title>
<style>
p{
color:green;
font-size:32px;
}
</style>
</head>
<body>
<p>
<?php

$var=$_GET['code'];
$var2=$_GET['name'];
$var3=$_GET['email'];
if(isset($var) && $var == 'SX1DF908RW')
{
echo nl2br("$var2 congratulations you have entered the lucky code: $var\n
You have won one T-shirt. We will contact you soon.");

// Save the user's e-mail for contacting him/her
$filename = "code.txt";
$handle = fopen($filename, "w") or die(" Unable to open file!");
if ($handle)
{
fwrite($handle, $var2);
fwrite($handle, PHP_EOL);
fwrite($handle, $var3);
fwrite($handle, PHP_EOL);
fclose($handle);
}
}
else
{
    echo "You didn't win, please try another time!";
}

?>
</p>
</body>
</html>
```

The three variable values submitted (code, name, and email) from header() in file validate.php are now retrieved as var, var2, and var3, respectively. The following if condition looks for the lucky code:

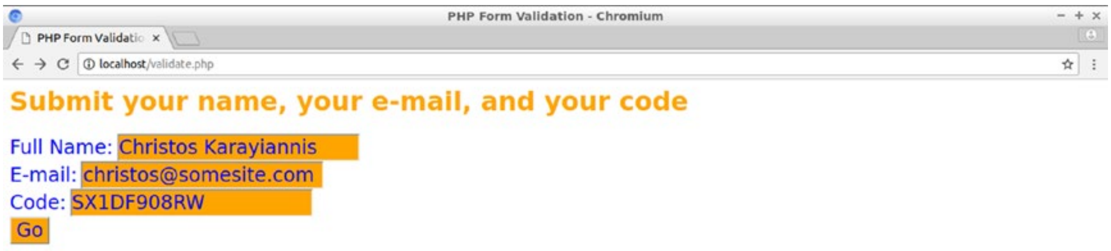
```
if(isset($var) && $var == 'SX1DF908RW')
```

If the condition is true, the following message is returned to the browser:

```
echo nl2br("$var2 congratulations you have entered the lucky code: $var\n
You have won one T-shirt. We will contact you soon.");
```

The function nl2br() is used to translate escape characters to their meaning; for instance, \n is treated now as a newline.

Test the validate.php form by providing the correct code, SX1DF908RW, as shown in Figure 2-19.

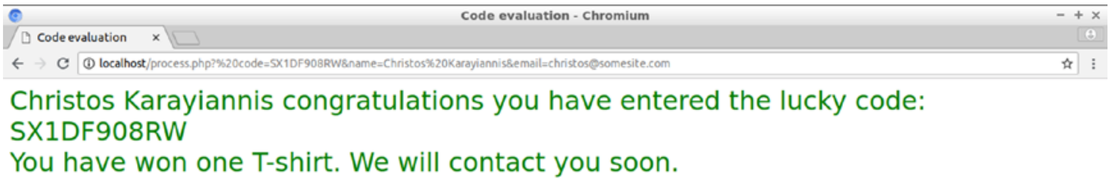


Submit your name, your e-mail, and your code

Full Name: Christos Karayiannis
E-mail: christos@somesite.com
Code: SX1DF908RW
Go

***Figure 2-19.** The validate.php form filled with the correct code*

Click the Go button. The form is submitted, and the browser redirects to `process.php`, which displays the message shown in Figure 2-20 to the client browser.

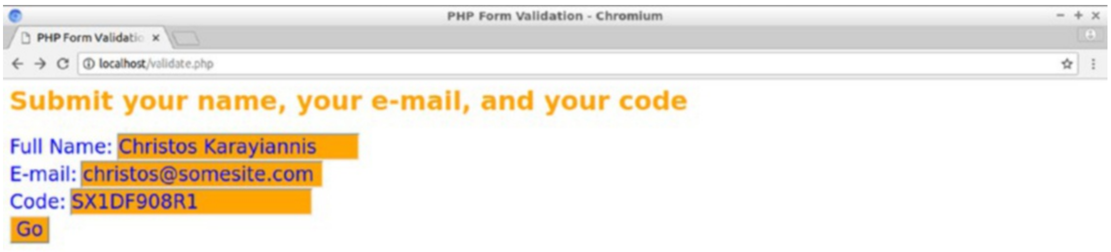


localhost/process.php?%20code=SX1DF908RW&name=Christos%20Karayiannis&email=christos@somesite.com

Christos Karayiannis congratulations you have entered the lucky code:
SX1DF908RW
You have won one T-shirt. We will contact you soon.

Figure 2-20. *The message displayed from process.php for the correct code*

Try validating `validate.php` with a wrong code, as displayed in Figure 2-21.

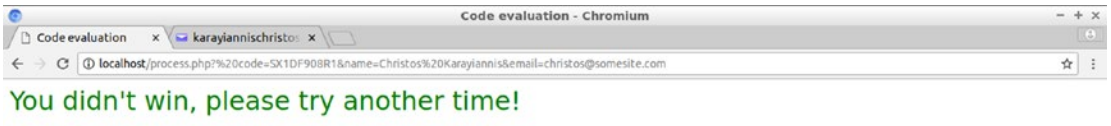


Submit your name, your e-mail, and your code

Full Name: Christos Karayiannis
E-mail: christos@somesite.com
Code: SX1DF908R1
Go

Figure 2-21. *Testing validate.php with a wrong code*

Click the Go button to redirect to `process.php`. The message displayed to the client's browser is shown in Figure 2-22.



localhost/process.php?%20code=SX1DF908R1&name=Christos%20Karayiannis&email=christos@somesite.com

You didn't win, please try another time!

Figure 2-22. *The reply viewed in the user's browser for a wrong code*

Let's not forget the promise to get back to the user. To save the visitor's details, the PHP source code is used to provide the interface between the web server and the local filesystem. A new file called `code.txt` is required to store the winner's personal details: the full name and the e-mail. With the following PHP code file, `code.txt` is used to store this information. The file handle `$handle` is created with `fopen()`, which in this example is used for writing (`w` mode) to the file, with the name indicated in the value of `$filename`. The function `fwrite()` is used twice to fill the winner's name and e-mail and also the `PHP_EOL` value between. This inserts a line break.

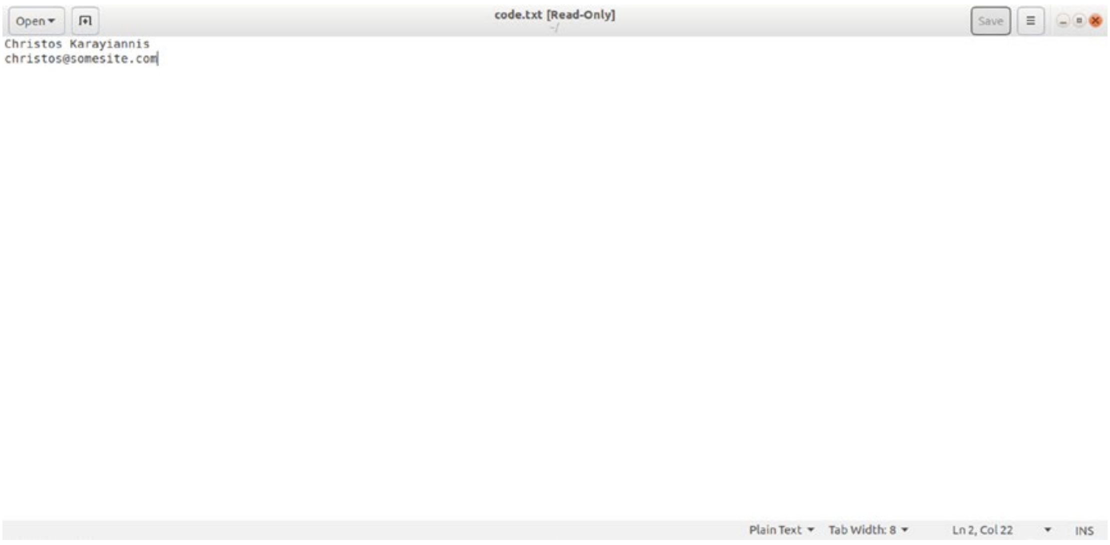
```
// Save the user's e-mail for contacting him/her
$filename = "code.txt";
$handle = fopen($filename, "w") or die(" Unable to open file!");
if ($handle)
{
fwrite($handle, $var2);
fwrite($handle, PHP_EOL);
fwrite($handle, $var3);
fwrite($handle, PHP_EOL);
fclose($handle);
}
```

To enable the web server (and the PHP engine) to access file `code.txt`, create it first with the `touch` command and then change its ownership to belong to the user `www-data`, a member of the group `www-data`, which is the user assumed by the web server. At the command line, enter the following:

```
$ sudo touch /var/www/html/code.txt
```

```
$ sudo chown www-data:www-data /var/www/html/code.txt
```

Figure 2-23 displays the content of `code.txt`, including the personal details for the user who provided the correct code.



```
Christos Karayiannis
christos@somesite.com
```

Figure 2-23. *The personal details of the winner stored in file code.txt*

The user's personal details are thus saved for contacting the user to claim their prize.

Summary

In this chapter, you saw some examples of the Apache web server utilizing the PHP engine to create programs that run on the server side, and you implemented similar-functioning programs with JavaScript that run on the client side. You also created a site where the form data was validated with PHP, and also PHP code was used to redirect to another web page and to interface the web server with the filesystem. In the following chapter, you will continue to use PHP in combination with the GeoIP geolocation module that you set up for Apache so that information about a visitor's location can be retrieved and used from the PHP source code on the site's web pages. But first you will set up your router to officially assign the Apache host as the web server of your LAN and thus enable your site to be accessible from the whole Internet.

CHAPTER 3

Connecting Your Apache Server to the Internet

In this chapter, you'll configure your router to forward any incoming packet with a TCP port number from the web service to the computer hosting your web server. TCP port 80 is the default port number for the HTTP protocol; however, other port numbers can also be used. Another port number used often for the HTTP protocol is port 8080. This port number, sometimes called the *HTTP alternate port*, is used when the ISP does not allow incoming traffic for port 80.

With the router configured to forward requests for the port you prefer to the web server, your site becomes available to the whole Internet. In this chapter, you'll use a DNS domain name for the server instead of an IP address and thus make the URL for your site more user-friendly.

By allowing the Apache web server to connect to the Internet, your next project is to utilize the GeoIP Apache module to allow the server to locate the geographic origin of the site visitors, pinpoint them on a map, and even respond in their native language.

The NAT Protocol

The router device that connects two networks requires two IP addresses. Like Janus, the two-faced ancient Roman god of gates, it looks in two directions: externally and internally to the network. These addresses are referred to as *public* and *private* addresses, respectively. All workstations in the LAN allocate private IP addresses. The router represents all the private IP addresses of the LAN with its unique public IP address by implementing the Network Address Translation (NAT) protocol. NAT was

C. Karayiannis, *Web-Based Projects that Rock the Class*, https://doi.org/10.1007/978-1-4842-4463-0_3

developed to address the problem of the IPv4 address shortage. With a single public IP address for the router, multiple computers and Internet-enabled devices can connect to the Internet in a seamless manner.

NAT comes in two variations: static and dynamic. With static NAT, each host requires one public IP address for its private IP address to be reachable over the Internet.

With dynamic NAT, multiple hosts can translate their private IP address to the public IP address of the router. An extension of dynamic NAT is port forwarding, aka port mapping, which consists of a router service. With port forwarding, the router is configured to dispatch packets with a specific destination port number to a specific machine on the LAN. For instance, the router in Figure 3-1 is set to forward all packets with destination port 80 to the host with the private IP address 192.168.1.100.

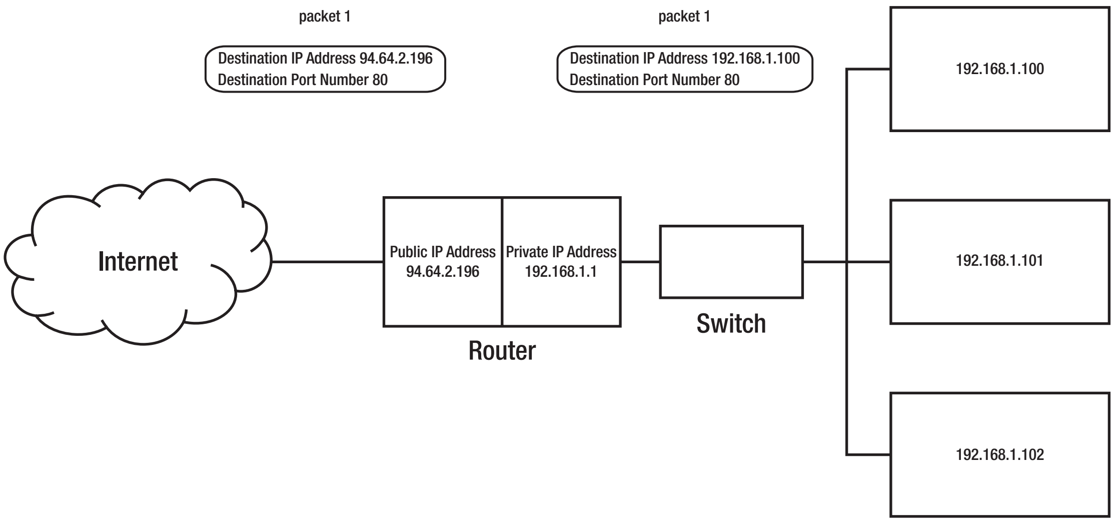
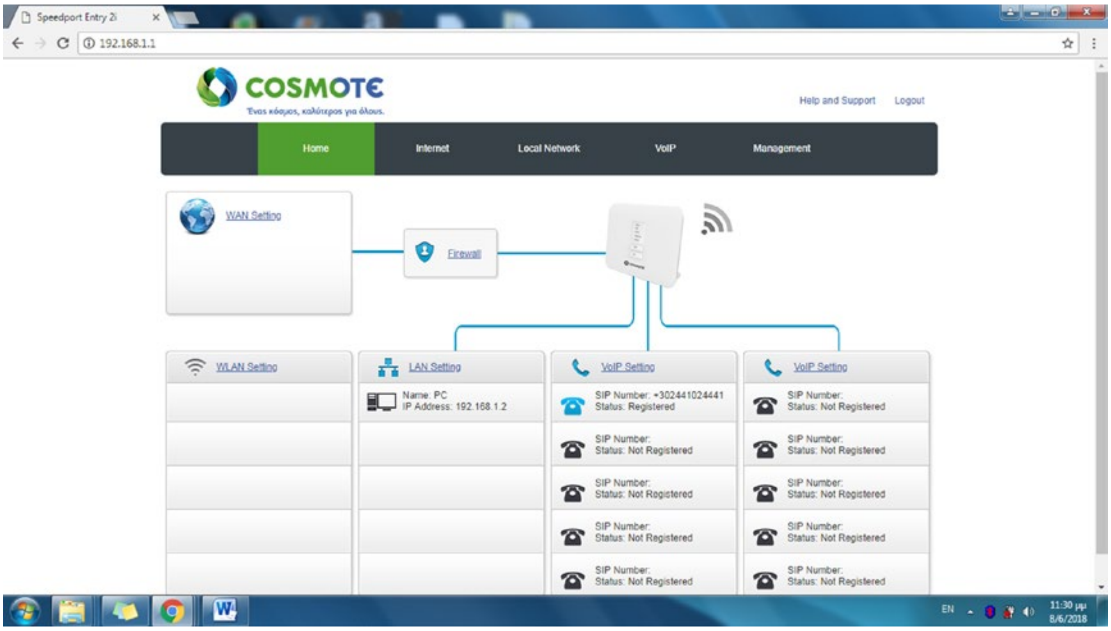

packet 1
Destination IP Address 94.64.2.196
Destination Port Number 80
packet 1
Destination IP Address 192.168.1.100
Destination Port Number 80
Internet
Public IP Address 94.64.2.196
Private IP Address 192.168.1.1
Router
Switch
192.168.1.100
192.168.1.101
192.168.1.102

Figure 3-1. *A packet with destination addresses the public IP address of the router and port number 80 with the dynamic NAT service is forwarded to the private IP address of the web server*

Enabling Port Forwarding to Your Router

To relay HTTP requests aimed at the public IP address of your router with the HTTP port number, you have to apply port forwarding on your web server. When an HTTP request with port 80 (or any other port number that you choose) arrives at the router, it will be forwarded to the private IP address of your web server. Most routers today include port forwarding not only because it's a feature of dedicated web servers but also of many home appliances that act as servers, for instance IP cameras.

Most router configuration options are accessed through the HTTP or Telnet protocol. To use the first approach, enter the private IP address of your router in the address bar of your browser and provide the username and the password to go to the web-based router setup page. Locate the Port Forwarding option in the main menu of your router. For the examples in this book, the private IP address of the router is 192.168.1.1. When using this address in the browser's address bar, the web page for the router appears; Figure 3-2 shows the page for the Speedport Entry 2i VDSL router.



Name: PC
IP Address: 192.168.1.2

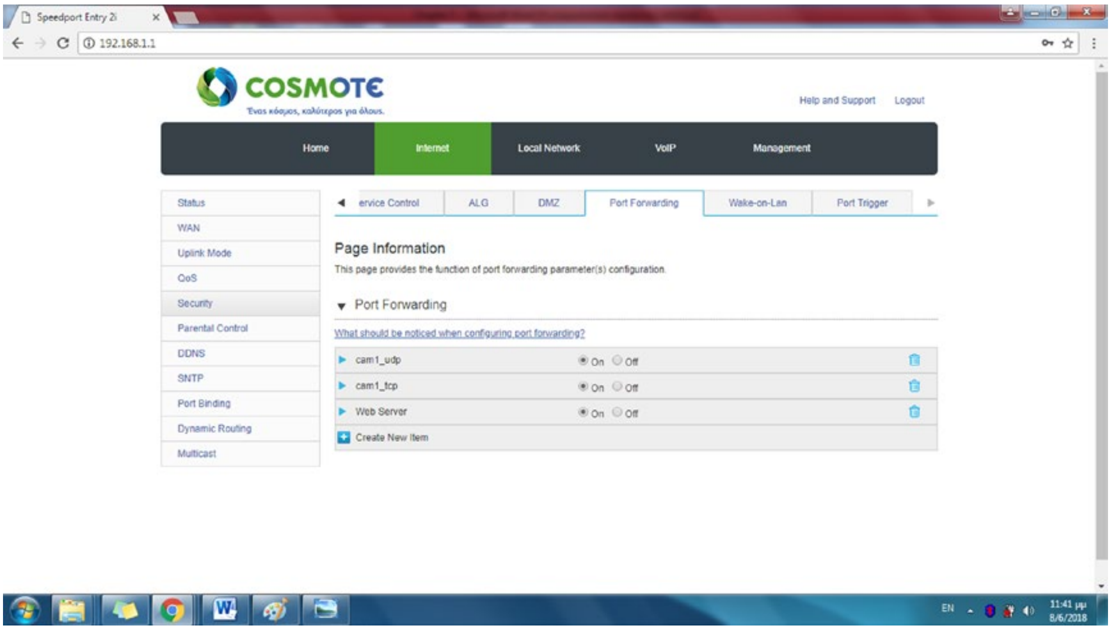
SIP Number: +302441024441
Status: Registered

SIP Number:
Status: Not Registered

Figure 3-2. *The home web page for the web-based configuration interface of the test router*

Click the Firewall link to go to the web page where the Port Forwarding option is available below the main navigation bar.

Click the Port Forwarding link to go to the web page displayed in Figure 3-3.



Page Information

This page provides the function of port forwarding parameter(s) configuration.

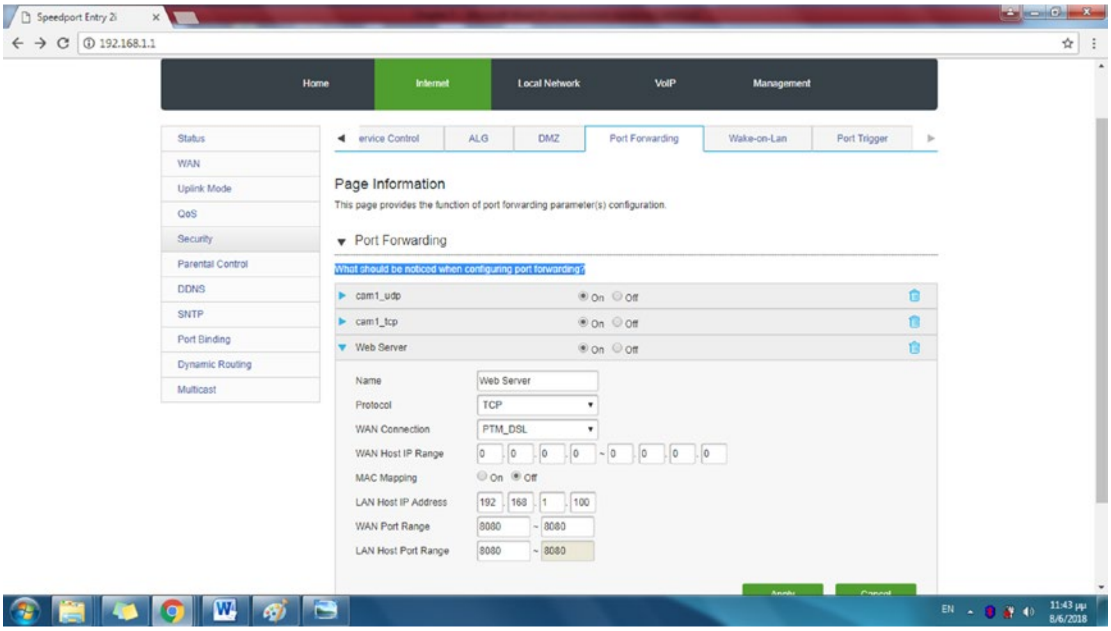
Port Forwarding

What should be noticed when configuring port forwarding?

cam1_udp	[✓ On] Off
cam1_tcp	[✓ On] Off
Web Server	[✓ On] Off

Figure 3-3. *The Port Forwarding configuration web page*

Click the Create New Item button to create a new entry for the Port Forwarding list. The form elements for the Port Forwarding settings appear, as shown in Figure 3-4.



Page Information

This page provides the function of port forwarding parameter(s) configuration.

Port Forwarding

What should be noticed when configuring port forwarding?

cam1_udp	[✓ On] Off
cam1_tcp	[✓ On] Off
Web Server	[✓ On] Off

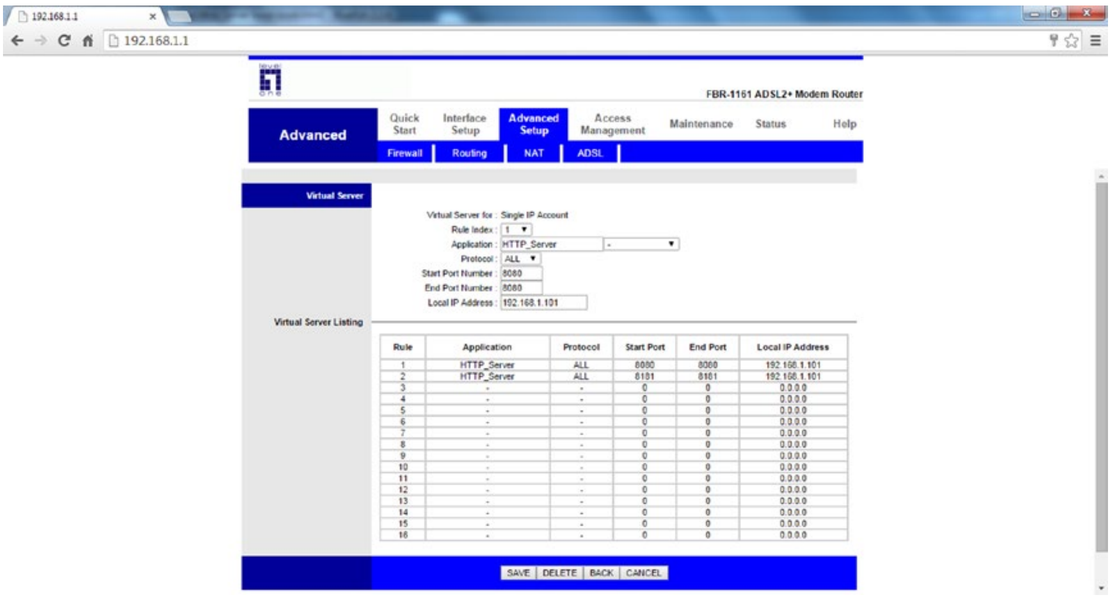
Name	Web Server
Protocol	TCP
WAN Connection	PTM_DSL
WAN Host IP Range	0.0.0.0 ~ 0.0.0.0
MAC Mapping	On [✓ Off]
LAN Host IP Address	192.168.1.100
WAN Port Range	8080 ~ 8080
LAN Host Port Range	8080 ~ 8080

Figure 3-4. *The form with the port forwarding details*

Enter a name for the service you implemented with port forwarding in the Name field, e.g., **Web Server**. Enter the private IP address for this computer, e.g., **192.168.1.100** (in the field LAN Host IP Address), and enter the port numbers you will use for the web service, e.g., **8080** (in the fields WAN Port Range and LAN Host Port Range). For the Protocol option, select TCP from the drop-down list to implement the HTTP protocol. Click the Apply button to confirm the settings. The new entry appears in the Port Forwarding list.

This is a good chance to add all the port numbers used for the HTTP and HTTPS protocols for the examples in this book. You can assign the computer with the private IP address of 192.168.1.100 the responsibility of receiving the TCP/IP packets on your LAN for the port numbers 80, 8080, 8181, and 443.

Each router model uses a different GUI environment to provide the Port Forwarding settings. Figure 3-5 shows the configuration page of the FBR-1161 LevelOne ADSL router, which displays the settings under the NAT option of the Advanced Setup menu.



Virtual Server for : Single IP Account
Rule Index : 1
Application : HTTP_Server -
Protocol : ALL
Start Port Number : 8080
End Port Number : 8080
Local IP Address : 192.168.1.101

Rule	Application	Protocol	Start Port	End Port	Local IP Address
1	HTTP_Server	ALL	8080	8080	192.168.1.101
2	HTTP_Server	ALL	8181	8181	192.168.1.101
3	-	-	0	0	0.0.0.0
4	-	-	0	0	0.0.0.0
5	-	-	0	0	0.0.0.0
6	-	-	0	0	0.0.0.0
7	-	-	0	0	0.0.0.0
8	-	-	0	0	0.0.0.0
9	-	-	0	0	0.0.0.0
10	-	-	0	0	0.0.0.0
11	-	-	0	0	0.0.0.0
12	-	-	0	0	0.0.0.0
13	-	-	0	0	0.0.0.0
14	-	-	0	0	0.0.0.0
15	-	-	0	0	0.0.0.0
16	-	-	0	0	0.0.0.0

Figure 3-5. *The port forwarding web page for the LevelOne FBR-1161 ADSL router*

The previous configuration assigns ports 8080 and 8181 to be forwarded to the LAN computer with IP 192.168.1.101 for *all* protocols (both TCP and UDP).

As a general rule, you have to provide three main settings: the port number on which the port forwarding applies for the router's public IP address, the private IP address of the LAN computer assigned with the task to dispatch client requests for this specific port, and TCP as the transport protocol used for the HTTP and HTTPS services. As each router implements a different user interface for the web-based settings, it is useful to locate your specific router model options for port forwarding at `https://portforward.com/router.htm`.

Implementing Port Forwarding with Apache Vhosts

To implement the port forwarding feature, you can use the `example1.conf` configuration file from Chapter 1, which is a simple copy of the file `000-default.conf` and which utilizes the default HTTP port 80. If your ISP blocks requests to this port, you can use another Apache virtual host that serves another port, for instance the HTTP alternate port, 8080. In that case, use the following commands at the Linux terminal to create a new configuration file by copying and modifying the default Apache configuration file `000-default.conf`:

```
$ cd /etc/apache2/sites-available
$ sudo cp 000-default.conf example4.conf
```

Use a text editor to edit the file `example4.conf`.

```
$ sudo gedit example4.conf
```

Change just the first two lines as indicated next:

```
Listen 8080
<VirtualHost *:8080>
        # The ServerName directive sets the request scheme, hostname and port that
        # the server uses to identify itself. This is used when creating
        # redirection URLs. In the context of virtual hosts, the ServerName
        # specifies what hostname must appear in the request's Host: header to
        # match this virtual host. For the default virtual host (this file) this
        # value is not decisive as it is used as a last resort host
          regardless.
        # However, you must set it for any further virtual host explicitly.
        #ServerName www.example.com

        ServerAdmin webmaster@localhost
        DocumentRoot /var/www/html

        # Available loglevels: trace8, ..., trace1, debug, info, notice, warn,
        # error, crit, alert, emerg.
        # It is also possible to configure the loglevel for particular
        # modules, e.g.
        #LogLevel info ssl:warn

        ErrorLog ${APACHE_LOG_DIR}/error.log
        CustomLog ${APACHE_LOG_DIR}/access.log combined

        # For most configuration files from conf-available/, which are
        # enabled or disabled at a global level, it is possible to
        # include a line for only one particular virtual host. For example the
        # following line enables the CGI configuration for this host only
        # after it has been globally disabled with "a2disconf".
        #Include conf-available/serve-cgi-bin.conf
</VirtualHost>

# vim: syntax=apache ts=4 sw=4 sts=4 sr noet
```

The first directive, `Listen 8080`, instructs Apache to listen on TCP port 8080. The starting `<VirtualHost *:8080>` container is used with the end `</VirtualHost>` container to enclose the group of directives that apply to the new vhost. The wildcard asterisk (*) with the port number 8080 appended with a colon indicates that the enclosed directives apply to incoming requests destined to any one of the available IP addresses (*) of the web server over port 8080.

Click the Save button of the gedit window to apply the configuration to the vhost. Next you need to enable the new configuration with the `a2ensite` command.

```
$ sudo a2ensite example4
```

To disable any previous configuration files that utilize the same port, for instance `example2.conf`, to avoid conflictions, use the `a2dissite` command.

```
$ sudo a2dissite example2
```

To enable the new configuration file, you need to reload the web server.

```
$ sudo service apache2 force-reload
```

If you intend to use port 8080 with the Apache server, you should configure ufw, the Linux firewall, to permit it. For port number 80, no actions are required because you already allowed this port in Chapter 1. Enter the following at the Linux terminal:

```
$ sudo ufw allow 8080
```

Testing the New Virtual Host

To implement the router's port forwarding service, you have to access your site from an external LAN using the public IP address of your router. The common case is your ISP assigns your router a dynamic public IP address that changes, e.g., each time the router restarts. Alternatively, an ISP can offer static IP addresses, usually after the client's request. In each case, to find the current public IP address of your router, use an online service like `https://bearsmyip.com/`. The current public IP address of your router is displayed in your browser, as shown in Figure 3-6.

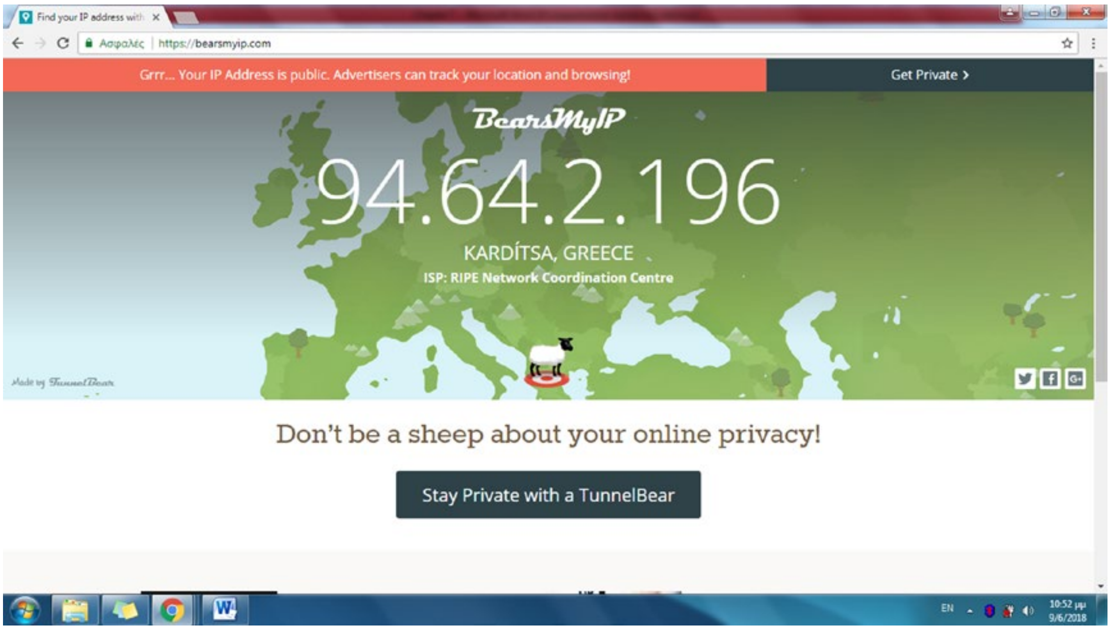

Find your IP address with
Ασφαλές | https://bearsmyip.com
Grrr... Your IP Address is public. Advertisers can track your location and browsing!
Get Private >
BearsMyIP
94.64.2.196
KARDÍTSA, GREECE
ISP: RIPE Network Coordination Centre
Made by TunnelBear
Don't be a sheep about your online privacy!
Stay Private with a TunnelBear
EN
10:52 μμ
9/6/2018

Figure 3-6. *Discovering the public IP address of the router with an online service*

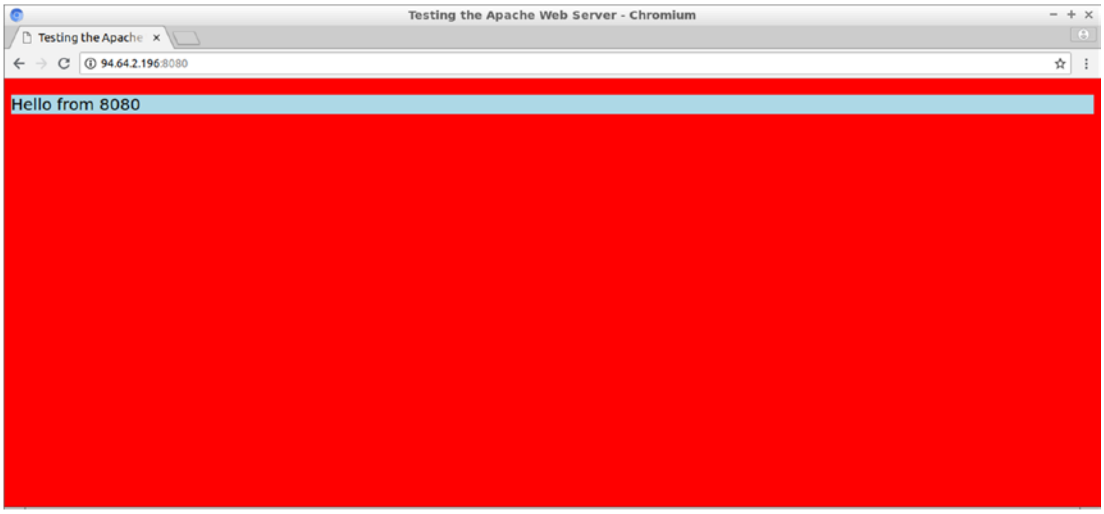
Enter the URL consisting of this IP address in your browser's address bar from a LAN computer.

```
http://94.64.2.196
```

Alternatively, if you utilize port 8080 for your web server, enter the following:

```
http://94.64.2.196:8080
```

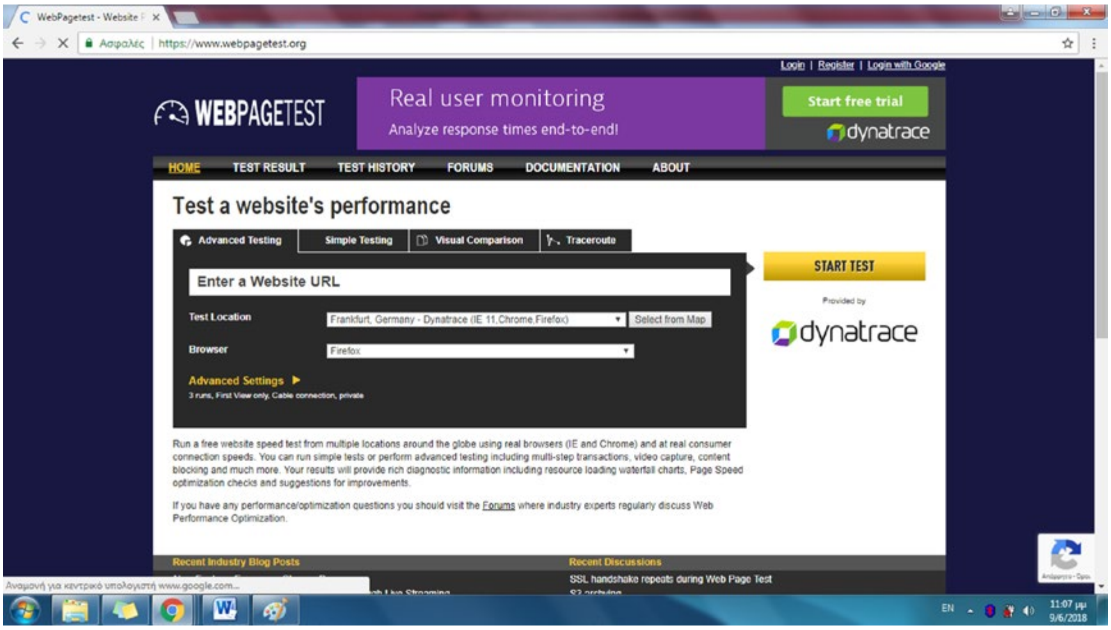
Your directory index is displayed in your browser, as shown in Figure 3-7.



Hello from 8080

Figure 3-7. *Testing the site using the public IP address of your router, from a computer of your LAN*

To make the test definitive, you next have to request the web page from an external computer to your LAN. You can either use your mobile phone's Internet connection and view the web page with the previous URL or have a remote computer make the connection for you. There are many online services for testing web pages from various positions around the world. Actually, in Chapter 5, you will follow the steps to create a similar Internet service all by yourself. Such an online service is `www.webpagetest.org`. Using the images sent to your browser by this site, you can view the web page the way it is downloaded to the site's remote browser. You can even choose the country, city, and browser, and also view statistics such as the download time. Figure 3-8 shows the `webpagetest.org` home page.



Test a website's performance

Enter a Website URL

Test Location: Frankfurt, Germany - Dynatrace (IE 11,Chrome,Firefox) | Select from Map

Browser: Firefox

Advanced Settings ▶
3 runs, First View only, Cable connection, private

Run a free website speed test from multiple locations around the globe using real browsers (IE and Chrome) and at real consumer connection speeds. You can run simple tests or perform advanced testing including multi-step transactions, video capture, content blocking and much more. Your results will provide rich diagnostic information including resource loading waterfall charts, Page Speed optimization checks and suggestions for improvements.

If you have any performance/optimization questions you should visit the Forums where industry experts regularly discuss Web Performance Optimization.

SSL handshake repeats during Web Page Test

Figure 3-8. The home page of webpagetest.org

Enter the URL you want to test in the main textbox.

```
94.64.2.196
```

Or if you use a different port such as port 8080 instead of the default HTTP port, append the port number to the IP address with a colon. Here's an example:

```
94.64.2.196:8080
```

Use the Test Location drop-down list to select a location (country and city) where the request to your server will originate from, and select the browser used from the Browser drop-down list. Click the Start Test button. After a few seconds, images of your web page are displayed along with info about the download time and the web page's size. Figure 3-9 displays the result web page.

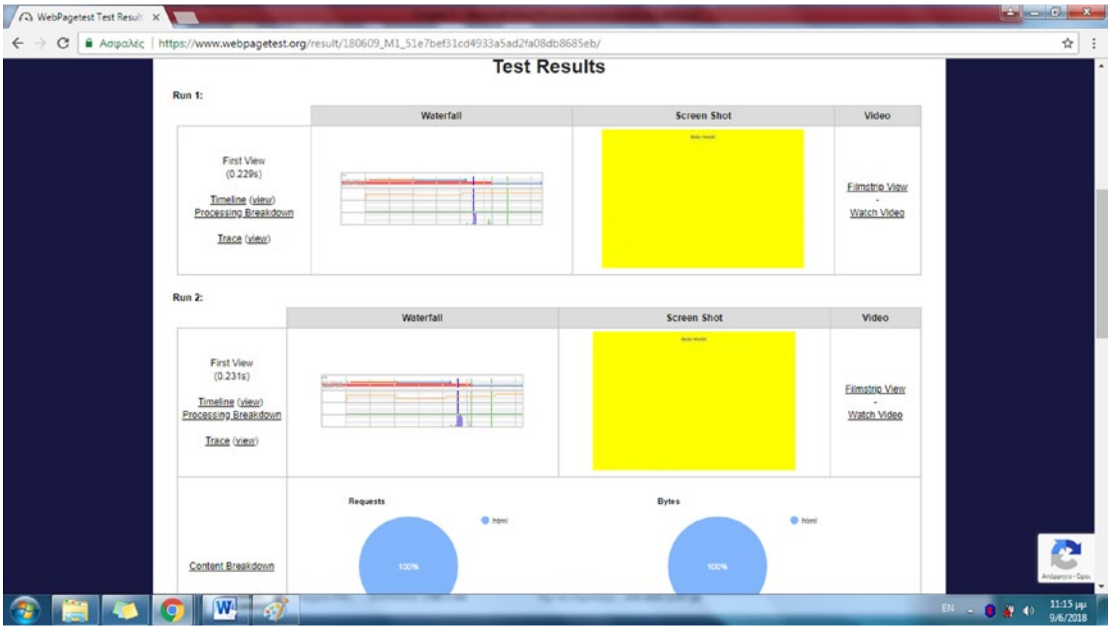


Figure 3-9. *The result web page for testing your site remotely with webpagetest.org*

On the web page in your browser, you can view screenshots of the directory index, each one taken from different tests for your site. You can click those images to enlarge them. This test verifies that your web site is able to be viewed externally.

With your site available to users throughout the world, you can make use of the GeoIP Apache module to give your web server information about the visitor's location based on their IP address. The PHP source code will use these geographical details and return geographical information in the web page sent back to the user.

Using the GeoIP Apache Module

With the online service proving that your web pages are available to the whole Internet, it is a good chance to use a geolocation service to retrieve information about the origin of the users visiting your site and at the same time try an Apache module. With a geolocation service, the IP addresses of your visitors are compared to a database and are matched to specific countries, cities, geographical coordinates (latitude or longitude), etc. Those values are assigned to the Apache server variables for each client's request and become available from the PHP engine.

With the following steps, you will implement a geolocation service with MaxMind's Apache module `geoip_module`.

Hint! To avoid prepending the `sudo` keyword in the following commands, enter the following at the Linux terminal:

```
$ sudo su
```

Install `geoip_module` with the following command:

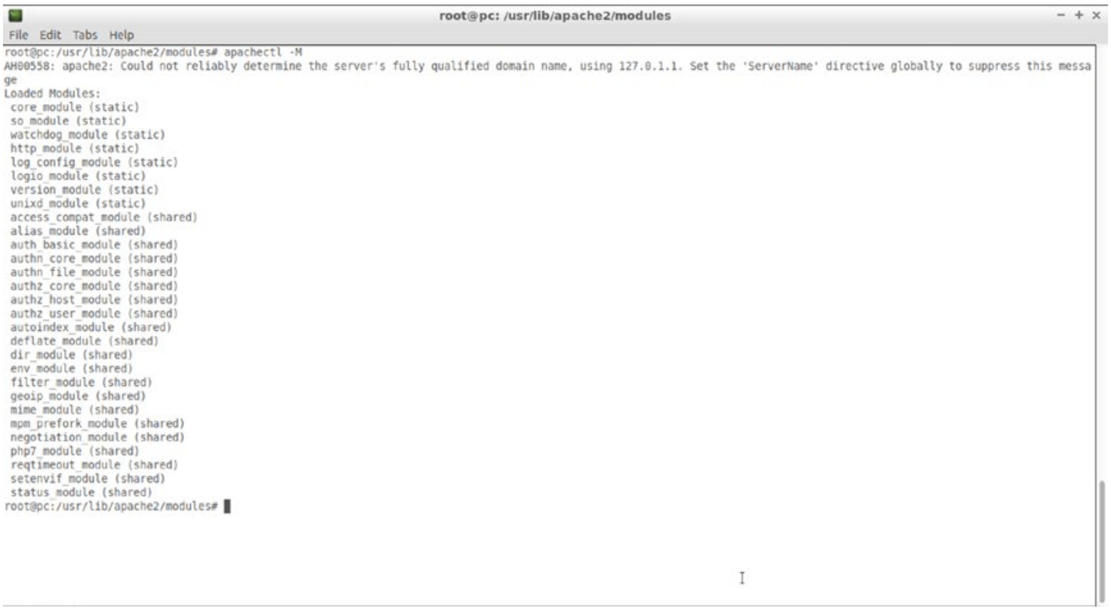
```
$ apt-get install libapache2-mod-geoip
```

The `geoip_module` shared object file (`mod_geoip.so`), which includes the compiled source code used by Apache, is installed in the directory `/usr/lib/apache2/modules`.

The `geoip_module` module is included among the other Apache modules loaded from Apache. Use the following command to view the list of loaded modules:

```
$ apache2ctl -M
```

Figure 3-10 displays the list of modules currently loaded.



```
root@pc:/usr/lib/apache2/modules# apachectl -M
AH00558: apache2: Could not reliably determine the server's fully qualified domain name, using 127.0.1.1. Set the 'ServerName' directive globally to suppress this messa
ge
Loaded Modules:
 core_module (static)
 so_module (static)
 watchdog_module (static)
 http_module (static)
 log_config_module (static)
 logio_module (static)
 version_module (static)
 unixd_module (static)
 access_compat_module (shared)
 alias_module (shared)
 auth_basic_module (shared)
 authn_core_module (shared)
 authn_file_module (shared)
 authz_core_module (shared)
 authz_host_module (shared)
 authz_user_module (shared)
 autoindex_module (shared)
 deflate_module (shared)
 dir_module (shared)
 env_module (shared)
 filter_module (shared)
 geoip_module (shared)
 mime_module (shared)
 mpm_prefork_module (shared)
 negotiation_module (shared)
 php7_module (shared)
 reqtimeout_module (shared)
 setenvif_module (shared)
 status_module (shared)
root@pc:/usr/lib/apache2/modules#
```

Figure 3-10. *Command apache2ctl -M returns the list of loaded Apache modules*

You can find the module's configuration files in the directory called `mods-available`. Using gedit from the Linux terminal, edit the configuration file `geoip.conf` of the `geoip_module` as follows:

```
$ gedit /etc/apache2/mods-available/geoip.conf
Set the GeoIPEnable directive from Off to On. The configuration file
includes then the following directives:
<IfModule mod_geoip.c>
  # For performance reasons, it's not recommended to turn GeoIP on
    serverwide,
  # but rather only in <Location> or <Directory> blocks where it's actually
  # needed.
  GeoIPEnable On
  GeoIPDBFile /usr/share/GeoIP/GeoIP.dat
</IfModule>
```

Enable the new configuration file using the `a2enmod` (apache2 enable module) command:

```
$ a2enmod geoip
```

Hint! If you need to disable the `GeoIP` module, you can use the `a2dismod` (apache2 disable module) command as follows:

```
$ a2dismod geoip
```

`geoip_module` is included now as a symbolic link to the directory `/etc/apache2/mods-enabled`.

Reload Apache using this:

```
$ sudo service apache2 force-reload
```

`geoip_module` looks up the client's IP address from MaxMind's database. The following are the steps to download the GeoIP database.

Change the working directory to `GeoIP`.

```
$ cd /usr/share/GeoIP/
```

wget is a command-line utility for downloading web pages and other resources with web protocols. You will use wget next to download the `GeoIP.dat.gz` zipped database file:

```
$ wget http://geolite.maxmind.com/download/geoip/database/GeoLiteCountry/
GeoIP.dat.gz
```

Decompress with the gunzip utility the zipped file `GeoIP.dat.gz` to the `GeoIP.dat` database file.

```
$ gunzip GeoIP.dat.gz
```

Create a PHP file for testing the GeoIP database.

Use gedit to create a PHP file called `geo1.php`.

```
$ gedit geo1.php
```

Enter the following PHP source code in the file `geo1.php`, which includes the function `apache_note()` and can be used from the Apache server:

```
<!DOCTYPE html>
<html>
<body>
<?php
$country_name = apache_note("GEOIP_COUNTRY_NAME");
print "Your Country: " . $country_name;
?>
</body>
</html>
```

The previous source code makes use of `apache_note()`, an Apache-specific function that accesses the Apache notes table to retrieve the information exchanged between Apache modules. The file `geo2.php`, on the other hand, includes PHP source code that can be used independently from other web servers as well.

```
<!DOCTYPE html>
<html>
<body>
<?php
$country_name = $_SERVER["GEOIP_COUNTRY_NAME"];
```

```
print "Your Country: " . $country_name;
?>
</body>
</html>
```

With the GeoIP module enabled, the web server looks up the IP address of the client in the database files and sets environment variables such as `GEOIP_COUNTRY_NAME` used next from the PHP global variable `$_SERVER`, for instance `$_SERVER["GEOIP_COUNTRY_NAME"]`.

Hint! You can test the environment variables with the following PHP code:

```
<?php
echo 'Client IP Address: '   . getenv('GEOIP_ADDR') . "<br>";
echo 'Client Country Code: ' . getenv('GEOIP_COUNTRY_CODE') . "<br>";
echo 'Client Country Name: ' . getenv('GEOIP_COUNTRY_NAME') . "<br>";
echo 'Client City: ' . getenv('GEOIP_CITY');
?>
```

Insert the previous source code in a PHP file located in the document root of your web server and request this file next in your browser. Here is some sample output:

```
Client IP Address: 206.189.190.142
Client Country Code: US
Client Country Name: United States
Client City: Chicago
```

Test the files `geo1.php` and `geo2.php` using a web page tester like webpagetest.org. On the home page of this site, enter a URL that includes the current IP public address of your router and the port set in the port forwarding service of your router, relative to the document root path of the PHP file you are testing. Here's an example:

```
94.64.2.196/geo1.php
```

If you are using another port other than the default, append this port number with a colon to the IP address, as shown here:

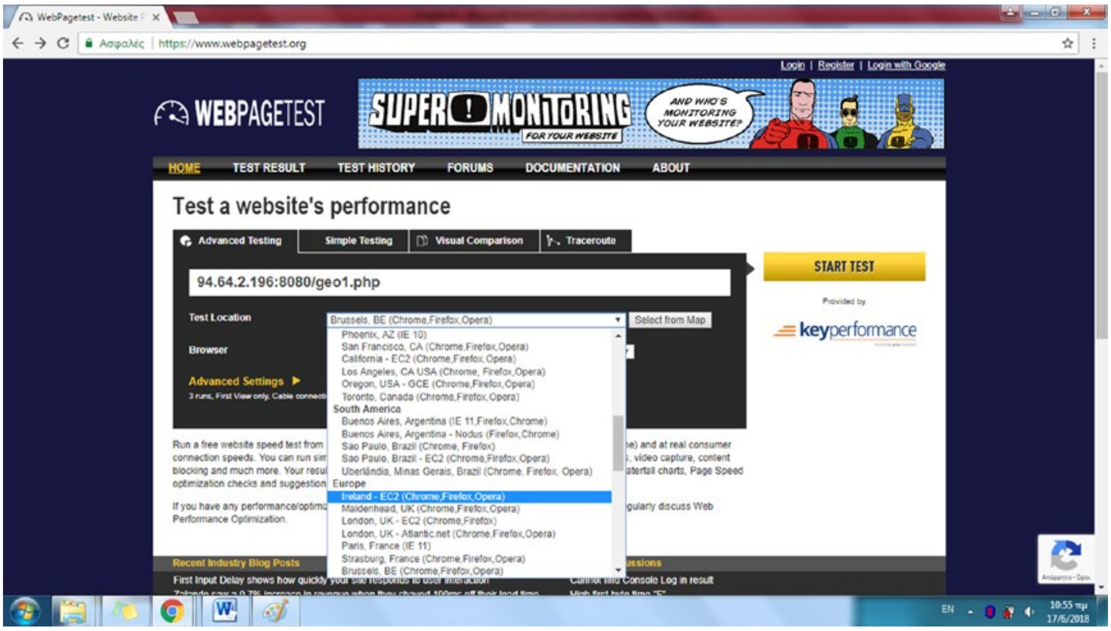
```
94.64.2.196:8080/geo1.php
```

Select a country in the Test Location drop-down list, as shown in Figure 3-11, where the test will run from. For instance, in the following test, Ireland was selected:

```
Ireland – EC2
```

Select also the browser's name in the Browser drop-down list.

```
Chrome
```



94.64.2.196:8080/geo1.php

Test Location: Brussels, BE (Chrome,Firefox,Opera)

Browser

Phoenix, AZ (IE 10)
San Francisco, CA (Chrome,Firefox,Opera)
California - EC2 (Chrome,Firefox,Opera)
Los Angeles, CA USA (Chrome, Firefox,Opera)
Oregon, USA - GCE (Chrome,Firefox,Opera)
Toronto, Canada (Chrome,Firefox,Opera)
South America
Buenos Aires, Argentina (IE 11,Firefox,Chrome)
Buenos Aires, Argentina - Nodus (Firefox,Chrome)
Sao Paulo, Brazil (Chrome, Firefox)
Sao Paulo, Brazil - EC2 (Chrome,Firefox,Opera)
Uberlândia, Minas Gerais, Brazil (Chrome, Firefox, Opera)
Europe
Ireland - EC2 (Chrome,Firefox,Opera)
Maidenhead, UK (Chrome,Firefox,Opera)
London, UK - EC2 (Chrome,Firefox)
London, UK - Atlantic.net (Chrome,Firefox,Opera)
Paris, France (IE 11)
Strasburg, France (Chrome,Firefox,Opera)
Brussels, BE (Chrome,Firefox,Opera)

Figure 3-11. *Selecting at the webpagetest.org site a specific computer in a country where the test will run*

Alternatively, you can select the country from a map using the Select from Map button. The available geographical locations are pinned on the map, as displayed in Figure 3-12. Click a specific pin to use the corresponding remote computer for your test.

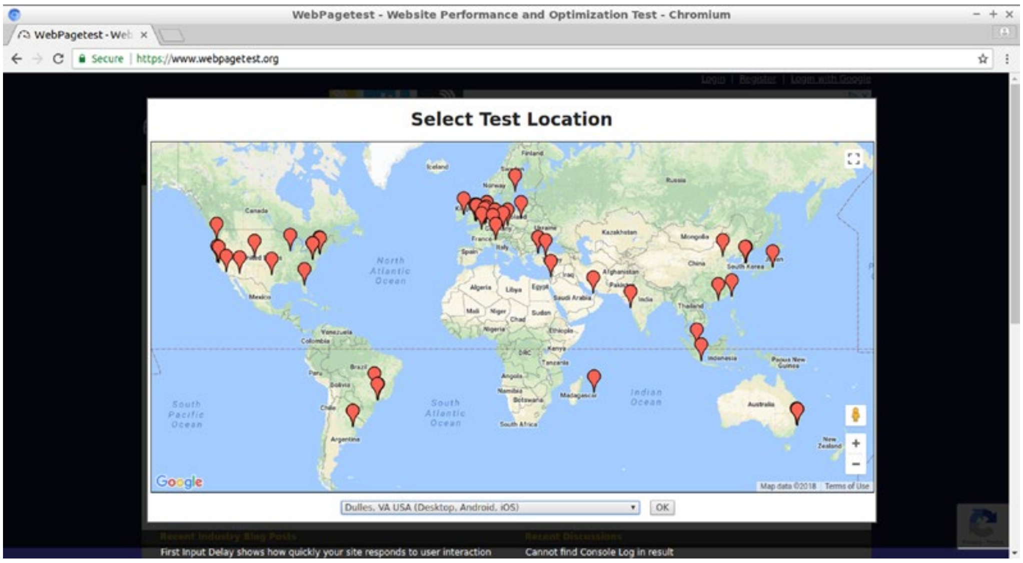

WebPagetest - Website Performance and Optimization Test - Chromium
https://www.webpagetest.org
Select Test Location
Dulles, VA USA (Desktop, Android, iOS)
OK
First Input Delay shows how quickly your site responds to user interaction
Cannot find Console Log in result

Figure 3-12. *Selecting a test computer from the webpagetest.org map*

Click the Start Test button.

Figure 3-13 displays the web page, returned when the test runs, enlarged by clicking it. This is the web page that will appear in the web browser of the user in Ireland.

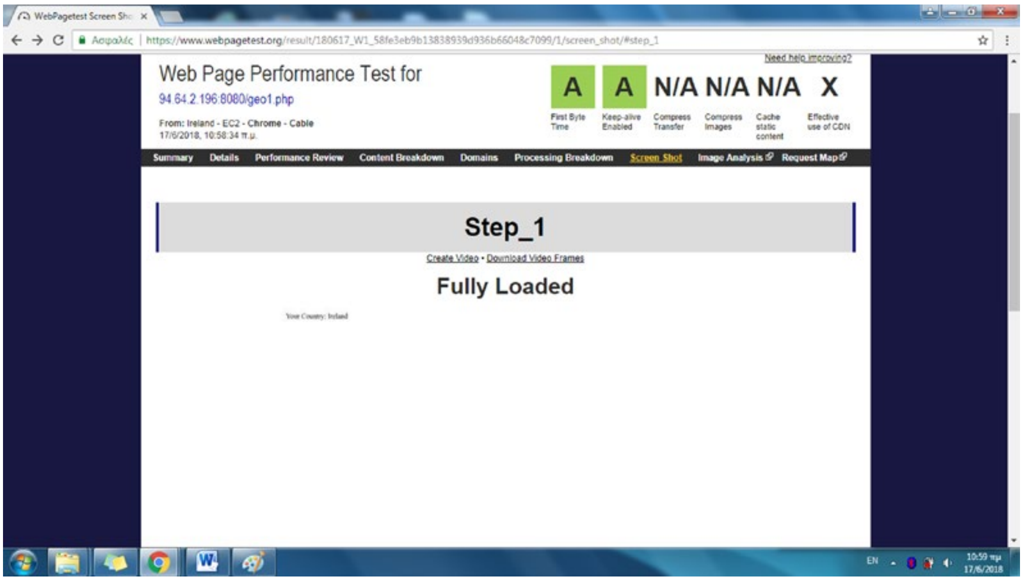

Web Page Performance Test for
94.64.2.196:8080/geo1.php
From: Ireland - EC2 - Chrome - Cable
A A N/A N/A N/A X
First Byte Time
Keep-alive Enabled
Compress Transfer
Compress Images
Cache static content
Effective use of CDN
Summary Details Performance Review Content Breakdown Domains Processing Breakdown Screen Shot Image Analysis Request Map
Step_1
Fully Loaded
Your Country: Ireland

Figure 3-13. *The web page displaying "Your Country: Ireland" as it appears on the computer located in Ireland*

The web page displays the following:

```
Your Country: Ireland
```

Hint! Notice that the geolocation service is not always accurate. Also, the GeoIP database file needs to be constantly updated, something that can be automated with a software tool like cron.

In the site in the following section, the geographical information for the user is taken from the PHP source code and processed to display web pages with text corresponding to the time in the official language of the country associated with the user's IP address.

Responding to the Visitor's Native Language

With this next project, you'll create a web site that looks up the IP address of the visitor to the GeoIP database, retrieves the visitor's two-letter country code (ISO 3166-1 alpha-2), and responds by saying "hello" in the official language of that country. This is a simplified example; however, similar techniques are used on the sites of international corporations to provide their content, e.g., device manuals, in different areas of the world.

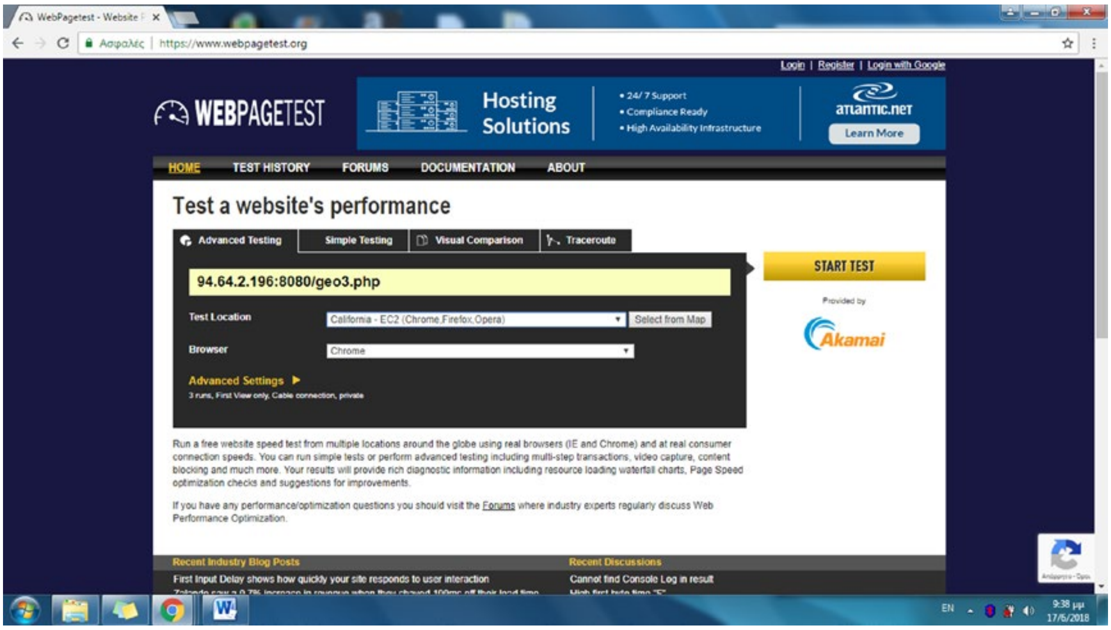
In the document root directory `/var/www/html`, create a file called `geo3.php` with the following source code:

```
<!DOCTYPE html>
<html>
<head>
<style>
p {
font-size:80px;
color:red;
}
</style>
</head>
<body>
<?php

$cc = $_SERVER["GEOIP_COUNTRY_CODE"];
```

```
switch ($cc) {
    case "US":
    case "UK":
        print "<p>hello</p>";
        break;
    case "FR":
        print "<p>bonjour</p>";
        break;
    default:
        print "<p> &#x1F600; </p>";
}

?>
</body>
</html>
```

The PHP code retrieves the `GEOIP_COUNTRY_CODE` environmental variable, whose value is a two-letter country code. A `switch` statement then checks this value against some predefined country codes, for instance, US, UK, and FR. You can add more switch statements for more country codes. For each country, a "hello" message in the corresponding language is printed on the screen. The default statement, which applies for all cases not covered in the previous `switch` statements, prints a Unicode smiley instead of a greeting. The specific smiley used in the example corresponds to Unicode hex code 1F600. To print the characters in a large red font, CSS style properties were used.

Visit the `webpagetest.org` home page to test your server and select a U.S. city from the Test Location list. In the example shown in Figure 3-14, a computer located in California was used.



Test a website's performance

94.64.2.196:8080/geo3.php

Test Location: California - EC2 (Chrome,Firefox,Opera)

Browser: Chrome

Advanced Settings
3 runs, First View only, Cable connection, private

Run a free website speed test from multiple locations around the globe using real browsers (IE and Chrome) and at real consumer connection speeds. You can run simple tests or perform advanced testing including multi-step transactions, video capture, content blocking and much more. Your results will provide rich diagnostic information including resource loading waterfall charts, Page Speed optimization checks and suggestions for improvements.

If you have any performance/optimization questions you should visit the Forums where industry experts regularly discuss Web Performance Optimization.

Recent Industry Blog Posts
First Input Delay shows how quickly your site responds to user interaction

Recent Discussions
Cannot find Console Log in result

Figure 3-14. *Running the test from a computer located in California*

Enter the following URL at the main textbox:

```
94.64.2.196/geo3.php
Or if your server configuration implements port number 8080 use:
94.64.2.196:8080/geo3.php
```

The IP address 94.64.2.196 used in this example should be substituted with the public IP address of your router. Click the Start Test button. The web page in Figure 3-15 displays the content of the web page viewed from the remote computer in California.

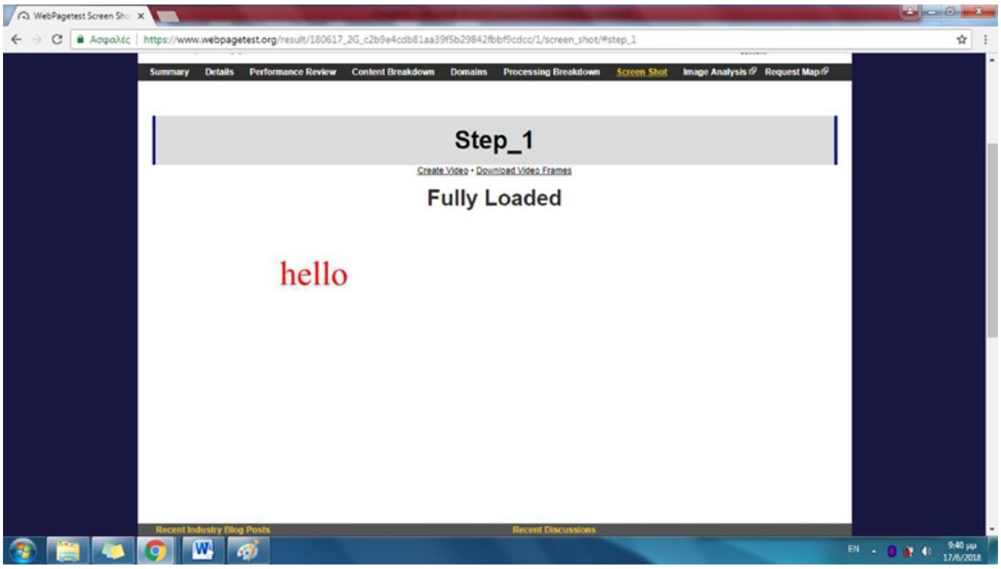
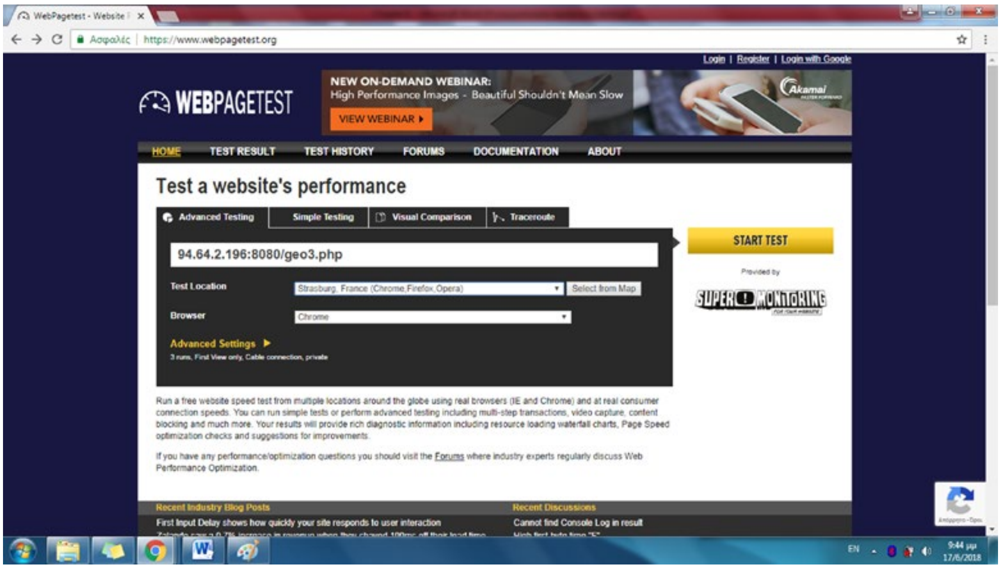


Figure 3-15. The message "hello" displayed in the browser of a test computer located in California

Perform the test again, this time from a French location. On the home page of `webpagetest.org`, displayed in Figure 3-16, a computer from Strasburg is selected to download your specified web page.



94.64.2.196:8080/geo3.php

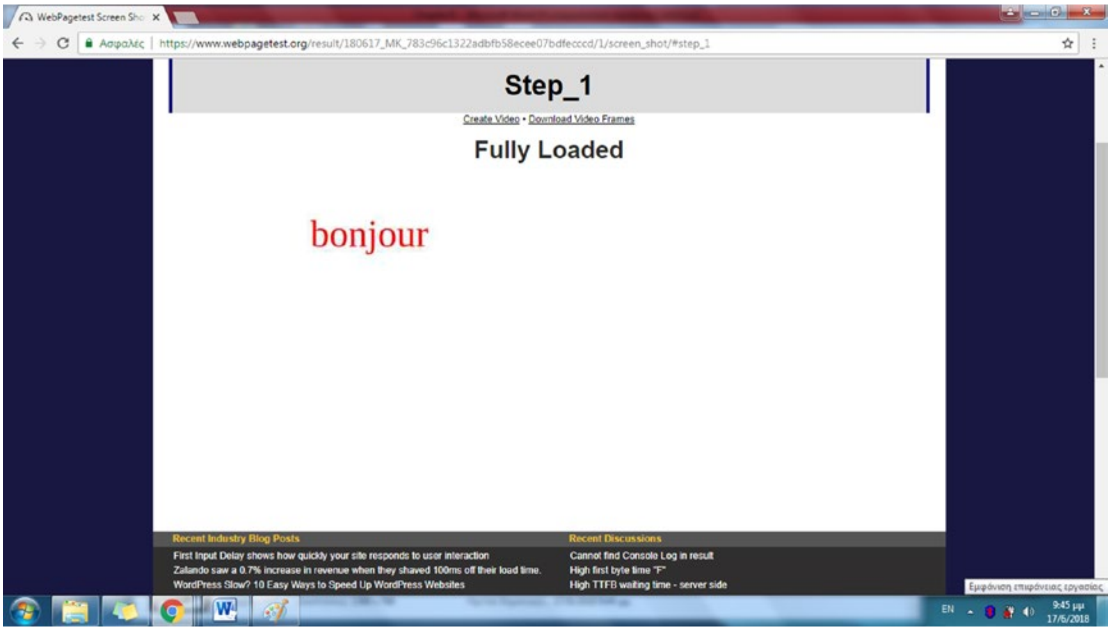
Test Location: Strasburg, France (Chrome,Firefox,Opera)

Browser: Chrome

Advanced Settings: 3 runs, First View only, Cable connection, private

Figure 3-16. Running the test from a computer located in Strasburg

Click the Start Test button to run the test. As displayed in Figure 3-17, the web page of your site greets the visitor with “bonjour.”


WebPagetest Screen Sho
Ασφαλής | https://www.webpagetest.org/result/180617_MK_783c96c1322adbfb58ecee07bdfecccd/1/screen_shot/#step_1
Step_1
Create Video • Download Video Frames
Fully Loaded
bonjour
Εμφάνιση επιφάνειας εργασίας
EN
9:45 μμ
17/6/2018

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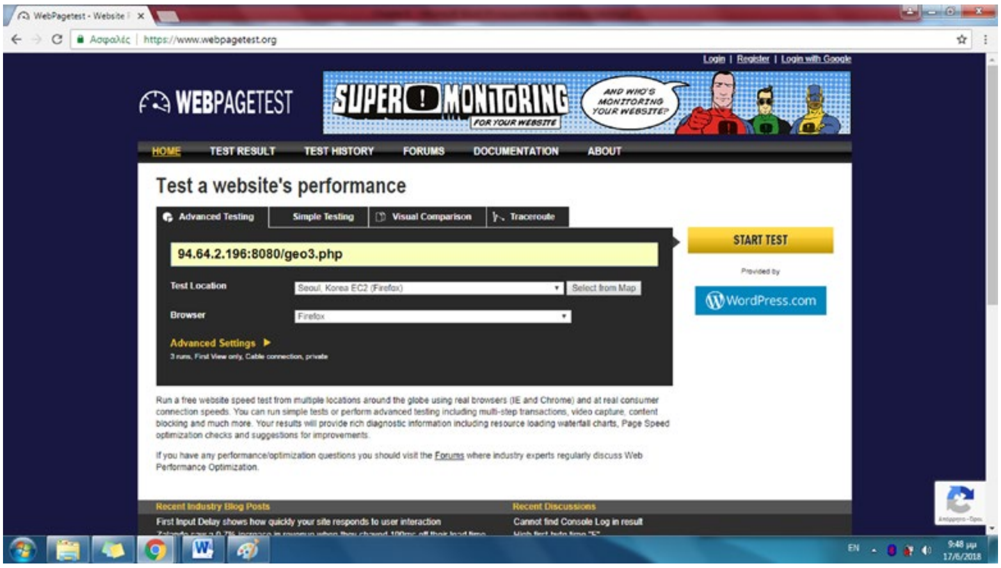
Zalando saw a 0.7% increase in revenue when they shaved 100ms off their load time.
WordPress Slow? 10 Easy Ways to Speed Up WordPress Websites

Recent Discussions
Cannot find Console Log in result
High first byte time "F"
High TTFB waiting time - server side

Figure 3-17. The message “bonjour” displayed in the browser of a computer located in France

Do a final test using a South Korean site. In the example in Figure 3-18, a computer located in Seoul was selected. For simplicity, the PHP code of `geo3.php` supports only three countries, leaving all other country visitors to be welcomed with a smiley.



Test a website's performance

94.64.2.196:8080/geo3.php

Test Location: Seoul, Korea EC2 (Firefox)

Browser: Firefox

Advanced Settings
3 runs, First View only, Cable connection, private

Run a free website speed test from multiple locations around the globe using real browsers (IE and Chrome) and at real consumer connection speeds. You can run simple tests or perform advanced testing including multi-step transactions, video capture, content blocking and much more. Your results will provide rich diagnostic information including resource loading waterfall charts, Page Speed optimization checks and suggestions for improvements.

If you have any performance/optimization questions you should visit the Forums where industry experts regularly discuss Web Performance Optimization.

Recent Industry Blog Posts
First Input Delay shows how quickly your site responds to user interaction

Recent Discussions
Cannot find Console Log in result

Figure 3-18. *Running the test from a computer located in Seoul*

As displayed in Figure 3-19, for a non-US, UK, or France visitor, instead of a written message, the downloaded web page from your site displays a broad smile.

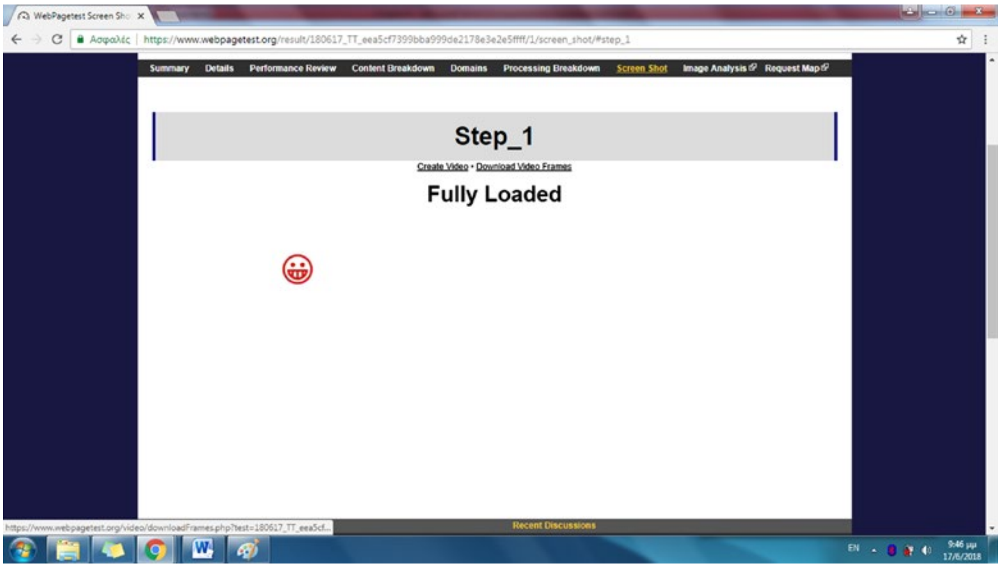


Figure 3-19. *The smiley displayed in the browser of a computer located in Korea*

Another site for testing your page is www.geoscreenshot.com. It performs multiple tests from different locations and displays the results in a single web page. Figure 3-20 shows a test for the geo3.php web page.

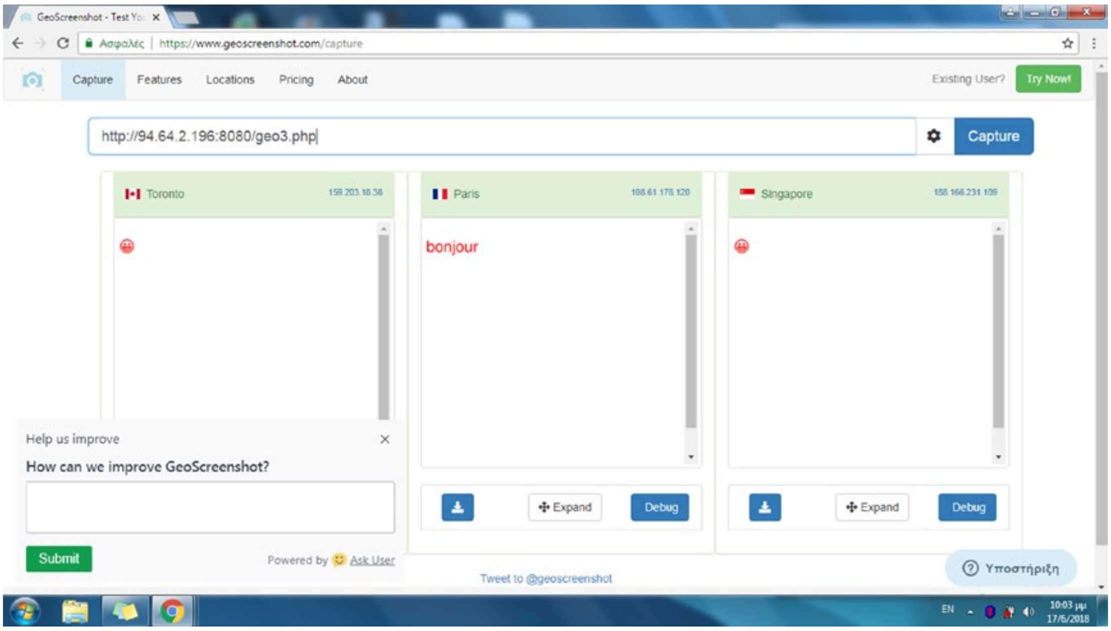


Figure 3-20. *Using geoscreenshot.com to test your site remotely*

In the following section, you'll install another database, GeoIPCity, to look up the IP address of the visitor and retrieve the latitude and longitude associated with the IP address so that the visitor's location on the map is returned to the user.

Using a Map to Display the Visitor's Location

In this project, you'll gather more information about the visitor, such as the city registered with the IP address used and also the geographical coordinates. The latitude and the longitude associated with the IP address of the client can be used to pinpoint the location of the client on a map. To use this information, another database file should also be downloaded and included in the files that the Apache server looks up.

Like previously, type sudo su to avoid prepending most of the following commands with sudo.

```
$ sudo su
```

Move to the GeoIP directory.

```
$ cd /usr/share/GeoIP/
```

Use the wget utility from the command line to download `GeoLiteCity.dat.gz` in the current directory.

```
$ wget http://geolite.maxmind.com/download/geoip/database/GeoLiteCity.dat.gz
```

To uncompress the database file, use the following command:

```
$ gunzip GeoLiteCity.dat.gz
```

Rename the uncompressed database file as required by the Apache module.

```
$ mv GeoLiteCity.dat GeoIPCity.dat
```

Enter the `GeoIPCity.dat` entry in the `geoip.conf` file.

```
$ cd /etc/apache2/mods-available
$ gedit geoip.conf
```

Insert the new entry in `geoip.conf` and save the file. The contents of the configuration file are now as follows:

```
<IfModule mod_geoip.c>
  # For performance reasons, it's not recommended to turn GeoIP on
    serverwide,
  # but rather only in <Location> or <Directory> blocks where it's actually
  # needed.
  GeoIPEnable On
  GeoIPDBFile /usr/share/GeoIP/GeoIP.dat
  GeoIPDBFile /usr/share/GeoIP/GeoIPCity.dat
</IfModule>
```

Reload Apache to enable the new configuration.

```
$ service apache2 force-reload
```

Create another PHP file, called `geo4.php`, in the document root of the web server.

```
$ cd /var/www/html
$ gedit geo4.php
```

Enter the following source code and save the geo4.php file:

```
<!DOCTYPE html>
<html>
<head><title>Location on the map</title>
</head>
<body>
<h1>Your position on the map</h1>
<?php
echo '
<img width="600" src="https://static-maps.yandex.ru/1.x/?lang=en-US&ll='
. $_SERVER['GEOIP_LONGITUDE']
. ','
. $_SERVER['GEOIP_LATITUDE']
. '&z=8&l=map&size=600,300">';
?>
</body>
</html>';
```

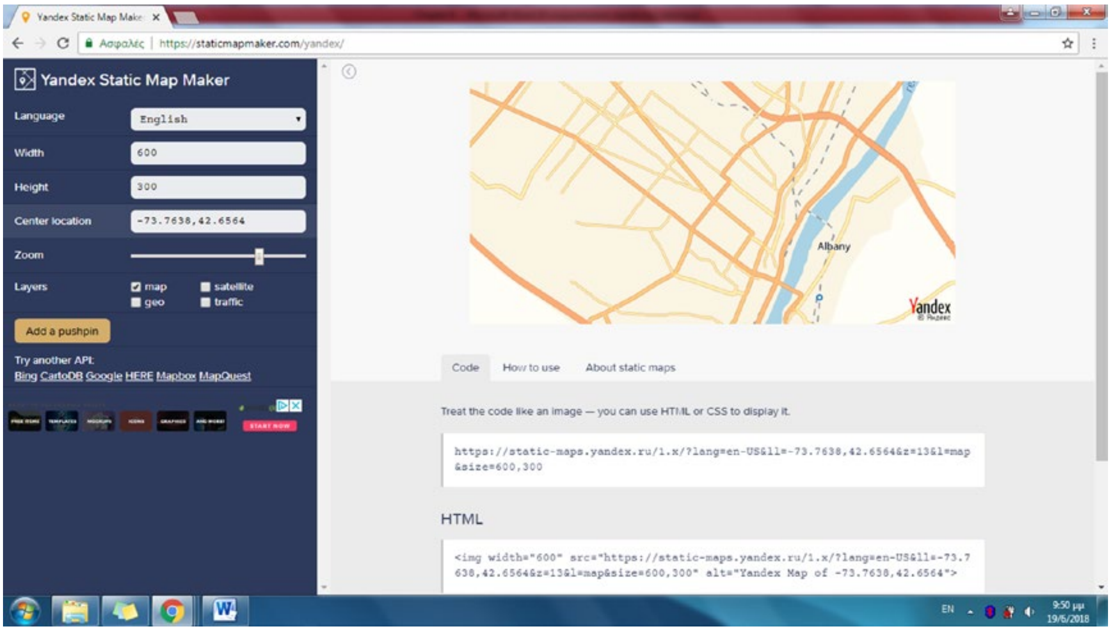
The previous PHP source code injects the basic HTML tags with the echo command. By using a single quote (') instead of a double quote (") in echo, you can maintain the double quotes of the HTML source code without having to escape them with a backslash (\") in order not to intervene with the PHP string delimiter double quotes.

The $_SERVER['GEOIP_LONGITUDE'] and $_SERVER['GEOIP_LATITUDE'] parts that correspond to the visitor's longitude and latitude, respectively, are the PHP global variables. The Apache module sets them by looking up the client's IP address in the GeoIPCity.dat database. The coordinates will be used in the URL value of the src attribute of the image element (img) to create the static map that will be displayed in the web page of the user. Static maps are image files, commonly in PNG or JPEG format, that do not require a mapping library. However, they lack interactivity with controls like the Zoom control or the Map Type control. According to the coordinates in the image URL, a specific area will be displayed that will reflect the origin of the client's host computer.

There are many static map APIs you can use; some require a registration and a fee. In this project, Yandex will be used. At `https://staticmapmaker.com/yandex/`, you can find the following example for using Yandex to create a static map:

```
<img width="600" src="https://static-maps.yandex.ru/1.x/?lang=en-
US&ll=-73.7638,42.6564&z=13&l=map&size=600,300" alt="Yandex Map of -
73.7638,42.6564">
```

The previous tag is inserted into the HTML source code and creates an image with a width of 600 pixels and a height of 300 pixels, with English language labels. It focuses on longitude 73.7638 and latitude 42.6564 with a zooming level set to 13. There is also alternative text (`alt`) in case a problem occurs and the map does not load. Figure 3-21 displays how the user visiting staticmapmaker.com can interact with the Static Map Maker online tool. By using the provided form, the user can use specific geographical coordinates, zoom level, width, and height for the image created, and they can define the category of the map formed, e.g., satellite or traffic. So, you can include this map on a site, a URL with the required query string according to the user settings is also created automatically. The image tag that includes the previous URL as the value of the `src` attribute is also formed to be used readily in the HTML source code.



Language: English
Width: 600
Height: 300
Center location: -73.7638,42.6564
Zoom
Layers: [✓ map] geo satellite traffic

Treat the code like an image — you can use HTML or CSS to display it.

```
https://static-maps.yandex.ru/1.x/?lang=en-US&ll=-73.7638,42.6564&z=13&l=map
&size=600,300
```

HTML

```
<img width="600" src="https://static-maps.yandex.ru/1.x/?lang=en-US&ll=-73.7
638,42.6564&z=13&l=map&size=600,300" alt="Yandex Map of -73.7638,42.6564">
```

***Figure 3-21.** Using the Static Map Maker tool to create a static map image*

You can use the format of the image element from Static Map Maker for the static map included in your web page. The basic attributes of the static map are set in the query string of the URL value of the `src` attribute. For instance, in the source code of `geo4.php`, the zoom level was set to 8 (`z=8`). The longitude and the latitude were replaced by the PHP global variables `$_SERVER['GEOIP_LONGITUDE']` and `$_SERVER['GEOIP_LATITUDE']` to hold the values associated with the client's IP address. To form the `src` attribute, which includes the PHP global variables, a number of `echo` commands are used.

```
<?php
echo '
<img width="600" src="https://static-maps.yandex.ru/1.x/?lang=en-US&ll='
. $_SERVER['GEOIP_LONGITUDE']
. ','
. $_SERVER['GEOIP_LATITUDE']
. '&z=8&l=map&size=600,300">
';
?>
```

To test this web page, use an online service like `whatismyipaddress.com` to find the public IP address of your router and replace it with the IP address used in this example, 87.202.116.192:

```
87.202.116.192/geo4.php
Or if you utilize port number 8080 use:
87.202.116.192:8080/geo4.php
```

Figure 3-22 displays the requested web page `geo4.php` from a computer in the LAN where the web server is hosted for this example.

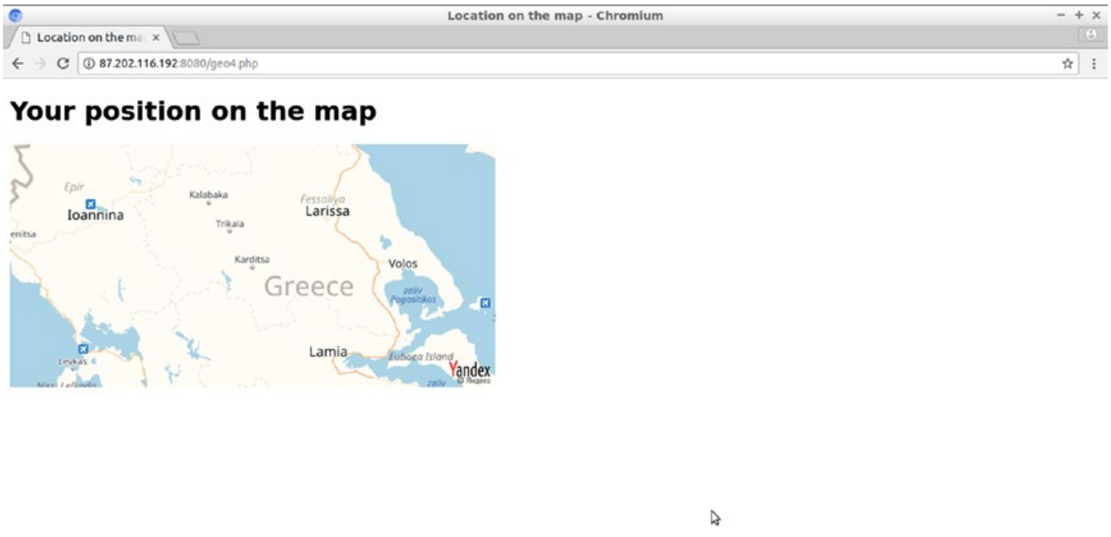


Figure 3-22. *Testing geo4.php from a computer of your LAN*

Right-click the web page and select View Page Source to display the web page source code and find the values for `$_SERVER['GEOIP_LONGITUDE']` and `$_SERVER['GEOIP_LATITUDE']` as included in the query string of the `src` attribute in the image element. For the previous example, the image element is formed as follows:

```
<img width="600" src="https://static-maps.yandex.ru/1.x/?lang=en-US&ll=21.9
21600,39.365601&z=8&l=map&size=600,300">
```

Rename the `geo4.php` file as `geo5.php` and use it to make a new version of the previous source code.

```
$ cp geo4.php geo5.php
$ gedit geo5.php
```

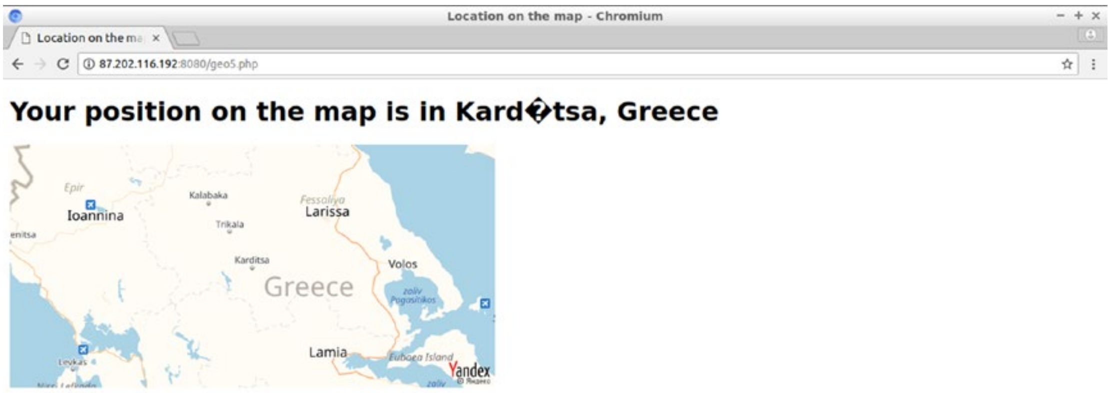
The contents of `geo5.php` are displayed here:

```
<!DOCTYPE html>
<html>
<head>
<title>Location on the map</title>
</head>
<body>
<h1>Your position on the map is in&nbsp;
```

```
<?php
echo $_SERVER['GEOIP_CITY']
. ',&nbsp;'
. $_SERVER['GEOIP_COUNTRY_NAME']
. '</h1><img width="600" src="https://static-maps.yandex.ru/1.x/?lang=en-
  US&ll='
. $_SERVER['GEOIP_LONGITUDE']
. ','
. $_SERVER['GEOIP_LATITUDE']
. '&z=8&l=map&size=600,300"></body></html>';
?>
</body>
</html>
```

Two more PHP global variables are used in the previous source code: `$_SERVER['GEOIP_CITY']`, which holds the name of the city and `$_SERVER['GEOIP_COUNTRY_NAME']`, which corresponds to the name of the country as registered with the client's IP address.

Using the URL of file geo5.php, the web page is displayed, as shown in Figure 3-23.



Your position on the map is in Kard�tsa, Greece

Figure 3-23. *Testing geo5.php*

In the next section of this chapter, you'll make changes to improve the appearance of the previous site.

A New Version of the Static Map Web Page

Here you'll use gedit to create in the document root of your web server a new version of the geo5.php file, called geo6.php.

```
$ cd /var/www/html
$ sudo gedit geo6.php
```

Enter the following source code and save the file:

```
<!DOCTYPE html>
<html>
<head>
<title>Your Location</title>
<style>
body{
background-color:#B9D6E5;
}
.center {
margin: auto;
}
p{
text-align: center;
}
</style>
</head>
<body>
<div class="center">
<p>
<?php
echo '
<h1 style="text-align:center">Your position on the map is in&nbsp;'
. $_SERVER['GEOIP_CITY']
. ',&nbsp;'
. $_SERVER['GEOIP_COUNTRY_NAME']
. '</h1><p><img width="600" src="https://static-maps.yandex.
  ru/1.x/?lang=en-US&ll='
. $_SERVER['GEOIP_LONGITUDE']
. ','
. $_SERVER['GEOIP_LATITUDE']
. '&z=4&l=map&size=600,300&pt='
. $_SERVER['GEOIP_LONGITUDE']
. ','
. $_SERVER['GEOIP_LATITUDE']
. ',pm2rdl"></p></body></html>';
?>
</p>
</div>
</body>
</html>
```

Test geo6.php in your browser, as shown in Figure 3-24.

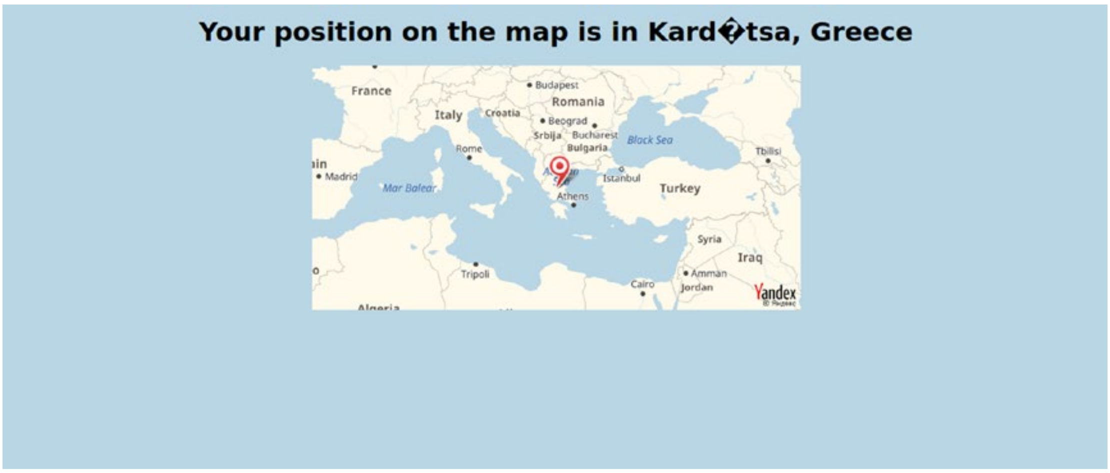

Your position on the map is in Kard�tsa, Greece

Figure 3-24. *The map as displayed in the new version, geo6.php*

In the new file geo6.php, there are a few significant differences from the web page created with the file geo5.php. First, the image is centered on the web page. A div element of the class center is used to include the image and the heading. The class is defined with CSS as follows:

```
.center {
margin: auto;
}
```

The second difference in the geo5.php source code is the zoom level, set now to 4, to include a larger area on the map. By zooming out on the map, the name of the city is not printed anymore, and instead a map pin is used to indicate the city's location. There are a lot of different placemarks offered for the Yandex maps. You can view them at https://tech.yandex.com/maps/doc/staticapi/1.x/dg/concepts/markers-docpage/. The format for the value of the pt variable on the image's URL, used for placing a specific marker, is as follows:

```
{longitude},{latitude},{style}{color}{size}{content}
```

In the URL of the map, the value of pt includes the coordinates of a city to pinpoint the marker at an exact location.

```
...pt='. $_SERVER['GEOIP_LONGITUDE'] . ',' . $_SERVER['GEOIP_LATITUDE'] .
',pm2rdl...
```

The value pm2rdl corresponds to a placemark that belongs to group 2 of the Yandex placemarks (pm2), is red (rd), and also has a large (l) size.

The third difference is the background color selected for the web page, which is actually the same color used for the oceans on the map. To find the specific color (RGB color code #B9D6E5 in this example), use the following instructions.

First make a screenshot of the geo6.pphp web page, using a Linux screenshot tool like Shutter. To download and install Shutter, use the following command at the Linux terminal:

```
$ sudo apt-get install shutter
```

Start the application from the Linux GUI or from the command line as follows:

```
$ shutter
```

The Shutter window opens, as displayed in Figure 3-25.

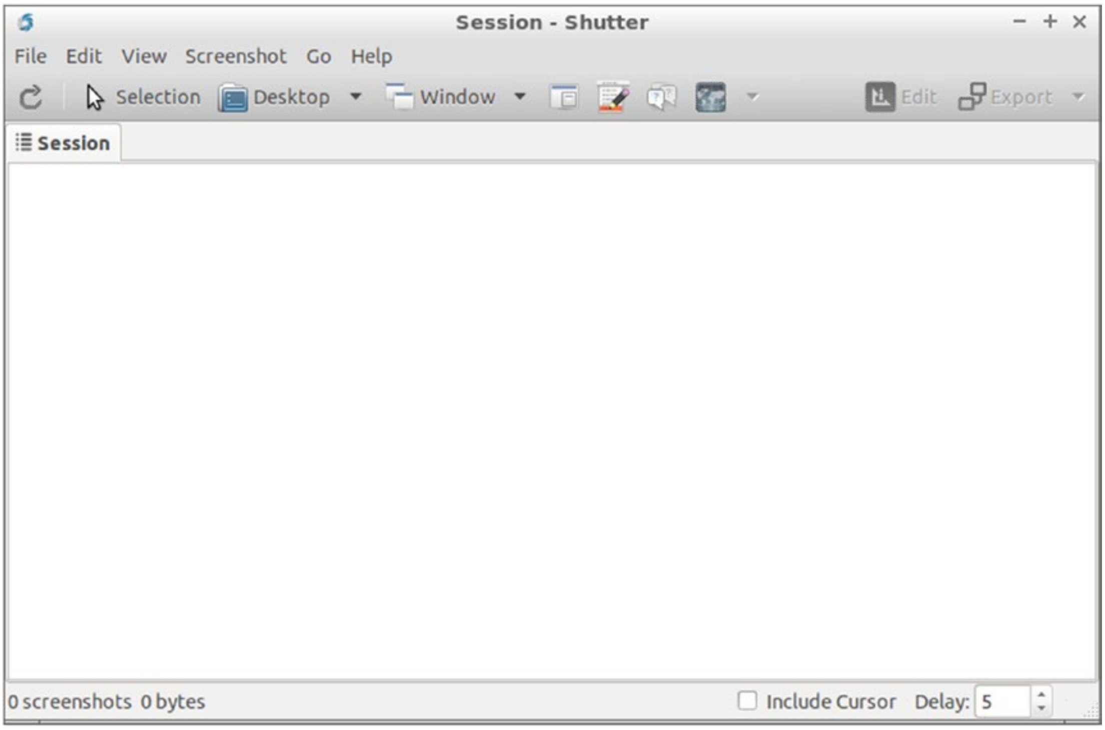


Figure 3-25. *The Shutter window*

Open with your browser the previous version, `geo5.php`, to detect the ocean color. Click the arrows for the up-down control at the bottom of the Shutter window to set the seconds (e.g., 5) of the Delay field. This corresponds to the delay timer for the shot. Click next to the Window menu button and select Active Window. The delay timer starts counting, and within this interval you have to select with the mouse the browser window, displaying `geo5.php`, for the screenshot. Click the browser window to select it. The image is saved in the `Pictures` folder of your home directory.

Use an image editor like mtPaint to open the image file. With the Eyedropper tool, click the color of the ocean. As displayed in Figure 3-26, the Eyedropper tool for mtPaint is included as a button in the Palette Editor window, which you open by selecting the Palette menu and then Palette Editor.

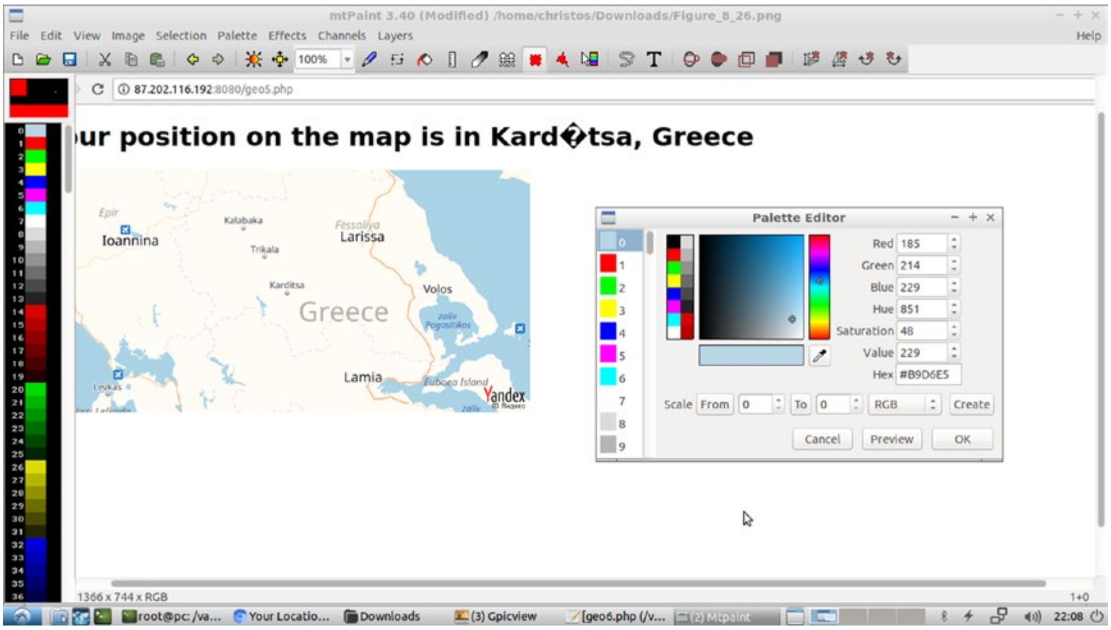

mtPaint 3.40 (Modified) /home/christos/Downloads/Figure_8_26.png
File Edit View Image Selection Palette Effects Channels Layers Help
87.202.116.192:8080/geo5.php
ur position on the map is in Kard�tsa, Greece
Palette Editor
Red 185
Green 214
Blue 229
Hue 851
Saturation 48
Value 229
Hex #B9D6E5
Scale From 0 To 0 RGB Create
Cancel Preview OK
1366 x 744 x RGB

Figure 3-26. *The Eyedropper tool of mtPaint*

The color used for the oceans in `geo5.php` is used in the source code of `geo6.php` as the background color, by setting the value of the background color in the CSS section to the RGB value `#B9D6E5`.

Summary

This chapter covered the following:

- You enabled the web server to become accessible to the whole Internet by configuring the router to implement port forwarding.
- You installed the `GeoIP` Apache module that associates the visitor's IP address with geographic information.
- You ran examples that use the information provided from the `GeoIP` module with the PHP source code.
- You used online tools to test your site remotely.

CHAPTER 4

Obtaining a Domain Name with DDNS

In the previous chapter, your site passed the borders of your LAN and became available to the whole Internet. URLs that were not exactly user-friendly like the following were used:

```
http://94.64.2.196:8080/
```

In this chapter, you will learn how to use the Dynamic DNS (DDNS) service to obtain and use a domain name for your site; for example, you can use `webtoolsonline.servehttp.com` instead of an IP address in the URL.

With a proper URL for your site, you can set up PHP to interface with the Linux shell and use an online service like WHOIS. Also, you will further improve your site's appearance by creating a favicon icon, which is an icon that represents your site in clients' browser tabs and in the list of bookmarks.

DNS and DDNS

The Domain Name System (DNS) service translates the domain name of a computer to the corresponding static IP address. Purchasing a static IP address from your ISP is usually more expensive than having a dynamic IP address that often changes, for instance every time your router reboots. Correlating a domain name to a dynamic IP address is still possible with DDNS. There are two ways to update the DDNS service provider data with your changed IP address. The method discussed in this chapter is to use a DDNS service in your router. Today most routers support DDNS services. The only drawback is that some router models support DDNS for only certain DDNS service providers. If your router does not support your DDNS provider, you can use a DDNS client program that runs in the background of your web server as a daemon process. This is the method implemented in Chapter 10, where you'll use the program `ddclient`. The program `ddclient` checks in constant time intervals to see whether the public IP address of your router has changed. If it has, an update message is sent to your DDNS service provider.

DDNS services can be free or require a monthly fee. A nice feature offered by most DDNS service providers is web redirect. Consider, for instance, the following URL with an IP address:

```
http://94.64.2.196:8080/
```

Using a DDNS service, the client can replace the public IP address of the router with a domain name and use the following in the address bar of a browser:

```
http://christos.ddns.net:8080
```

The domain name is used instead of the IP address; however, the port number is present. Web redirect helps you hide the port number and enables your visitors to use a more readable URL, as shown here:

```
http://christos.ddns.net
```

Registering with a DDNS Service Provider

This section describes the steps to register with a no-IP DDNS service provider. This is one of the providers supported by the router that is used in the examples of this book. You can register with any other provider supported by your router following a similar process. As with most online services, you sign up by providing your e-mail address and a unique password. For a DDNS service provider, you can choose a third-level domain name. For instance, I chose `christos` under the configuration authority of the second-level domain name `ddns` (the DDNS service provider itself), which is under the configuration authority of the top-level domain (TLD) or first-level domain `net`. The fully qualified domain name (FQDN), used in the site, therefore becomes the following:

```
 christos.ddns.net
```

With this specific DDNS server provider, you can choose three hostnames and also implement web redirect for free.

Now visit the no-IP site.

```
http://www.noip.com
```

Once there, click the Sign Up button to begin the registration process (Figure 4-1).

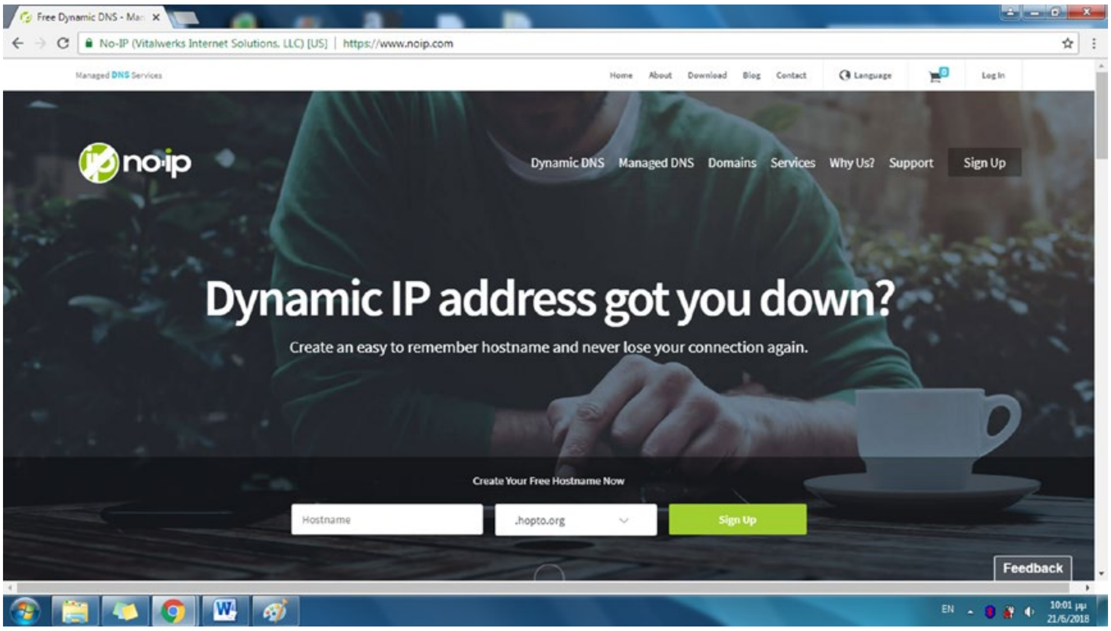
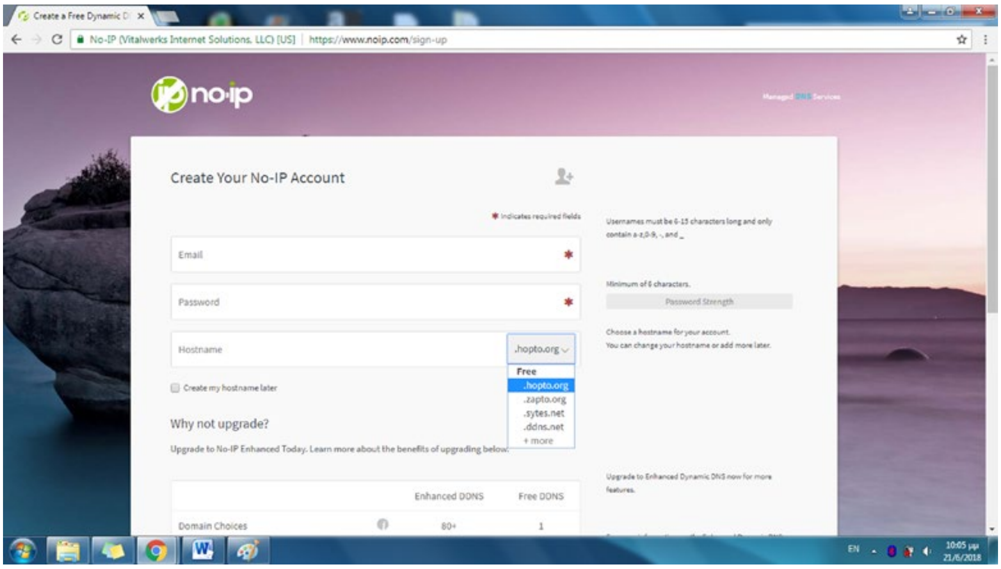

Free Dynamic DNS - Man
No-IP (Vitalwerks Internet Solutions, LLC) [US] | https://www.noip.com
Managed DNS Services
Home
About
Download
Blog
Contact
Language
Log In
no-ip
Dynamic DNS
Managed DNS
Domains
Services
Why Us?
Support
Sign Up
Dynamic IP address got you down?
Create an easy to remember hostname and never lose your connection again.
Create Your Free Hostname Now
Hostname
.hopto.org
Sign Up
Feedback

Figure 4-1. *The Sign Up button of the no-IP home page*

The next page, shown in Figure 4-2, allows you to select a hostname (e.g., `christos`) and the second-level domain name (for instance, `zapto.org` or `ddns.net`) from a drop-down list. You need also to provide your password and your e-mail. Click the Terms of Service and Privacy Policy box and then click the Free Sign Up button.


Create a Free Dynamic D
No-IP (Vitalwerks Internet Solutions, LLC) [US] | https://www.noip.com/sign-up
no-ip
Managed DNS Services

Create Your No-IP Account

* Indicates required fields

Email *

Password *

Hostname .hopto.org

Free
.hopto.org
.zapto.org
.sytes.net
.ddns.net
+ more

Create my hostname later

Usernames must be 6-15 characters long and only contain a-z,0-9, -, and _

Minimum of 6 characters.

Password Strength

Choose a hostname for your account.
You can change your hostname or add more later.

Why not upgrade?

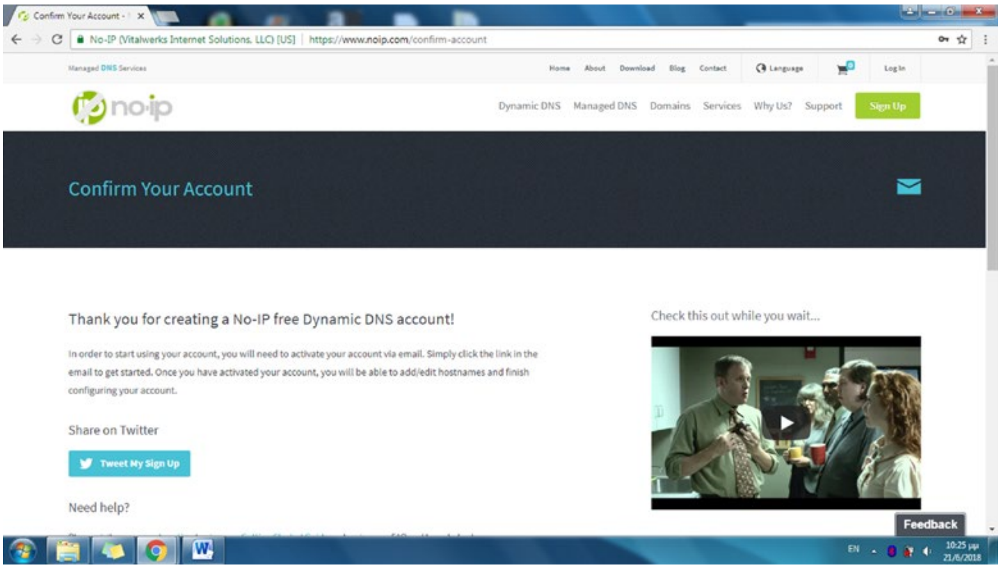
Upgrade to No-IP Enhanced Today. Learn more about the benefits of upgrading below.

Upgrade to Enhanced Dynamic DNS now for more features.

	Enhanced DDNS	Free DDNS
Domain Choices	80+	1

Figure 4-2. *Setting your preferences for your hostname with no IP*

The next page, shown in Figure 4-3, asks you to confirm your account by clicking the link of the e-mail sent to the account you provided. This allows the DDNS provider to verify that your e-mail account is a real one.



Confirm Your Account

Thank you for creating a No-IP free Dynamic DNS account!

In order to start using your account, you will need to activate your account via email. Simply click the link in the email to get started. Once you have activated your account, you will be able to add/edit hostnames and finish configuring your account.

Share on Twitter

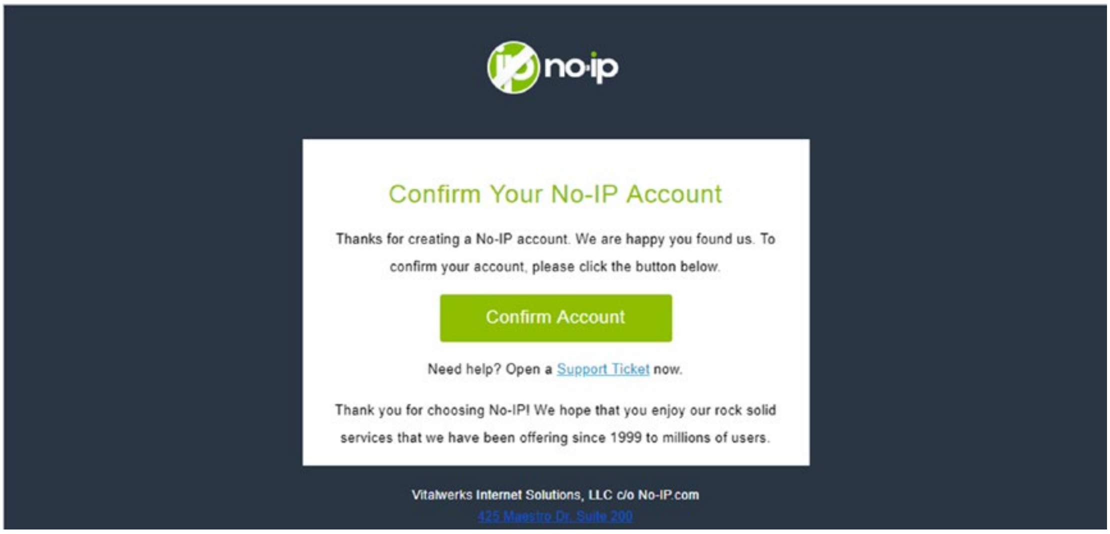
Tweet My Sign Up

Need help?

Check this out while you wait...

Figure 4-3. *The web page requiring e-mail account confirmation*

Figure 4-4 displays a snapshot of the e-mail received.



Confirm Your No-IP Account

Thanks for creating a No-IP account. We are happy you found us. To confirm your account, please click the button below.

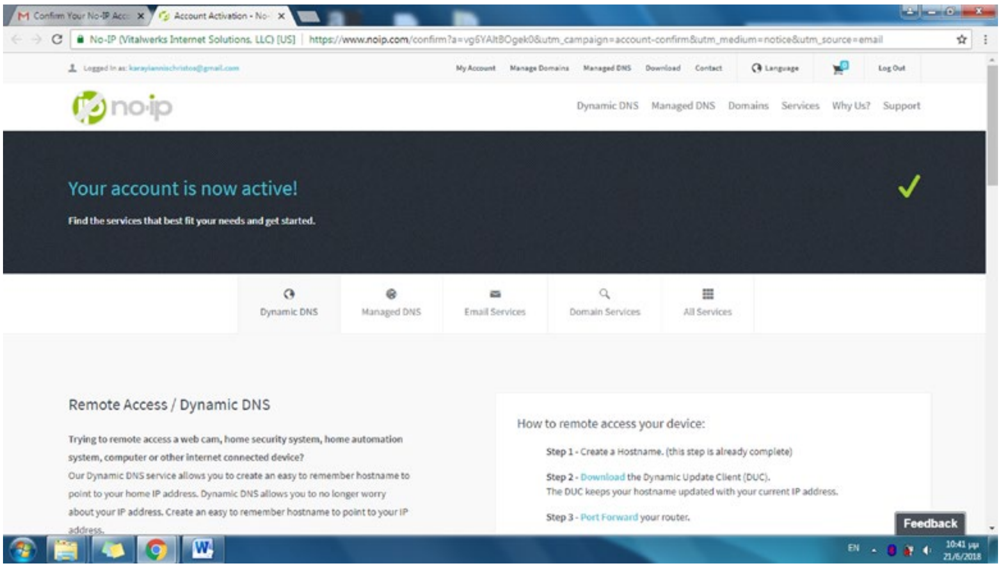
Need help? Open a Support Ticket now.

Thank you for choosing No-IP! We hope that you enjoy our rock solid services that we have been offering since 1999 to millions of users.

Vitalwerks Internet Solutions, LLC c/o No-IP.com
425 Maestro Dr. Suite 200

Figure 4-4. ***Figure 4-4.*** *The e-mail, including a Confirm Account button for validating the no-IP account*

After clicking the Confirm Account button, the window shown in Figure 4-5 appears in a new tab of your browser with the message “Your account is now active!”



Your account is now active!

Find the services that best fit your needs and get started.

Remote Access / Dynamic DNS

Trying to remote access a web cam, home security system, home automation system, computer or other internet connected device?
Our Dynamic DNS service allows you to create an easy to remember hostname to point to your home IP address. Dynamic DNS allows you to no longer worry about your IP address. Create an easy to remember hostname to point to your IP address.

How to remote access your device:

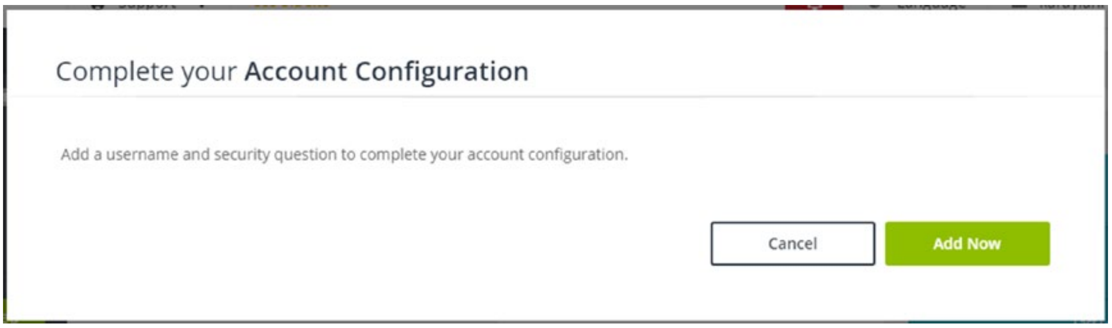
Step 1 - Create a Hostname. (this step is already complete)

Step 2 - Download the Dynamic Update Client (DUC).
The DUC keeps your hostname updated with your current IP address.

Step 3 - Port Forward your router.

Figure 4-5. *The web page informing you that the account is activated*

Click the “Get started with Dynamic DNS” link to continue. The window displayed in Figure 4-6 informs you to create a username and a security question to complete your account configuration. Click the Add Now button to proceed.

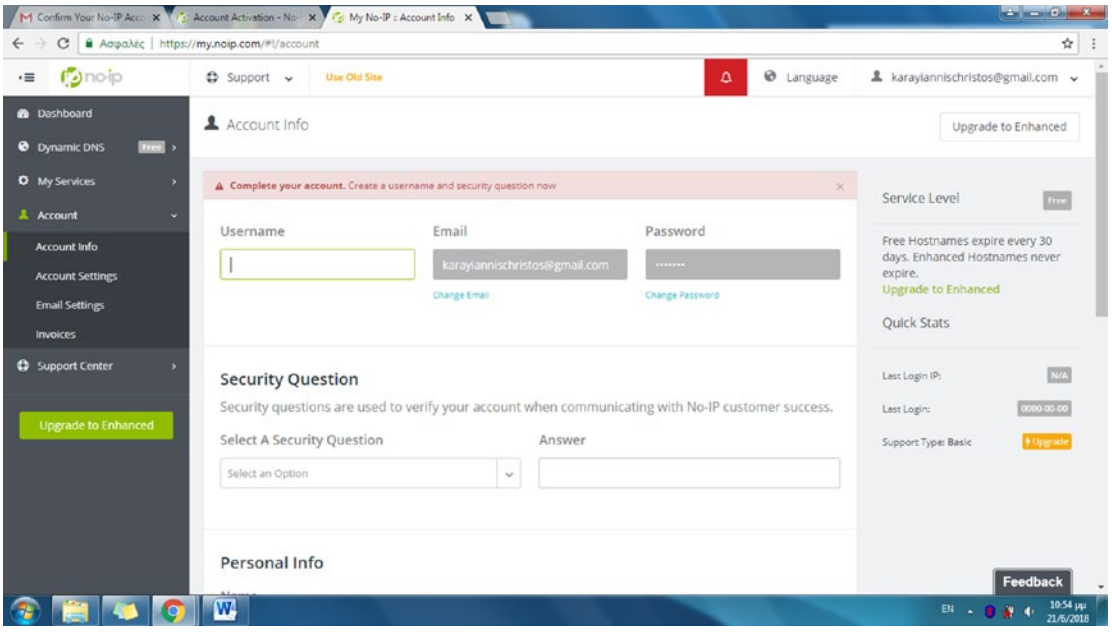


Complete your Account Configuration

Add a username and security question to complete your account configuration.

Figure 4-6. *The dialog for proceeding to the final step of creating a DDNS account*

In the web page shown in Figure 4-7, you set your username, security question, and also some personal information.



https://my.noip.com/#!/account

Account Info

Complete your account. Create a username and security question now

Username

Email: karayiannischristos@gmail.com

Password: •••••••

Security Question

Security questions are used to verify your account when communicating with No-IP customer success.

Select A Security Question: Select an Option

Answer

Personal Info

Service Level: Free

Free Hostnames expire every 30 days. Enhanced Hostnames never expire.

Quick Stats

Last Login IP: N/A

Last Login: 0000-00-00

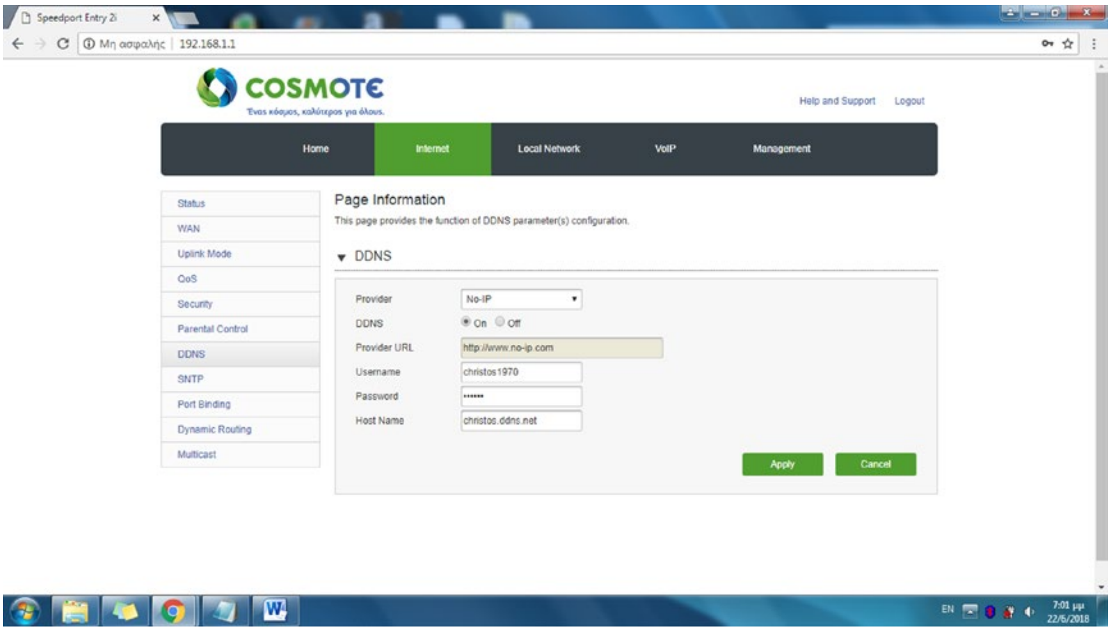
Support Type: Basic

Figure 4-7. *The final web page of the DDNS account setup process*

Click the Save button to save the information entered and thus complete the account setup process. You can use the hostname obtained here to configure the router of your LAN to implement the DDNS service.

Configuring the Router's DDNS

With a new domain name obtained in the previous section, you can now configure your router to relay its public IP address to the DDNS provider each time this IP address changes. Locate the DDNS section in the web-based configuration interface of your router. As shown in Figure 4-8, for the router used in the examples, you can view the DDNS configuration options by selecting Internet and then DDNS from the menu.



Page Information

This page provides the function of DDNS parameter(s) configuration.

▼ DDNS

Provider	No-IP
DDNS	[✓ On] Off
Provider URL	http://www.no-ip.com
Username	christos1970
Password	••••••
Host Name	christos.ddns.net

Figure 4-8. *The DDNS configuration section for the router used in the examples*

Select the DDNS provider from the Provider drop-down list, which has all the DDNS providers that the router supports. Enter the details required: your username, your password, and the hostname you chose at the DDNS registration process. Complete also the Provider URL field, and select the On DDNS radio button. Click the Apply button to confirm the new settings.

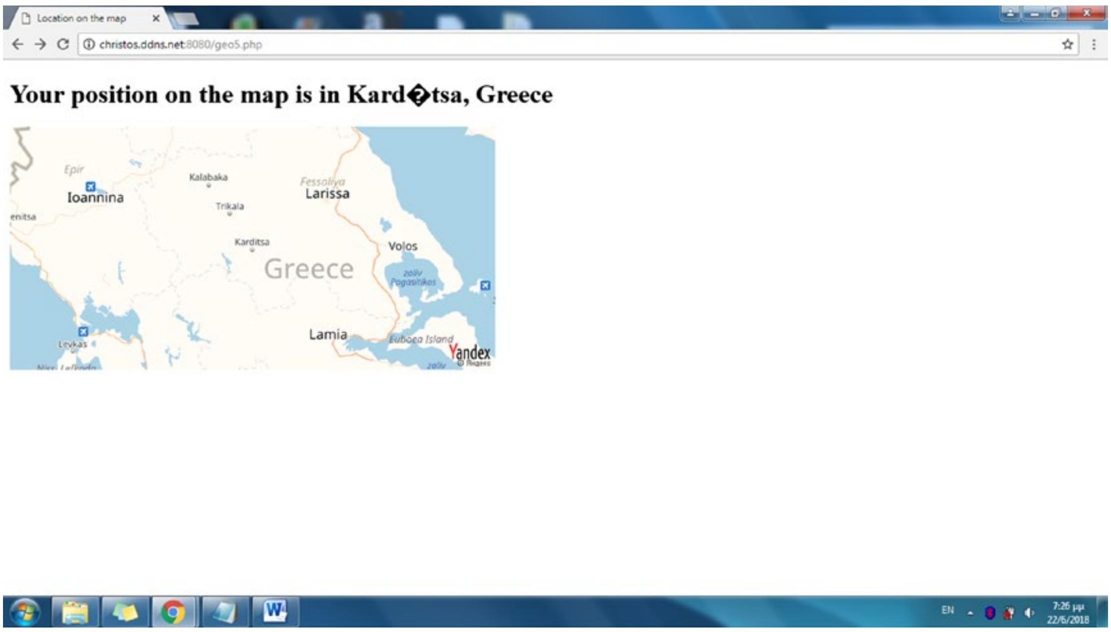
Test your new domain name (`christos.ddns.net` is used in the following examples). In this chapter, the Apache configuration created in Chapter 1 is used. You can test the URLs of the web pages created in the previous chapter, for instance `geo5.php`. Enter the following URL for `geo5.php` in the address bar of your browser, substituting the domain name used here with yours:

```
http://christos.ddns.net/geo5.php
```

If your ISP blocks inbound port 80, which is the default HTTP port, use an alternate port like 8080.

```
http://christos.ddns.net:8080/geo5.php
```

The web page `geo5.php` is displayed, as shown in Figure 4-9.



Your position on the map is in Kard�tsa, Greece

Figure 4-9. *Testing the web page geo5.php with the new domain name*

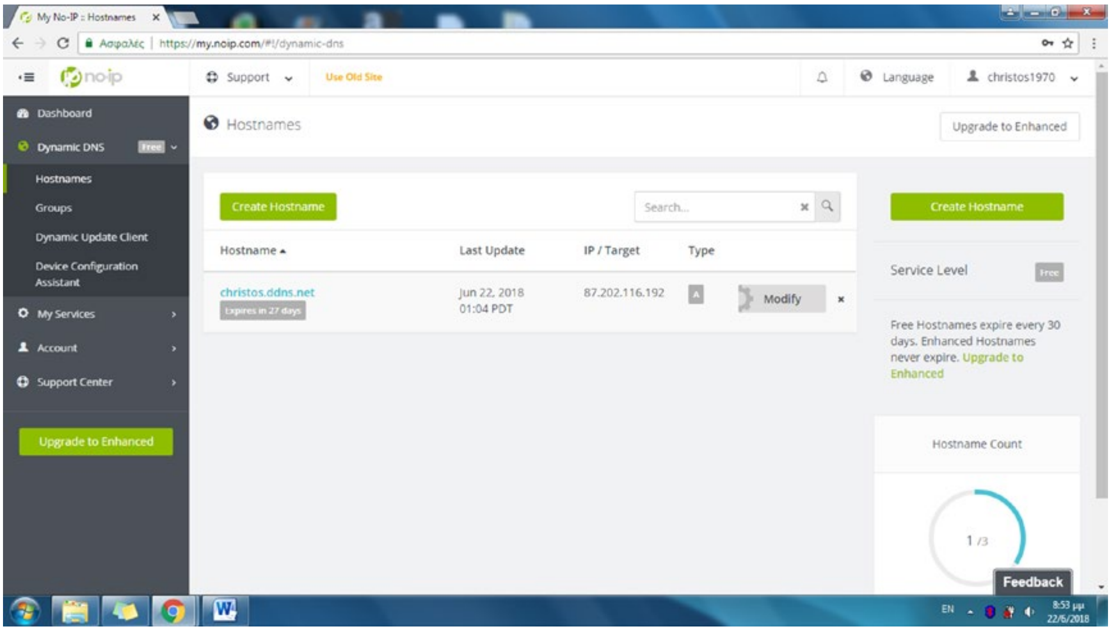
The web page `geo5.php` loads with the URL that includes the previously acquired domain name. In the following section, you will implement web redirect so that if you do not utilize the default HTTP port number, but another one such as 8080, this number is hidden from the URL.

Implementing Web Redirect

If your ISP blocks the default HTTP port for incoming connections to your LAN, you can still use URLs that do not append a colon and the port number after the domain name, although behind the scenes the specific port number *is* actually used. To include this feature, you need to configure the web redirect service offered by DDNS providers.

By setting a specific port number, such as port 8080 in the web redirect option, you are enabling clients to use a port-free URL. The DDNS provider redirects visitors to another domain name, where the port number is already appended with a colon. To test the web redirect feature, another domain name is required, so this is a good chance to utilize the second of the three domain names offered from the DDNS provider.

Log in on the DDNS provider home web page and click the Dynamic DNS link in the left panel. The first domain name, e.g., `christos.ddns.net`, appears as a link that leads to the configuration web page of this domain name, as displayed in Figure 4-10.



Hostname ▴	Last Update	IP / Target	Type
christos.ddns.net Expires in 27 days	Jun 22, 2018 01:04 PDT	87.202.116.192	A

Free Hostnames expire every 30 days. Enhanced Hostnames never expire. Upgrade to Enhanced

Figure 4-10. *The Hostnames web page displays the hostnames created so far*

Click the Create Hostname button to create your second domain name, the one used for web redirect. Enter the third-level domain name in the Hostname textbox, as shown in Figure 4-11. For instance, in this example, `webtoolsonline` was used.

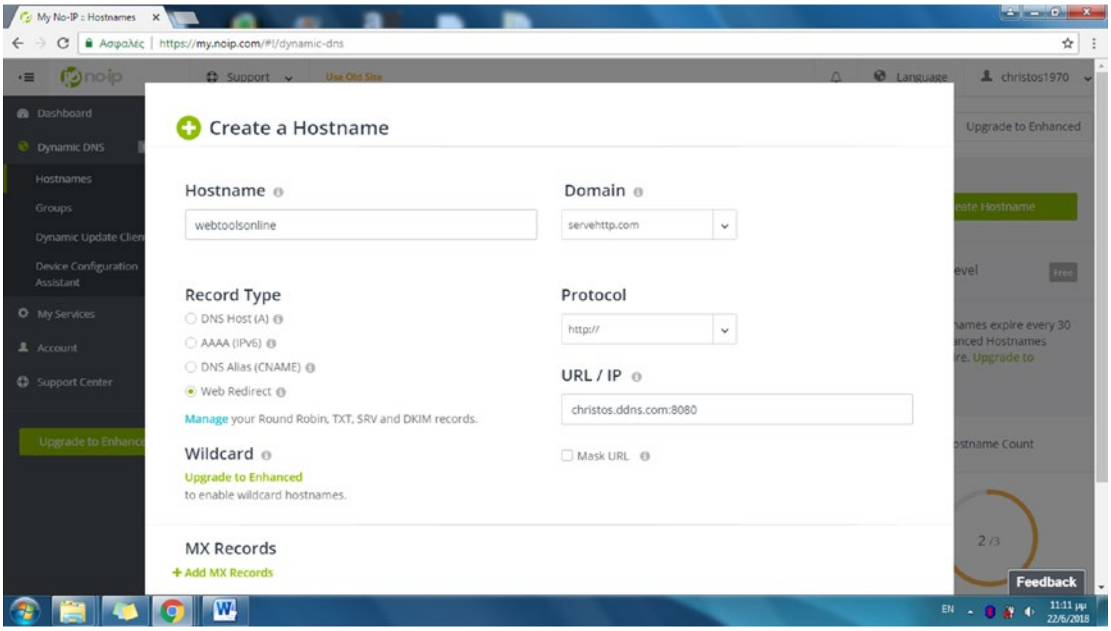
To also change the second-level domain name, select a different one from ddns.net in the Domain drop-down list. In this example, servehttp.com was used. The FQDN therefore becomes as follows:

```
webtoolsonline.servehttp.com
```

For the Record Type radio buttons, select Web Redirect to implement this service for the new domain name. By selecting this option, a new textbox URL/IP address appears. Type the first domain name with port 8080 appended after a colon.

```
christos.ddns.net:8080
```

Each time the new hostname `webtoolsonline.servehttp.com` is used from a client, the DDNS service redirects the request to `christos.ddns.net:8080`.



Create a Hostname

Hostname: webtoolsonline

Domain: servehttp.com

Record Type: DNS Host (A) / AAAA (IPv6) / DNS Alias (CNAME) / [✓ Web Redirect]

Manage your Round Robin, TXT, SRV and DKIM records.

Protocol: http://

URL / IP: christos.ddns.com:8080

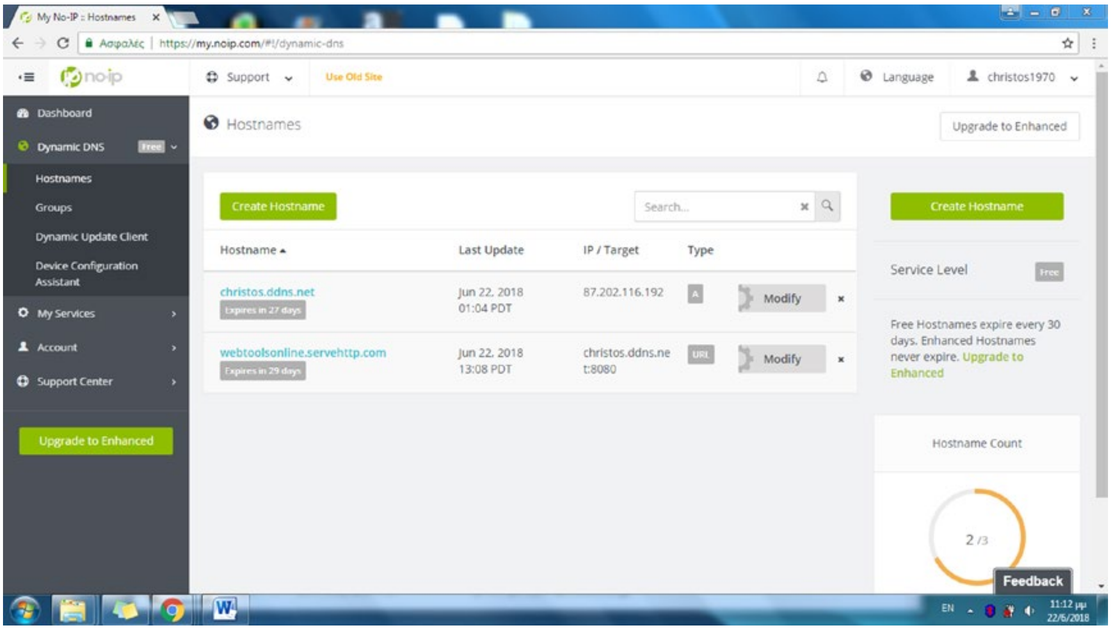
Mask URL: ☐

Wildcard: Upgrade to Enhanced to enable wildcard hostnames.

MX Records: + Add MX Records

Figure 4-11. *Creating the second hostname with the Web Redirect option set*

Click the Create Hostname button. As viewed in Figure 4-12, the new domain name is added in the Hostname list.



Hostname	Last Update	IP / Target	Type
christos.ddns.net Expires in 27 days	Jun 22, 2018 01:04 PDT	87.202.116.192	A
webtoolsonline.servehttp.com Expires in 29 days	Jun 22, 2018 13:08 PDT	christos.ddns.ne t:8080	URL

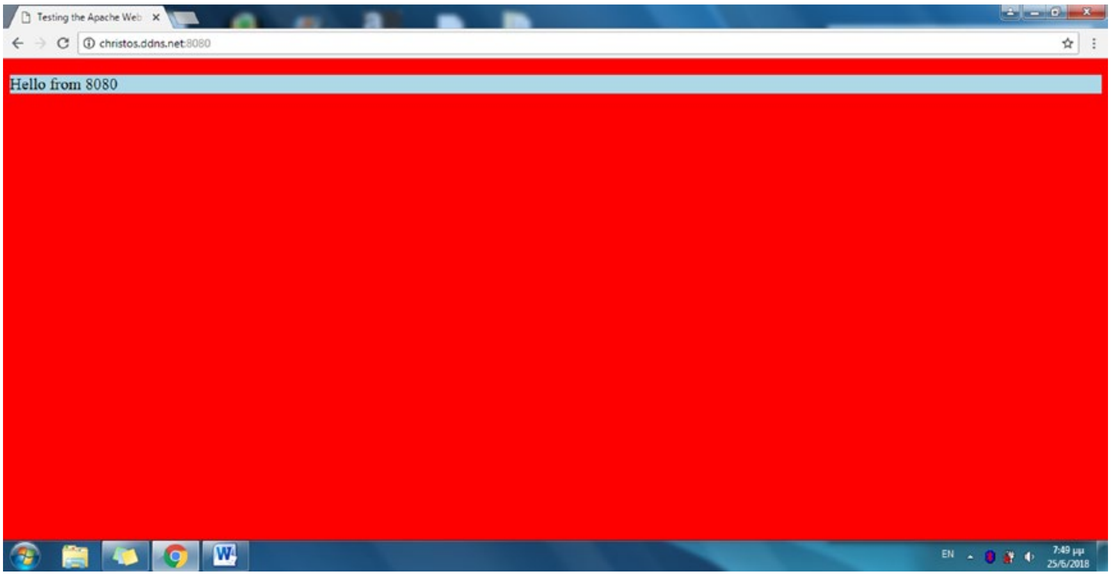
Free Hostnames expire every 30 days. Enhanced Hostnames never expire. Upgrade to Enhanced

Figure 4-12. *The Hostnames web page displays the hostnames created so far*

To try the new domain name, enter the following in the address bar of your browser:

```
http://webtoolsonline.servehttp.com
```

With the web redirect service enabled, the URL `http://webtoolsonline.servehttp.com` redirects to `christos.ddns.net:8080`. The directory index of the Apache vhost listening to port number 8080 (used in Chapter 1) is displayed in the web browser, as shown in Figure 4-13.



Hello from 8080

Figure 4-13. *The URL webtoolsonline.servehttp.com redirects to christos.ddns.net:8080*

To visibly retain the original URL, you have to implement the Mask URL feature by configuring the DDNS provider. Edit the hostname on the Hostnames web page of the DDNS provider's site and select the Mask URL box. Click the Update Hostname button to apply the configuration.

With the URL mask enabled, the DDNS service injects JavaScript into the source code of the web page to create an HTML frame that covers the entire browser window and includes the same content but a different URL in the address bar of the browser. The result, as displayed in Figure 4-14, is a web page with the same content; however, instead of the expected URL shown here where the client redirects:

```
http://christos.ddns.net:8080
```

the following URL appears in the address bar:

```
http://webtoolsonline.servehttp.com
```

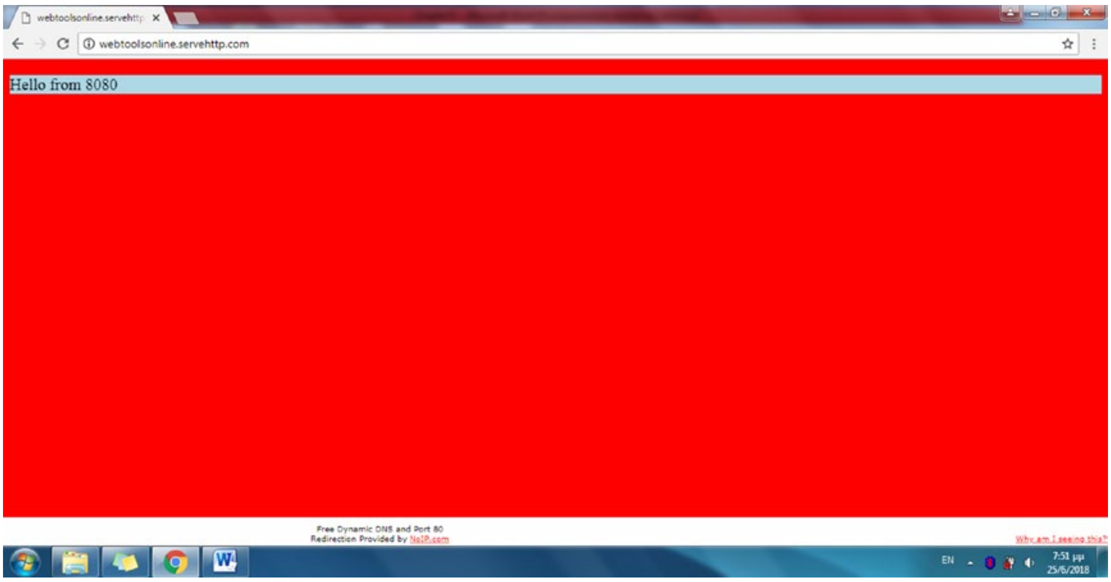

webtoolsonline.servehttp
webtoolsonline.servehttp.com
Hello from 8080
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?
EN
7:51 μμ
25/6/2018

***Figure 4-14.** Using the URL mask option to modify the URL displayed in the client browser*

Hint! To view the frame created with the Mask URL option, right-click the web page and select View Page Source for Chrome or the corresponding option for other browsers. In this case, the URL of the address bar is altered with JavaScript code.

You have so far created and used two hostnames for your registered DDNS account. You will use the third hostname, e.g., `secureserver.ddns.net`, in Chapter 8. In Chapter 9, you will find the steps to obtain and use your own second-level domain name, e.g., `httpsserver.eu`, required for running a secure site. In the following section, you will put the hostnames created so far to use to create your next project.

Implementing an Online Web Service

With such a catchy domain name like `webtoolsonline.servehttp.com`, it is tempting to implement an actual online web service. You can implement, for instance, the WHOIS service, which applies `whois`, a query and response protocol that is widely used for querying databases that store the assignees of Internet resources, such as domain names and IP addresses. You can run the `whois` command at the command line, but it is also offered as an online web service from various sites, e.g., `whois.domaintools.com` or `ping.eu`, which is shown in Figure 4-15.

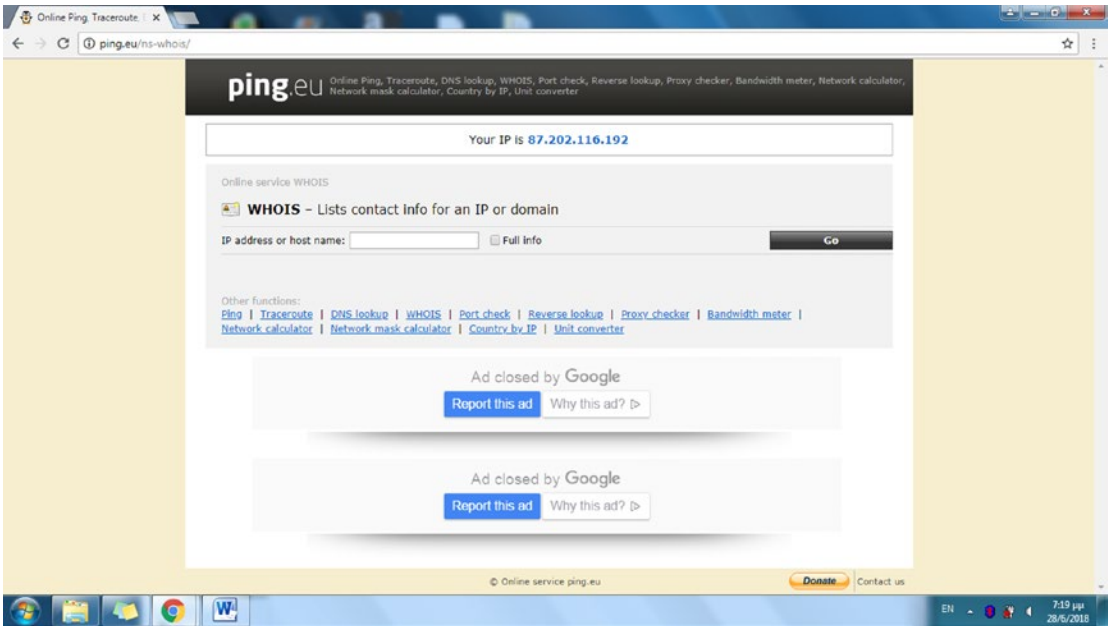

Online Ping, Traceroute
ping.eu/ns-whois/
ping.eu
Online Ping, Traceroute, DNS lookup, WHOIS, Port check, Reverse lookup, Proxy checker, Bandwidth meter, Network calculator, Network mask calculator, Country by IP, Unit converter
Your IP is 87.202.116.192
Online service WHOIS
WHOIS – Lists contact info for an IP or domain
IP address or host name:
Full info
Go
Other functions:
Ping | Traceroute | DNS lookup | WHOIS | Port check | Reverse lookup | Proxy checker | Bandwidth meter | Network calculator | Network mask calculator | Country by IP | Unit converter
Ad closed by Google
Report this ad
Why this ad?
Ad closed by Google
Report this ad
Why this ad?
© Online service ping.eu
Donate
Contact us
EN
7:19 μμ
28/6/2018

Figure 4-15. *The web page of the ping.eu WHOIS service*

Ping.eu, along with other similar sites, offers online web services, for instance DNS lookup, ping, traceroute, and port check. You will implement port checking in Chapter 10.

To create a site that offers WHOIS as an online service, you can use a web page with a form; the form will include a textbox to submit an IP address to the PHP program on the web server that interfaces with the Linux shell and returns information about the corresponding domain name.

The first step to implement the online service is to change the default web page that Apache sends in response to using port 8080. As explained in the previous sections of this chapter, the domain name `webtoolsonline.servehttp.com` resolves to `christos.ddns.net:8080` and to the router's public IP address through port 8080. The Apache vhost configuration file for serving port 8080 for any domain name was set up in Chapter 1 to `example2.conf`. The directory index used in this file for port 8080 is `index3.html`, which is actually the web page shown in the previous section with the URL `http://webtoolsonline.servehttp.com`. As a second step, edit `example2.conf` and replace `index3.html` with another HTML file, for instance `onlineservice.html`.

Create a new web page called `onlineservice.html` that includes a form similar to the one on the `ping.eu` page. This form will be used to submit the user's data to the web server, and as viewed from `ping.eu`, two form elements are required at a minimum: the textbox that will receive the IP address or the hostname and a submit button. The form's `action` attribute will refer to a PHP file that receives the user's data, interfaces with the `whois` command-line program, and then passes the user's data as arguments. Finally, the `whois` output is included on the web page generated by PHP and sent back to the user. With similar steps, you can implement any other online service such as the ones offered by `ping.eu`.

Editing the Apache Configuration File

In this section, you'll edit the configuration file `example2.conf` used in Chapter 1 to implement two sites with two vhosts, one listening on port 8080 and one listening on port 8181. In this example, only the vhost listening to port 8080 is required; therefore, for this vhost the Apache `DirectoryIndex` directive is edited to set the file `onlineservice.html` as the new directory index of the site.

At the Linux terminal, enter the following:

```
$ cd /etc/apache2/sites-available
$ sudo gedit example2.conf
```

Replace `index3.html` with `onlineservice.html`.

```
Listen 8080
Listen 8181
# 1st vhost
<VirtualHost *:8080>
      ServerAdmin webmaster@localhost
      DocumentRoot /var/www/html
      DirectoryIndex onlineservice.html
      ErrorLog ${APACHE_LOG_DIR}/error.log
      CustomLog ${APACHE_LOG_DIR}/access.log combined
</VirtualHost>

# 2nd vhost
<VirtualHost *:8181>
```

```
      ServerAdmin webmaster@localhost
      DocumentRoot /var/www/html
      DirectoryIndex index4.html
      ErrorLog ${APACHE_LOG_DIR}/error.log
      CustomLog ${APACHE_LOG_DIR}/access.log combined
</VirtualHost>
```

Click the Save button in the gedit window to confirm the changes. To reflect the configuration changes for the vhost listening on port 8080, the Apache web server needs to be reloaded. At the Linux terminal, enter the following:

```
$ sudo service apache2 force-reload
```

Hint! In this example, an existing configuration file was used. Consider the case that you implement the site with a new configuration file for a vhost that listens to the default HTTP port, which is 80. You can create the configuration with the following commands:

```
$ cd /etc/apache2/sites-available

$ sudo gedit onlineservice.conf
```

Enter the following directives and save the file:

```
Listen 80

<VirtualHost *:80>

   ServerAdmin webmaster@localhost

   DocumentRoot /var/www/html

   DirectoryIndex onlineservice.html

   ErrorLog ${APACHE_LOG_DIR}/error.log

   CustomLog ${APACHE_LOG_DIR}/access.log combined

</VirtualHost>
```

Then use the following:

```
$ sudo a2ensite onlineservice
$ sudo service apache2 force-reload
```

To test the site, you create the first file called `onlineservice.html` as described in the following section, and you enter the first hostname, `christos.ddns.net`, in the address bar of the browser. The second one, `webtoolsonline.servehttp.com`, redirects to `christos.ddns.net:8080`, which listens to port 8080 instead of the default port.

The next step is to create the directory index used from the vhost. This is called `onlineservice.html` and is the web page that contains the form for submitting an IP address.

Editing the Web Page for Submitting the User's Data

The HTML file that includes the form used by the user to provide the data to the web server is `onlineservice.html`, which was set in the previous section in the vhost configuration file as the directory index for the site `webtoolsonline.servehttp.com`. Figure 4-16 displays the directory index.

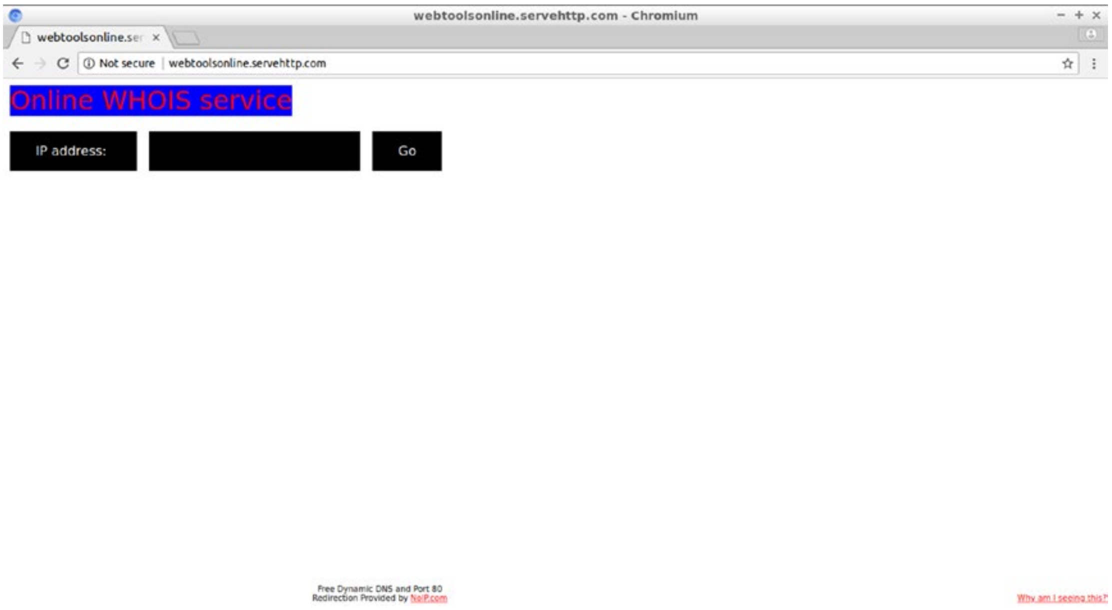

webtoolsonline.servehttp.com - Chromium
webtoolsonline.ser
Not secure
webtoolsonline.servehttp.com
Online WHOIS service
IP address:
Go
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Figure 4-16. *The browser displays onlineservice.html, the directory index of the site*

Create the file `onlineservice.html` in the document root of the vhost. At the Linux terminal, enter the following:

```
$ cd /var/www/html
$ sudo gedit /var/www/html/onlineservice.html
```

Enter the following lines and save the file:

```
<!DOCTYPE html>
<html>
<head>
<title>
Online WHOIS service
</title>
<style>
p.large {
font-size:32px;
color:red;
```

```
background-color:blue;
display:inline;
}
p.small {
font-size:16px;
color:white;
background-color:black;
display:inline;
padding: 15px 32px;
}
input {
    background-color: black;
    border: none;
    color: white;
    padding: 15px 32px;
    text-align: center;
    font-size: 16px;
}
</style>
</head>
<body>
<p class="large">Online WHOIS service</p>
<br><br>
<form method="POST" action="result.php" name="f1" onsubmit="return
validate()">
<p class="small">IP address: </p>&nbsp;&nbsp;
<input type="text" name="user_data">&nbsp;&nbsp;
<input type="submit" value="Go">
</form>

<script>
function validate() {
var f = document.forms["f1"]["user_data"].value;
f=f.trim();
var ipformat = /^((25[0-5]|2[0-4][0-9]|1[0-9][0-9]|[1-9][0-9]|[0-9])\.){3}
(25[0-5]|2[0-4][0-9]|1[0-9][0-9]|[1-9][0-9]|[0-9])$/
```

```
if(!(f.match(ipformat))){
alert("Enter a valid IP address");
return false;
}
}
</script>
</body>
</html>
```

The HTML source code includes a form that implements the method POST for submitting the data and sets the value of the action attribute to result.php. This is the program on the server side that will accept and process the data submitted.

There are two more attributes in the form element, both required for the form validation, which is implemented locally by JavaScript. The name attribute is used by the JavaScript function validate(), which validates the form, to refer to this form. The return value of validate() is set as the value of the fourth attribute of the form, the onsubmit event. Events are actions applied to the web page that JavaScript responds to. The onsubmit event defines the form submission as the exact instant in time that the source code bound to this event will run.

By setting the onsubmit event value to return validate(), the function validate() will run when the form is submitted, and also the form will be submitted only when validate() returns true. The function validate() is implemented in the following script:

```
<script>
function validate() {
var f = document.forms["f1"]["user_data"].value;
f=f.trim();
var ipformat = /^((25[0-5]|2[0-4][0-9]|1[0-9][0-9]|[1-9][0-9]|[0-9])\.){3}
(25[0-5]|2[0-4][0-9]|1[0-9][0-9]|[1-9][0-9]|[0-9])$/

if(!(f.match(ipformat))){
alert("Enter a valid IP address");
return false;
}
}
</script>
```

The `name` attribute of the form is used next to refer to the specific form in the HTML file and then return the value of the `user_data` textbox to variable `f`. For the variable `f`, which is an object of class `string`, the `trim()` method removes whitespace from both sides of the string. If the user accidentally enters spaces in the `user_data` textbox with the IP address, `trim()` is used so that `validate()` won't reject the IP address.

The `ipformat` regular expression (*regex*) is used next to check whether the value of variable `f` matches the pattern of a valid IP address according to `ipformat`. The details of this regex are explained in the following section.

The `match string()` method is used to search string `f` for a match against the regular expression. The following `if` command uses `match()` to verify whether the `ipformat` regex does not (`!`) match string `f`:

```
if(!(f.match(ipformat))){
```

If a match is not met, the IP address is considered invalid, and `validate()` returns false. In that case, the form is not submitted, and the user is asked to enter a valid IP address with a pop-up window message, created by `alert()`.

Working with Regular Expressions

Expressions are character sequences that define search patterns. They are extremely useful in validating or extracting information from text. The regular expression assigned to the JavaScript variable `ipformat` is used to describe the pattern for a valid IP address and validate the user data. The following command assigns the regex to the `ipformat` variable:

```
var ipformat = /^((25[0-5]|2[0-4][0-9]|1[0-9][0-9]|[1-9][0-9]|[0-9])\.){3}
(25[0-5]|2[0-4][0-9]|1[0-9][0-9]|[1-9][0-9]|[0-9])$/
```

A regex usually uses two slash characters, e.g., `/abc/`, to delimit the search pattern. The caret (`^`) and the dollar sign (`$`) anchors match the start and the end, respectively, of the string the regex pattern is applied to.

The first block is repeated three times, as indicated by the quantifier `{3}`. A valid IP address consists of four numbers from 0 to 255, separated with three periods. Each repetition validates one number from 0 to 255 with a period appended. The bracket expressions (`[]`) are replaced by one of the characters specified in the range. The following expressions are used:

- `25[0-5]` matches text numbers (in text form) from 250 up to 255.
- `2[0-4][0-9]` matches numbers (in text form) from 200 up to 249.
- `1[0-9][0-9]` matches numbers (in text form) from 100 up to 199.
- `[1-9][0-9]` matches numbers (in text form) from 10 up to 99.
- `[0-9]` matches numbers (in text form) from 0 to 9.

The `or` (|) operator is used to include just one number of the previous expressions. With the quantifier `{3}`, three numbers are required, each followed by a period. Here's an example:

```
89.4.100.
```

For the fourth number, a period is not allowed. An example of matching text is as follows:

```
223
```

The total regex validates the IP addresses in this form:

```
89.4.100.223
```

Testing the JavaScript Form Validation

You'll now test the form validation in the HTML file `onlineservice.html` using JavaScript. In the address bar of your browser, enter the URL of the site, as shown here:

```
http://webtoolsonline.servehttp.com
```

Enter in the textbox an invalid IP address, for instance:

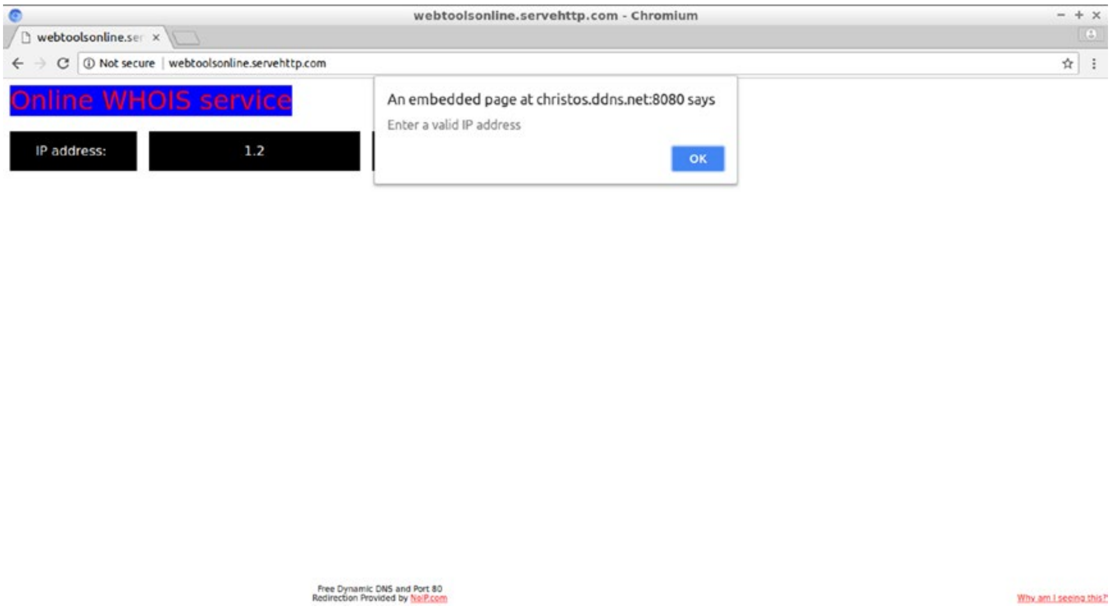
```
256.5.46.7
```

or the following:

```
1.2
```

Click the Go button, which submits the IP address to the web server. A web server program to receive the data is not defined yet, but you can still view the warning message the JavaScript creates for an invalid IP address.

A pop-up window with the message "Enter a valid IP address" appears, as displayed in Figure 4-17. In the message, the domain name of the server is included as `christos.ddns.net:8080`, which is the domain name that `webtoolsonline.servehttp.com` actually redirects to.


webtoolsonline.servehttp.com - Chromium
webtoolsonline.se
Not secure
webtoolsonline.servehttp.com
Online WHOIS service
IP address:
1.2
OK
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

An embedded page at christos.ddns.net:8080 says

Enter a valid IP address

Figure 4-17. *Testing the web page using an invalid IP address*

Next you will create the action program for the form, `result.php`, which receives that IP address and uses it with the `whois` command-line program. But first you can try to run `whois` from the command line to find out how it outputs data and comments. The latter will be excluded from the output of the PHP program for the WHOIS service.

Running whois from the Command Line

The IP address entered by the user in the textbox of form `f1` will be submitted to program `result.php` on the web server. The PHP engine that processes `result.php` will run the `whois` shell utility with this specific IP address as an argument. The output of `whois` will be entered in the web page the user receives from the `echo` PHP command.

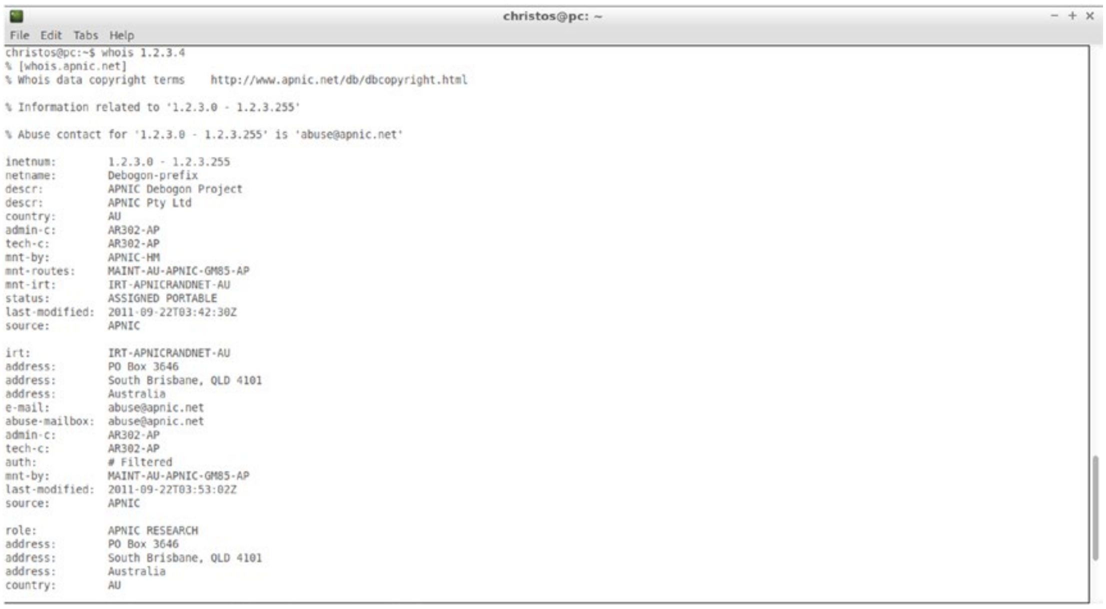
Before using PHP to interface with the `whois` utility, try to run `whois` directly from the Linux terminal. To install `whois` at the command line, enter the following:

```
$ sudo apt install whois
```

Test `whois` with an IP address. You can try a random IP address, for instance:

```
$ whois 1.2.3.4
```

Figure 4-18 displays the `whois` output at the Linux terminal.



```
christos@pc:~$ whois 1.2.3.4
% [whois.apnic.net]
% Whois data copyright terms    http://www.apnic.net/db/dbcopyright.html

% Information related to '1.2.3.0 - 1.2.3.255'

% Abuse contact for '1.2.3.0 - 1.2.3.255' is 'abuse@apnic.net'

inetnum:        1.2.3.0 - 1.2.3.255
netname:        Debogon-prefix
descr:          APNIC Debogon Project
descr:          APNIC Pty Ltd
country:        AU
admin-c:        AR302-AP
tech-c:         AR302-AP
mnt-by:         APNIC-HM
mnt-routes:     MAINT-AU-APNIC-GM85-AP
mnt-irt:        IRT-APNICRANDNET-AU
status:         ASSIGNED PORTABLE
last-modified:  2011-09-22T03:42:30Z
source:         APNIC

irt:            IRT-APNICRANDNET-AU
address:        PO Box 3646
address:        South Brisbane, QLD 4101
address:        Australia
e-mail:         abuse@apnic.net
abuse-mailbox:  abuse@apnic.net
admin-c:        AR302-AP
tech-c:         AR302-AP
auth:           # Filtered
mnt-by:         MAINT-AU-APNIC-GM85-AP
last-modified:  2011-09-22T03:53:02Z
source:         APNIC

role:           APNIC RESEARCH
address:        PO Box 3646
address:        South Brisbane, QLD 4101
address:        Australia
country:        AU
```

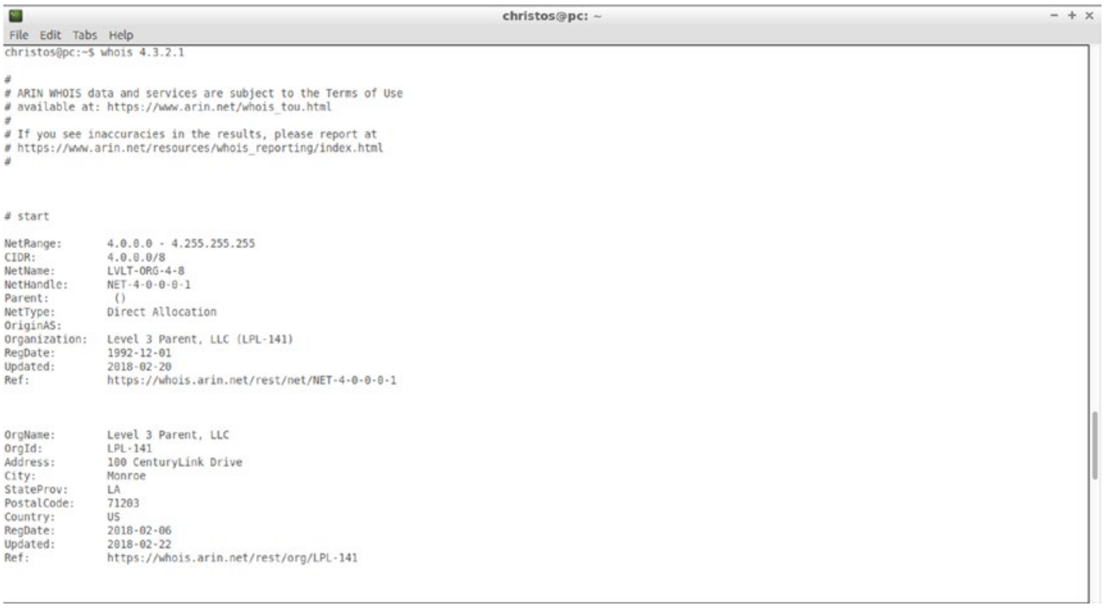
Figure 4-18. *The whois output with percent symbols indicating comments*

Notice that some lines include comments starting with the percent (%) symbol. In the evaluated `result.php`, it is probably a good idea to remove those comments and make the output appear more professional.

Try another IP address, for instance 4.3.2.1:

```
$ whois 4.3.2.1
```

Figure 4-19 displays the `whois` output for the second IP address.



```
christos@pc:~$ whois 4.3.2.1

#
# ARIN WHOIS data and services are subject to the Terms of Use
# available at: https://www.arin.net/whois_tou.html
#
# If you see inaccuracies in the results, please report at
# https://www.arin.net/resources/whois_reporting/index.html
#


# start

NetRange:       4.0.0.0 - 4.255.255.255
CIDR:           4.0.0.0/8
NetName:        LVLT-ORG-4-8
NetHandle:      NET-4-0-0-0-1
Parent:          ()
NetType:        Direct Allocation
OriginAS:
Organization:   Level 3 Parent, LLC (LPL-141)
RegDate:        1992-12-01
Updated:        2018-02-20
Ref:            https://whois.arin.net/rest/net/NET-4-0-0-0-1


OrgName:        Level 3 Parent, LLC
OrgId:          LPL-141
Address:        100 CenturyLink Drive
City:           Monroe
StateProv:      LA
PostalCode:     71203
Country:        US
RegDate:        2018-02-06
Updated:        2018-02-22
Ref:            https://whois.arin.net/rest/org/LPL-141
```

Figure 4-19. *The whois output with hash symbols indicating comments*

Notice in this case that the hash symbol is also used to indicate the start of the comments. Now it's time to create `result.php`, the program that receives the IP address entered by the user, processes it with the `whois` command, and returns to the user the output with the comments excluded.

Editing the File That Processes the User Data

You create next `result.php` in the document root (`/var/www/html`) of the vhost used.

At the Linux terminal, enter the following:

```
$ sudo gedit /var/www/html/result.php
```

Enter the following lines and save the file:

```
<!DOCTYPE html>
<html>
<body>
<span style="color:red;text-align:left;font-size:32px;background-
color:blue;float:left">
Online WHOIS Service
</span>
<span style="color:yellow;text-align:right;font-size:32px;background-
color:blue;float:right">
<?php echo "Your IP address: " . $_SERVER['REMOTE_ADDR']; ?>
</span>
<?php
echo '<h1 style="color:blue;text-align:center"> whois ' . $_POST['user_
data'] . '</h1>';
echo '<p style="font-family:monospace;font-size:16px;background-
color:black;color:white">';
$user_data = $_POST['user_data'];
if (isset($user_data)) {
   $exec_string = "whois $user_data";
   $output = shell_exec($exec_string);
   $stream = fopen('data://text/plain,' . $output,'r');
   while(! feof($stream)) {
       $x = fgets($stream);
       if((strpos(trim($x), '%') === 0) || (strpos(trim($x), '#') === 0))
       continue;
       echo $x;
       echo "<br>";
   }
}
echo '</p>';
?>
</body>
</html>
```

In the `result.php` source code, the global PHP variable `$_SERVER`, set by the PHP engine, includes the element `$_SERVER['REMOTE_ADDR']`, which holds the visitor's IP address. This information is not required by the WHOIS service but could be used as additional info for users who view your site.

With the following source code, the IP address entered by the user in the `user_data` textbox in the file `onlineservice.html` is now received by the PHP engine as `$_POST['user_data']`. This IP address is part of the message displayed when `result.php` is evaluated. For instance, for the IP address 1.2.3.4, the message is `whois 1.2.3.4`, which indicates the query `whois` performed. This information is included as a header, because it consists of the content of an `h1` HTML element.

```
echo '<h1 style="color:blue;text-align:center"> whois ' . $_POST['user_
data'] . '</h1>';
```

```
The $_POST['user_data'] valus is assigned then to the  PHP variable $user_
data.
```

The variable `$exec_string` is set to the string that represents the command that will be executed from the terminal at the web server. It is set to `whois $user_data`. This evaluates to `whois <IP address>`, where `<IP address>` is the specific value provided by the user, e.g., 87.202.116.192.

Hint! To implement a different service, you could change the command assigned as a value to `$exec_string`. For instance, for the ping service, you could use the following:

```
$exec_string = "ping -c 3 $user_data";
```

This sends three ICMP `echo` messages to the destination IP address and receives the reply. ICMP stands for Internet Control Message Protocol. It is part of the TCP/IP protocol suite and is used for diagnostic purposes.

The command defined in `exec_string` is passed to the Linux terminal with the function `shell_exec()`.

```
   $output = shell_exec($exec_string);
```

The value stored in shell_exec is the output of the whois command that you ran previously at the terminal. The output of the command executed is returned to the $output variable. This is a long string that usually includes multiple lines. To process this string, one approach is to store it in a file. Another approach is to process it on the fly using the notion of a Unix stream. A stream treats a string like a file. To access the $output string as a stream, for a read (r) operation, the file descriptor $stream is used in the following command:

```
$stream = fopen('data://text/plain,' . $output,'r');
```

For this stream, the data wrapper specifies the stream type, and the text/plain target specifies the stream format.

The following while loop is used to read one line at a time of the $stream and output all noncomment lines:

```
while(! feof($stream)) {
    $x = fgets($stream);
    if((strpos(trim($x), '%') === 0) || (strpos(trim($x), '#') === 0))
    continue;
    echo $x;
    echo "<br>";
}
```

The while condition, ! feof($stream), is true, while the end of the stream is not reached. Each line of the stream is returned in each while iteration by the fgets() function to variable $x.

```
    $x = fgets($stream);
```

The following command ignores all the lines starting with the percent (%) or the hash (#) symbol:

```
    if((strpos(trim($x), '%') === 0) || (strpos(trim($x), '#') === 0))
    continue;
```

The function trim() is used to remove the characters specified in its second argument. Since in this example no second argument exists, it returns a string stripped of any space, tab, or newline characters at the start and the end of the string. This is the corresponding PHP function to the JavaScript trim() method used previously in file onlineservice.html.

The two `strpos()` functions receive the returned string and check whether the character at position 0 (first position) is either the percent or the hash character. If this is the case, the command `continue` executes, and as a result, the `while` loop proceeds without executing the last two `while` commands in the current iteration. If the current line starts with the percent or hash character, this line is therefore ignored.

Hint! To check the result of the functions `trim()` and `strpos()` and of other string functions of PHP, use the PHP CLI utility. CLI stands for command-line interface, and if this program is not installed on your system, install it now by using this:

```
$ sudo apt-get install php7.0-cli
```

In the current directory, create a PHP file, for instance `test.php`.

```
$ gedit test.php
```

Enter the following code snippet and save the file:

```
<?php
$str = "\n\n\t\t Hello World!";
echo $str;
echo "\nPosition of character H: ";
echo strpos($str, 'H');
echo "\n";
$str2 = trim($str);
echo "$str2";
echo "\nPosition of character H: ";
echo strpos($str2, 'H');
?>
```

The value of variable `$str` is prepended with two newline characters (`\n`), which have the effect of pressing the Enter key of the keyboard, and two tab characters (`\t`), which have the effect of pressing the Tab key. The first `strpos()` call returns the position of character H in the string. The return value is 5 because character H is in the sixth position, which is position 5 starting counting from 0. Next, `trim()` is used to strip the tab and newline characters at the start of the string. The second `strpos()` therefore returns 0 because now H is the first character.

To run the program, use the following:

```
$ php test.php
```

The output in the Linux terminal is as follows:

```
christos@pc:~$ php test.php

            Hello World!

Position of character H: 5

Hello World!

Position of character H: 0
```

If the current line is not a comment, it is printed with the echo command, and also a break tag is used to change the line.

```
echo $x;
echo "<br>";
```

All not-commented lines are thus included in the output generated by the PHP engine and returned to the user from the web server.

Testing the WHOIS Online Service

You can test next your online WHOIS service at `webtoolsonline.servehttp.com`. Enter one of the IP addresses previously tested with the `whois` command from the terminal, e.g., 1.2.3.4, as viewed in Figure 4-20.

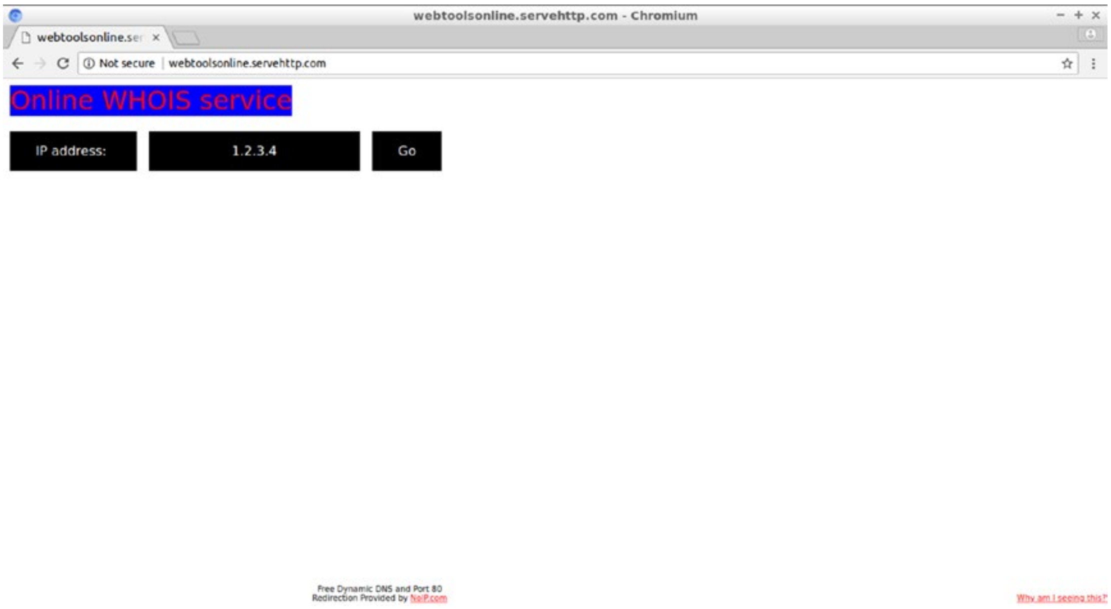
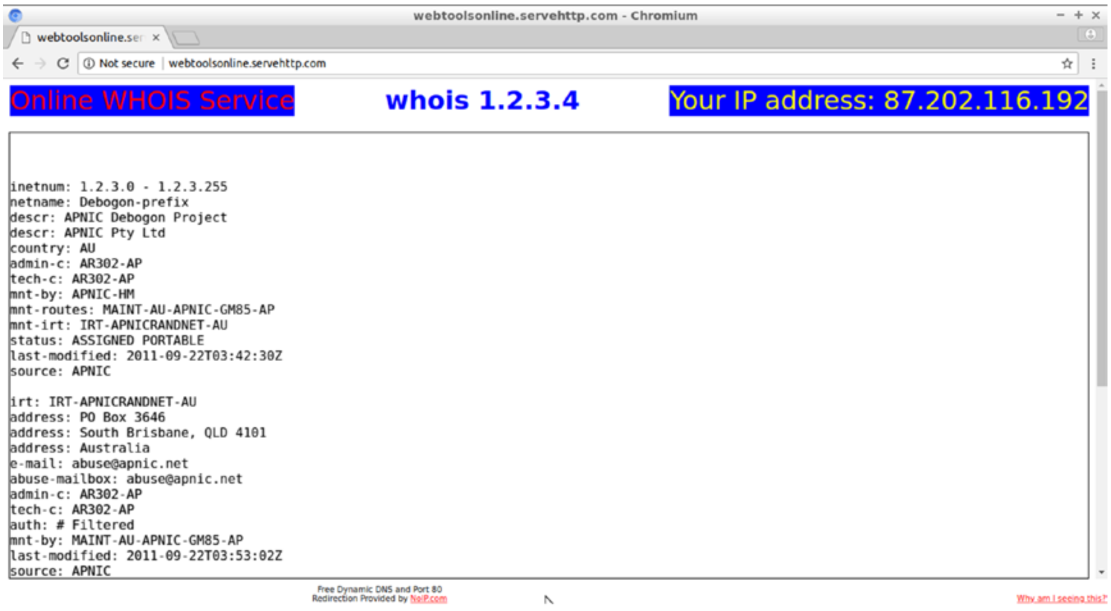

webtoolsonline.servehttp.com - Chromium
Not secure | webtoolsonline.servehttp.com
Online WHOIS service
IP address:
1.2.3.4
Go
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Figure 4-20. *Testing a valid IP address with the online service*

Click the Go button to submit the IP address to the web server.

The `result.php` evaluated web page for the IP address 1.2.3.4 is displayed in Figure 4-21.


webtoolsonline.servehttp.com - Chromium
Not secure | webtoolsonline.servehttp.com
Online WHOIS Service
whois 1.2.3.4
Your IP address: 87.202.116.192

```
inetnum: 1.2.3.0 - 1.2.3.255
netname: Debogon-prefix
descr: APNIC Debogon Project
descr: APNIC Pty Ltd
country: AU
admin-c: AR302-AP
tech-c: AR302-AP
mnt-by: APNIC-HM
mnt-routes: MAINT-AU-APNIC-GM85-AP
mnt-irt: IRT-APNICRANDNET-AU
status: ASSIGNED PORTABLE
last-modified: 2011-09-22T03:42:30Z
source: APNIC

irt: IRT-APNICRANDNET-AU
address: PO Box 3646
address: South Brisbane, QLD 4101
address: Australia
e-mail: abuse@apnic.net
abuse-mailbox: abuse@apnic.net
admin-c: AR302-AP
tech-c: AR302-AP
auth: # Filtered
mnt-by: MAINT-AU-APNIC-GM85-AP
last-modified: 2011-09-22T03:53:02Z
source: APNIC
```

Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Figure 4-21. *The online WHOIS service output*

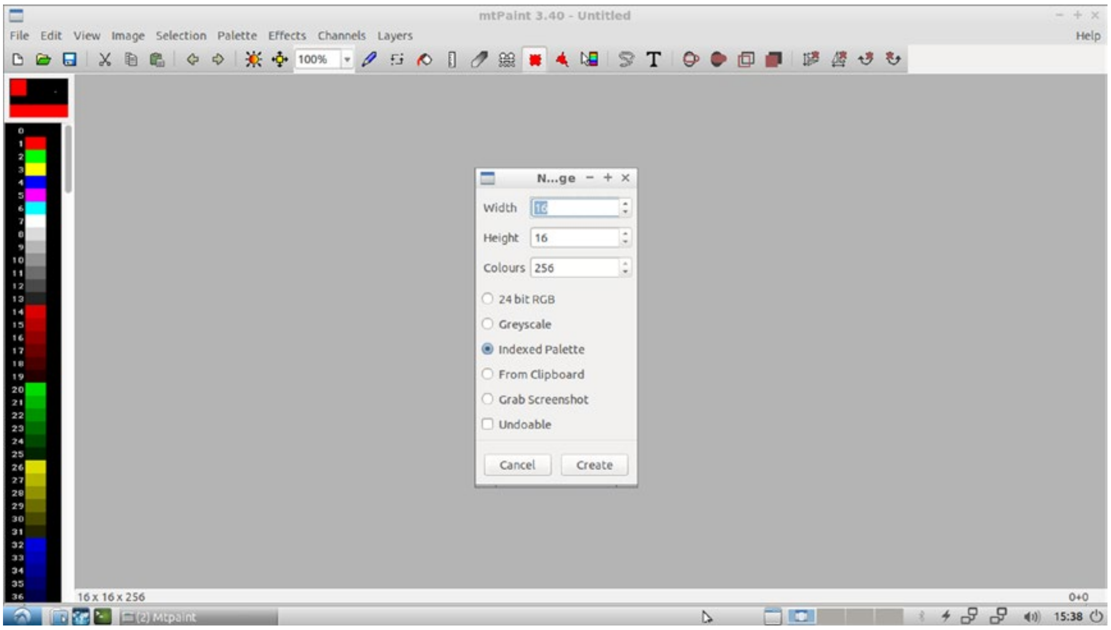
You will notice that the style of this web page resembles the Linux terminal. At the top of the web page, the message `whois 1.2.3.4` appears in the center, and the public IP address of the client is displayed on the right. The output differs from the `whois` terminal command because it lacks comment lines.

In the next section, you can add a favicon image to the web site to make the site instantly recognizable.

Adding a Favorite Icon to the Site

A favorite icon, referred as a *favicon* in its filename, is the tiny icon you see on the left of your browser tab when a web page loads. It makes a site recognizable because you can easily locate it when lots of tabs are open in the browser. Even before the web page loads, the favicon icon appears in the address bar of the browser, next to the address, which is completed with the autofill feature. This ensures that the address you are about to enter is the correct one. Favicons appear also in the bookmark list, where the URLs of your favorite sites are saved.

The first step of including a favicon image is to design it. In the Linux locate an image editor program or download and install one if necessary. The example shown here uses the mtPaint editor, which is the default image editor on the Linux system I'm using. Open mtPaint, and from the File menu select New. Favicons require a size of 16×16 pixels; therefore, in the dialog that appears (Figure 4-22), set the dimensions of the new image to 16 pixels width by 16 pixels height.


mtPaint 3.40 - Untitled
File Edit View Image Selection Palette Effects Channels Layers Help
100%
N...ge
Cancel
Create
16 x 16 x 256
0+0
15:38

Width 16
Height 16
Colours 256
24 bit RGB
Greyscale
[✓ Indexed Palette]
From Clipboard
Grab Screenshot
Undoable

Figure 4-22. *Setting the dimensions of the favicon icon to 16x16 pixels*

mtPaint displays a black-colored canvas, sized 16×16 pixels, for the new image (Figure 4-23).

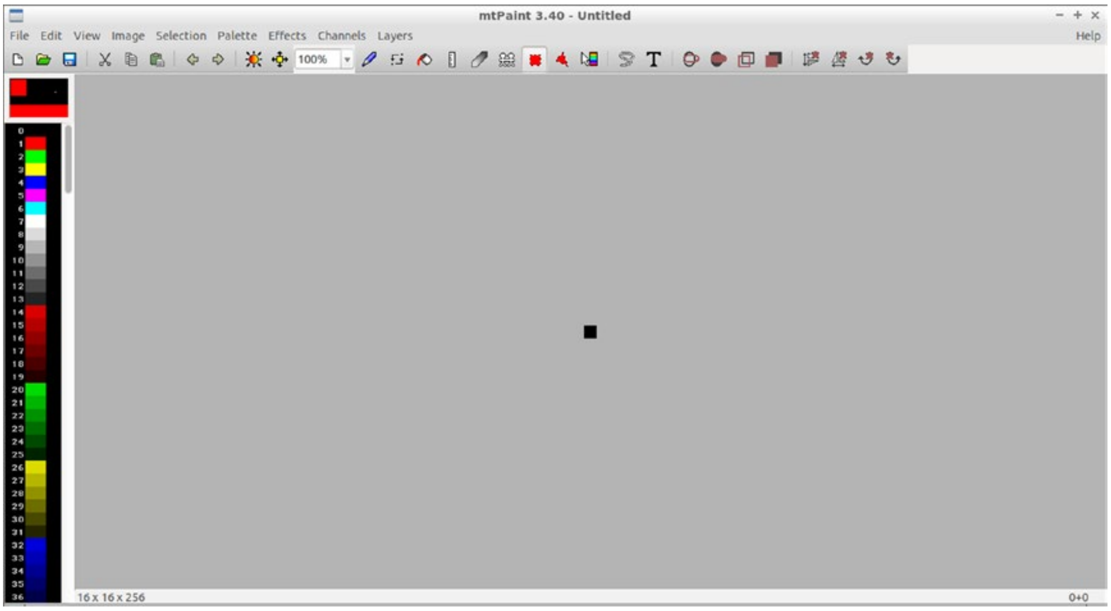

mtPaint 3.40 - Untitled
File Edit View Image Selection Palette Effects Channels Layers Help
100%
16 x 16 x 256
0+0

Figure 4-23. *The tiny favicon image with a 16×16 pixel size*

This is a tiny canvas to work with, so zoom in to enlarge it. To do this, in the zoom percentage drop-down, use a bigger zoom than 100%, for instance 1200% (Figure 4-24).

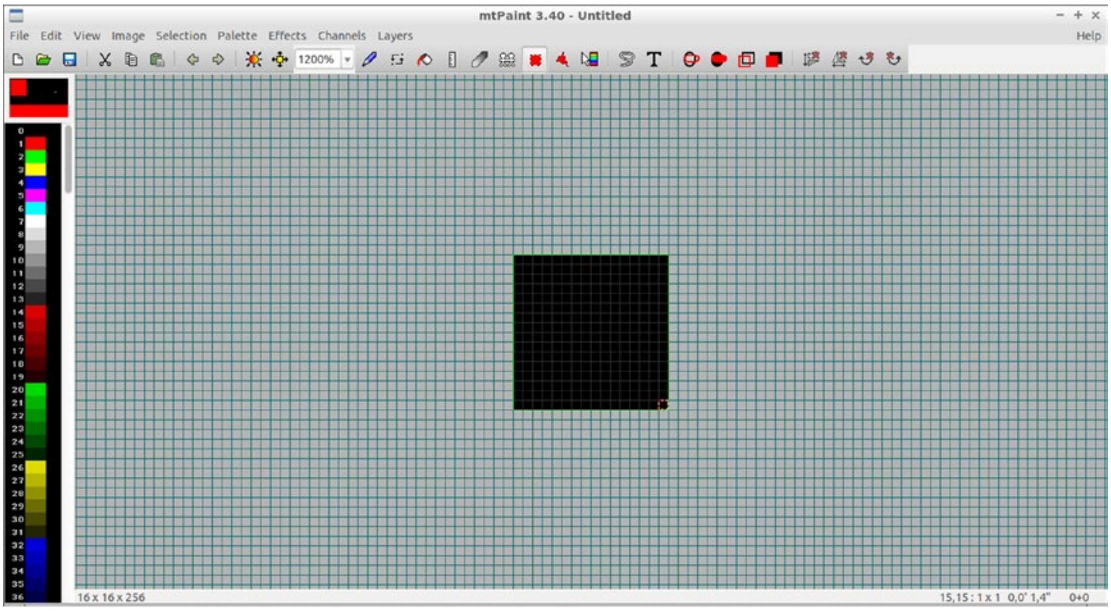


Figure 4-24. *Zooming in on the image for detailed drawing*

You can start by applying your ideas to the canvas. For instances, you can click the Flood Fill button (the paint bucket), select a white color (e.g., color 7 from the color list on the left), and click next any pixel of the canvas to turn the background of your image to white. Using the Paint button (the blue pencil), select a color from the list and click any pixel to color it. In Figure 4-25, the blue and red colors are being used. The image displayed includes two letters, OT, for "online tools." The letter *T* strives to look like a hammer.

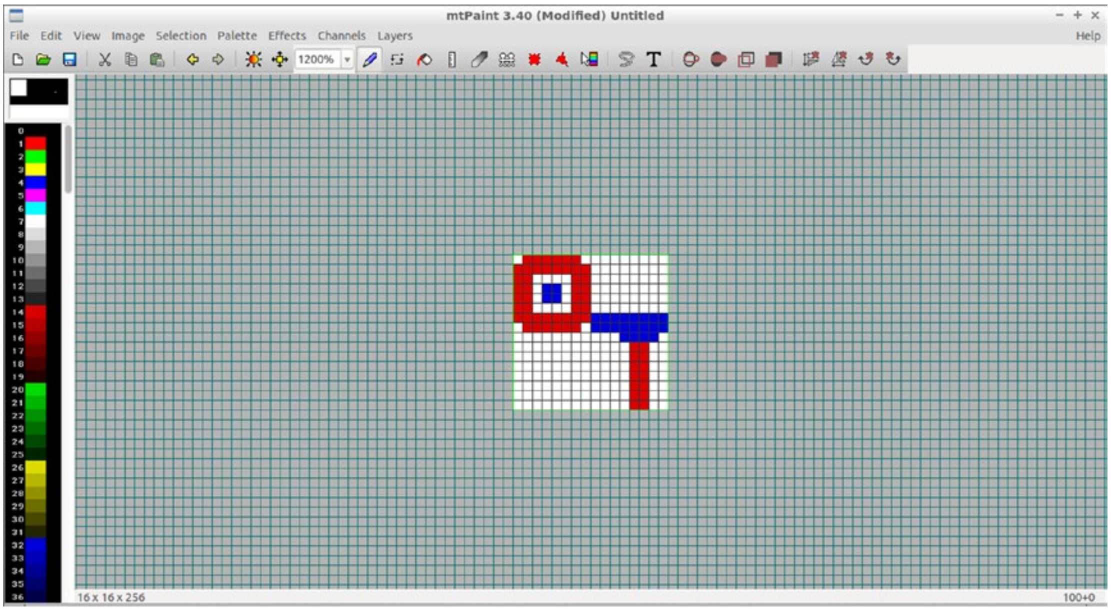

mtPaint 3.40 (Modified) Untitled
File Edit View Image Selection Palette Effects Channels Layers
Help
1200%
16 x 16 x 256
100+0

Figure 4-25. *The favicon image completed*

From the File menu, choose Save As to save the image to one of your directories, e.g., `Pictures`, and in the dialog that appears, provide the `Pictures` file path and favicon file name. Select also PNG as the image format in the File Format list and click the OK button.

Although you can use the PNG file type for the favicon files, the default one used for the whole site defaults to the name `favicon.ico`. The ICO file type is not supported by mtPaint. You can, however, change the file type from the terminal using the `convert` command included in the `imagemagick` package. Install `imagemagick` using the following:

```
$   sudo apt-get install imagemagick
Change then the file type using:
$ convert -background transparent "favicon.png" -define icon:auto-
resize=16,24,32,48,64,72,96,128,256 "favicon.ico"
Copy next the favicon.ico file to the document root:
$ sudo cp ~/Pictures/favicon.png /var/www/html
```

Test your site next. As viewed in Figure 4-26, the favicon image appears on the left of the web page tab in your browser.

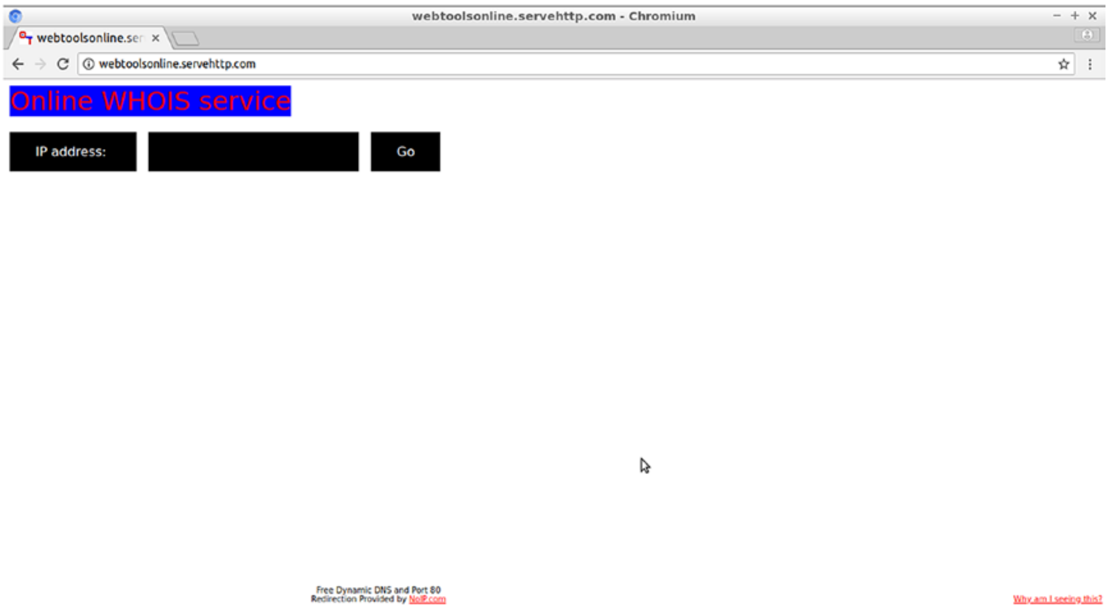

webtoolsonline.servehttp.com - Chromium
webtoolsonline.ser
webtoolsonline.servehttp.com
Online WHOIS service
IP address:
Go
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Figure 4-26. *The site's home page includes a favicon image on the browser's tab*

To use a different favicon image for another web page of your site, make explicit reference from the web page to another favicon image. Create a second favicon file, `favicon2.png`, that includes for simplicity just a yellow background, and copy it to the document root directory. Edit a web page, for instance the `result.php` file, and add in the head section a link reference to `favicon2.png`. Specifically, in the head section of the HTML source code, enter the following tag:

```
<link rel="icon" href="favicon2.png"/>
```

Because this is a specific reference where the file name is provided, the file type used can be of a different type than ICO; e.g., in this example PNG is used. The source code of `result.php` becomes the following:

```
<!DOCTYPE html>
<html>
<head>
<link rel="icon" href="favicon2.png"/>
</head>
<body>
```

```
<span style="color:red;text-align:left;font-size:32px;background-
color:blue;float:left">
Online WHOIS Service
</span>
<span style="color:yellow;text-align:right;font-size:32px;background-
color:blue;float:right">
<?php echo "Your IP address: " . $_SERVER['REMOTE_ADDR']; ?>
</span>
<?php
echo '<h1 style="color:blue;text-align:center"> whois ' . $_POST['user_
data'] . '</h1>';
echo '<p style="font-family:monospace;font-size:16px;background-
color:black;color:white">';
$user_data = $_POST['user_data'];
if (isset($user_data)) {
   $exec_string = "whois $user_data";
   $output = shell_exec($exec_string);
   $stream = fopen('data://text/plain,' . $output,'r');
   while(! feof($stream)) {
       $x = fgets($stream);
       if((strpos(trim($x), '%') === 0) || (strpos(trim($x), '#') === 0))
       continue;
       echo $x;
       echo "<br>";
   }
}
echo '</p>';
?>
</body>
</html>
```

Test the `onlineservice.html` file using, for instance, the following URL:

`127.0.0.1:8080.`

As shown in Figure 4-27, the home page of the site loads with the default favicon image.

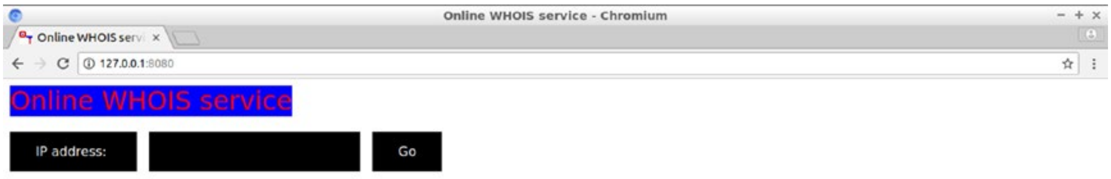
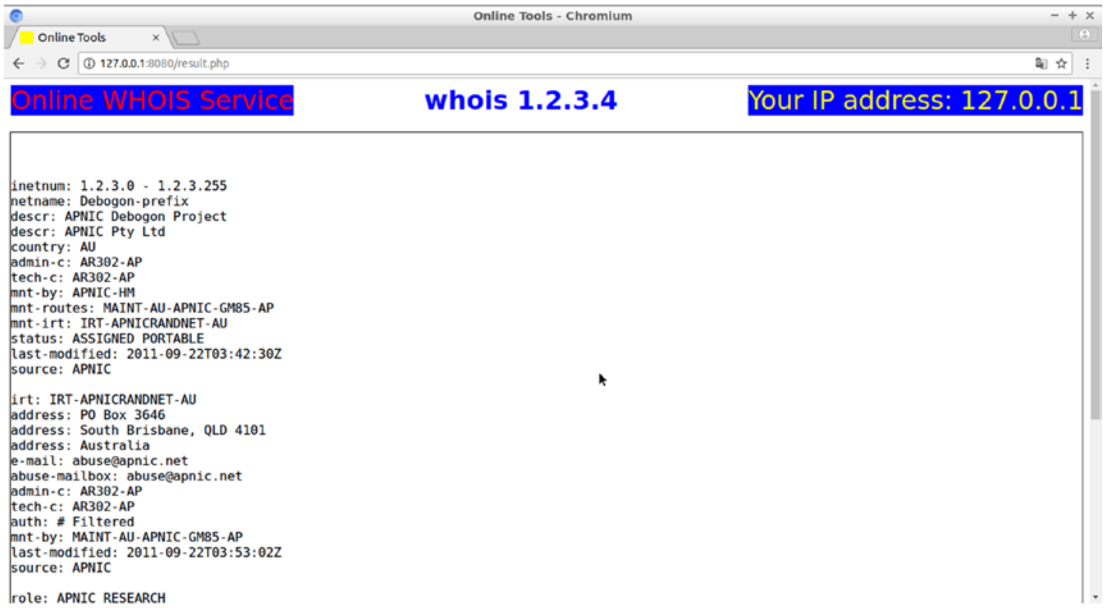


Figure 4-27. *The home page of the site loads with the default favicon image*

Enter in the form textbox an IP address and click the Go button. The `result.php` web page is displayed in your browser. As shown in Figure 4-28, `result.php` includes the yellow `favicon2.png` icon on the left of its tab.



```
inetnum: 1.2.3.0 - 1.2.3.255
netname: Debogon-prefix
descr: APNIC Debogon Project
descr: APNIC Pty Ltd
country: AU
admin-c: AR302-AP
tech-c: AR302-AP
mnt-by: APNIC-HM
mnt-routes: MAINT-AU-APNIC-GM85-AP
mnt-irt: IRT-APNICRANDNET-AU
status: ASSIGNED PORTABLE
last-modified: 2011-09-22T03:42:30Z
source: APNIC

irt: IRT-APNICRANDNET-AU
address: PO Box 3646
address: South Brisbane, QLD 4101
address: Australia
e-mail: abuse@apnic.net
abuse-mailbox: abuse@apnic.net
admin-c: AR302-AP
tech-c: AR302-AP
auth: # Filtered
mnt-by: MAINT-AU-APNIC-GM85-AP
last-modified: 2011-09-22T03:53:02Z
source: APNIC

role: APNIC RESEARCH
```

Figure 4-28. *The web page result.php uses a different favicon image*

You can create a favicon icon in a few steps to provide an image that personalizes your site and even become the motivation for an inspired logo for the web content of the site.

Summary

In this chapter, you did the following:

- You used the DDNS service to provide a user-friendly domain name to your site.
- You created a web project with an online web service, specifically WHOIS.
- You created a `favicon.ico` image for your site.

In the next chapter, the source code of another web service is displayed, which creates a site that allows web server administrators and web designers find how their site looks from a remote location. But first you are introduced to another popular open source web server, the Lighttpd server.

CHAPTER 5

The Lighttpd Web Server

Most of the web browsers used today have the same common features; therefore, it's easy for users to make the transition from using one browser to another. This is an advantage that it is not found on the server side. Web servers are specialized programs, not expected to be used by the average user. Therefore, the graphical user interface (GUI), if the web server is supplied with one, or the commands used at the terminal for configuring and running the server may be completely different from one server to another. In this chapter, you will have the chance to use another open source web server, Lighttpd (called "Lighty"). You will run the server and identify characteristics that you used previously in Apache, like the document root and the virtual servers. Experimenting with a second server will make it easier for you to transition to a third one.

You will then use Lighttpd with PHP to create your next online web service, which will simulate a web service like `webpagetest.org` that tests the appearance of your site remotely; you used `webpagetest.org` in Chapter 3.

Installing Lighttpd

Running two web servers at the same time is possible but not recommended because if the servers are not carefully configured (for instance, bound to different port numbers), this might lead to conflicts and unpredictable results. To stop the `apache2` process and leave the field free for Lighttpd, use the following:

```
$ sudo service apache2 stop
```

This stops Apache until you shut down and reboot your computer. To avoid restarting the Apache process the next time your computer starts, use the following:

```
$ sudo systemctl disable apache2
```

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C. Karayiannis, *Web-Based Projects that Rock the Class*, https://doi.org/10.1007/978-1-4842-4463-0_5

You don't have to worry about your saved work so far—all the files saved in the document root directory (e.g., `/var/www/html`) remain there.

To install Lighttpd from the terminal, use the following commands:

```
$ sudo apt-get update
$ sudo apt-get install lighttpd
```

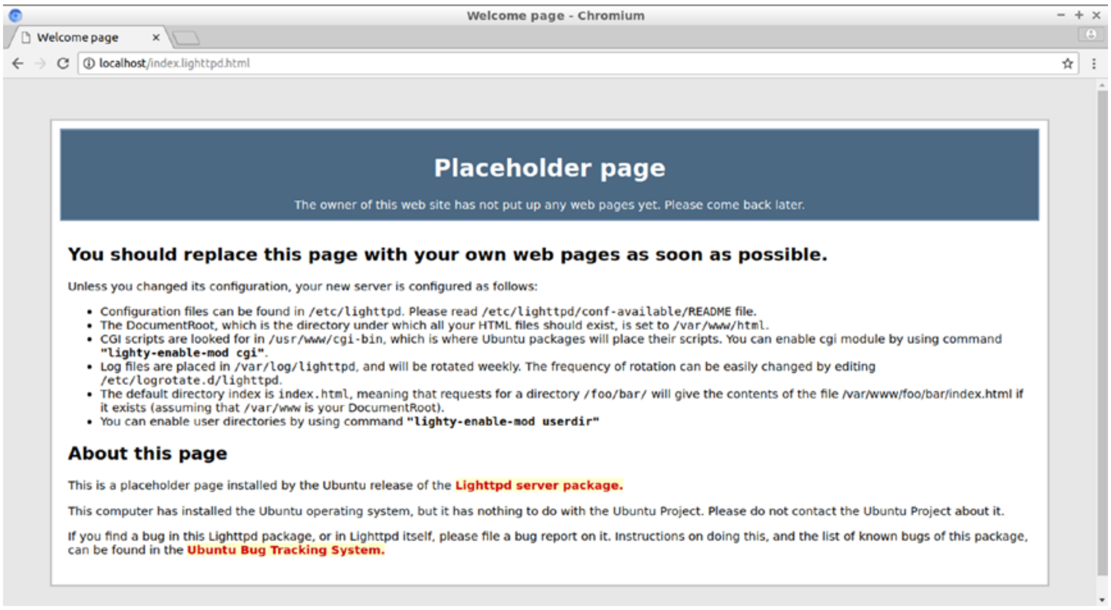
Testing Lighttpd

The default document root for Lighttpd is `/var/www/html`, which is the same directory as with Apache's document root. Notice that for some Ubuntu distributions the default document root is `/var/www`. You can change the default document root from the Lighttpd configuration file, as discussed in the following section. A directory index with the name `index.lighttpd.html` was already created in the document root. Enter this file in your browser's address bar using the default loopback address, 127.0.0.1, or the corresponding hostname `localhost`, as shown here:

```
localhost/index.lighttpd.html
```

Although `index.lighttpd.html` is a directory index, including the file name in the URL path is required because this is the third directory index name included in the configuration file, discussed in the following section. The files `index.php` and `index.html`, included first in the list, take precedence and are displayed instead.

The web page `index.lighttpd.html` is the test page for the Lighttpd web server. As shown in Figure 5-1, it provides information about the basic Lighttpd configuration.



Placeholder page

The owner of this web site has not put up any web pages yet. Please come back later.

You should replace this page with your own web pages as soon as possible.

Unless you changed its configuration, your new server is configured as follows:

- Configuration files can be found in `/etc/lighttpd`. Please read `/etc/lighttpd/conf-available/README` file.
- The DocumentRoot, which is the directory under which all your HTML files should exist, is set to `/var/www/html`.
- CGI scripts are looked for in `/usr/www/cgi-bin`, which is where Ubuntu packages will place their scripts. You can enable cgi module by using command **"lighty-enable-mod cgi"**.
- Log files are placed in `/var/log/lighttpd`, and will be rotated weekly. The frequency of rotation can be easily changed by editing `/etc/logrotate.d/lighttpd`.
- The default directory index is `index.html`, meaning that requests for a directory `/foo/bar/` will give the contents of the file /var/www/foo/bar/index.html if it exists (assuming that `/var/www` is your DocumentRoot).
- You can enable user directories by using command **"lighty-enable-mod userdir"**

About this page

This is a placeholder page installed by the Ubuntu release of the **Lighttpd server package.**

This computer has installed the Ubuntu operating system, but it has nothing to do with the Ubuntu Project. Please do not contact the Ubuntu Project about it.

If you find a bug in this Lighttpd package, or in Lighttpd itself, please file a bug report on it. Instructions on doing this, and the list of known bugs of this package, can be found in the **Ubuntu Bug Tracking System.**

Figure 5-1. *The test page of the Lighttpd web server*

If you see a file with the name `index.html`, created when using Apache, in the document root, rename it as follows:

```
$ sudo mv index.html index.htmlOLD
```

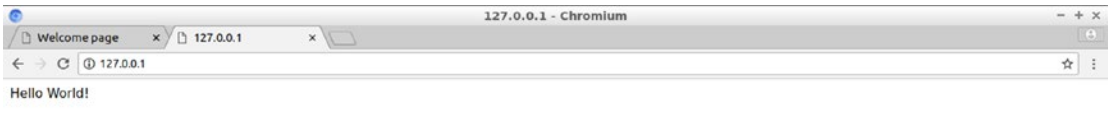
Create a new directory index for the Lighttpd server in the document root `index.html`.

```
$ cd /var/www/html
$ sudo gedit index.html
```

Enter a simple HTML source code, like the following, and save the file:

```
<!DOCTYPE html>
<html>
<head>
</head>
<body>
Hello World!
</body>
</html>
```

Then test your new directory index using the `localhost` hostname or the IP address 127.0.0.1 in the browser's address bar. Figure 5-2 displays the directory index dispatched by Lighttpd.

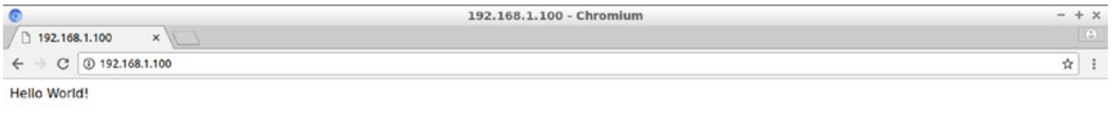


Hello World!

Figure 5-2. *The directory index viewed from a browser locally*

Try also to use in the URL the private IP address of the web server, which is 192.168.1.100 for the examples used in this text.

Figure 5-3 displays the directory index viewed from another computer in the same LAN with the web server.



Hello World!

Figure 5-3. *The directory index viewed from a browser on another computer in the web server LAN*

To view the web page from outside the local LAN, you have to use either the public IP address of the router or one of the fully qualified domain names obtained in Chapter 4. In the following section, you will make the required changes to the Lighttpd configuration file to test your web server externally from your LAN.

Working in the Lighttpd Configuration File

The Lighttpd configuration file is `lighttpd.conf`, located in the directory `/etc/lighttpd`.

Before starting to modify the configuration file, make a copy of the original one with the following commands:

```
$ cd /etc/lighttpd/
$ sudo cp lighttpd.conf lighttpd.conf.bak
```

Edit `lighttpd.conf` with a text editor, for instance gedit.

```
$ sudo gedit lighttpd.conf
```

The file contents are as follows:

```
  server.modules = (
      "mod_access",
      "mod_alias",
      "mod_compress",
      "mod_redirect",
)

server.document-root        = "/var/www/html"
server.upload-dirs          = ( "/var/cache/lighttpd/uploads" )
server.errorlog             = "/var/log/lighttpd/error.log"
server.pid-file             = "/var/run/lighttpd.pid"
server.username             = "www-data"
server.groupname            = "www-data"
server.port                 = 80

index-file.names            = ( "index.php", "index.html", "index.lighttpd.
                              html" )
url.access-deny             = ( "~", ".inc" )
static-file.exclude-extensions = ( ".php", ".pl", ".fcgi" )

compress.cache-dir          = "/var/cache/lighttpd/compress/"
compress.filetype           = ( "application/javascript", "text/css",
                              "text/html", "text/plain" )

# default listening port for IPv6 falls back to the IPv4 port
## Use ipv6 if available
#include_shell "/usr/share/lighttpd/use-ipv6.pl " + server.port
include_shell "/usr/share/lighttpd/create-mime.assign.pl"
include_shell "/usr/share/lighttpd/include-conf-enabled.pl"
```

The Lighttpd directives follow object-oriented programming principles. The first part is the object that is referred to, and then after a dot the specific attribute of this object is indicated. The attribute is then assigned a value using the equal (=) sign.

At the start of the configuration file, you will see the `server.modules` directive, which is a list with the modules of the web server to be loaded. Other directives follow. Here are some examples:

- `server.errorlog`, the location of the error log file.
- `server.pid-file`, the file that stores the process ID (PID) of the Lighttpd server. This is the PID that you can find using the command `ps xa | grep lighttpd`.
- `server.username`, the username of the user the Lighttpd server assumes.
- `server-groupname`, the group the Lighttpd user belongs to.
- `server.document-root`, which defines the document root.

Applying a Basic Configuration

If in your Lighttpd version the document root directive (`server.document-root`) is set to `/var/www`, you can change this to `/var/www/html` so you can test the book's sites from both Lighttpd and Apache without modification.

If you use the default HTTP port number (80) for your server, you can use the server's configuration file as is. If, on the other hand, your ISP blocks the inbound port 80 and you utilize another port, e.g., 8080, or if you plan to implement the HTTPS protocol (more about this in Chapter 8) that uses port 443, you can change the default `server.port` value.

```
server.port                    = 80
```

In the previous section, you viewed the directory index `index.lighttpd.html`. This is included third in the directory's indexes list, indicated by the `index-file.names` directive.

```
index-file.names               = ( "index.php", "index.html", "index.lighttpd.
                                 html" )
```

This directive assigns the list of files used as directory indexes for the web server. From this directive, you can change the order of the filenames used. To enable any changes in the configuration file, click the Save button in the gedit window and reload the web server as follows:

```
$ sudo service lighttpd force-reload
```

With the configuration file updated and the Linux firewall already set from Chapter 1, you can connect to the web server from any location on the Internet. Use the public IP address of your router in your browser's address bar. This time retrieve your external IP address by using the following command:

```
$ curl ifconfig.co
The output in this example is:
87.202.116.97
```

You can also use a fully qualified domain name, like the ones created in Chapter 4, in the URL of your site. Here's an example:

```
webtoolsonline.servehttp.com
```

Hint! To ensure that your site runs as expected from any Internet-connected computer, you have to test the web server externally from your LAN, by using your mobile Internet connection or an online web service like `webpagetest.org`. Actually, the web project you will develop in this chapter creates a similar web service.

Binding to a Specific IP Address or Hostname

With the `bind` directive, you can restrict the server to a specific IP address or hostname, where the web server listens for client requests, for instance:

```
server.bind = "87.202.116.97"
```

87.202.116.97 is the public IP address of the router used in this example. To implement this directive, insert the previous directive in the configuration file, save the file, and reload the server using the following:

```
$ sudo service lighttpd force-reload
```

In the following example, it is assumed that the server listens on port 8080. Use the following IP address and port number combination in the browser's address bar:

```
87.202.116.97:8080
```

The web page is loaded as usual. Use the following IP address and port number combination:

```
127.0.0.1:8080
```

The web page does not load anymore. Comment out the previous directive in the configuration file by prepending it with the hash symbol.

```
#server.bind = "87.202.116.97"
```

Next enable the new configuration.

```
$ sudo service lighttpd force-reload
```

Use the IP address and port number combination one more time in the browser's address bar.

```
 127.0.0.1:8080
```

The web page loads again normally.

You can also test the `server.bind` directive with domain names. One of the two domain names created in Chapter 4 is the following:

```
christos.ddns.net
```

To bind the web server to this domain name, uncomment the `server.bind` directive and replace the IP address in its value with the FQDN `christos.ddns.net`.

```
server.bind = "christos.ddns.net"
```

Save the configuration file and reload the server using this command:

```
$ sudo service lighttpd force-reload
```

Test the domain name from the browser. Using `christos.ddns.net`, it loads as usual. If you try the public IP address of the router, e.g., 87.202.116.97, in the address bar, you'll see it does not load anymore. Comment out the `server.bind` directive and reload the server to bring its configuration to the previous state.

Changing the Document Root

The default document root as set in the configuration file is `/var/www/html`. Try to set another one, for instance `/var/www/html2`. First you have to create the new `html2` directory in `www`.

```
$ sudo mkdir /var/www/html2
```

Create a new directory index called `index.html` in `html2`.

```
$ sudo gedit /var/www/html2/index.html
```

Enter the following source code and save the file:

```
<!DOCTYPE html>
<html>
<head>
</head>
<body>
This is file /var/www/html2/index.html
</body>
</html>
```

Next edit the configuration file.

```
$ sudo gedit /etc/lighttpd/lighttpd.conf
```

Change the value of the `server.document-root` directive from `/var/www/html` to `/var/www/html2`. Save the file and reload the server.

```
$ sudo service lighttpd force-reload
```

Test locally the new document root using the port the server listens on, either the following:

```
localhost
```

or the following:

```
localhost:8080
```

The new web page is loaded.

Restore the document root to `/var/www/html` to set the web server to the previous state.

Enabling and Disabling the Directory Listing

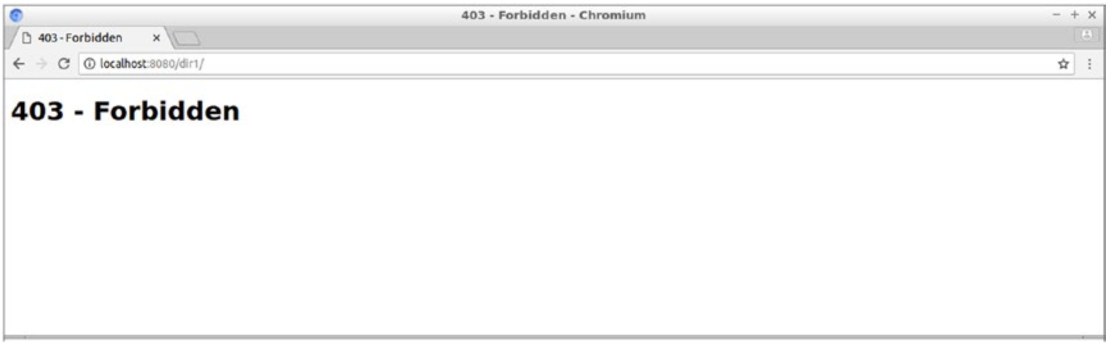
To allow the user to view the contents of a directory, when no directory index is present in this directory, you can set the `dir-listing.activate` directive. By default the directory listing is disabled. To test this, create directory `dir1` under the document root, and inside `dir1` create two files, for instance `file1` and `file2`, using the following commands at the terminal:

```
$ sudo gedit mkdir /var/www/html/dir1
$ cd /var/www/html/dir1
$ sudo touch file1 file2
```

Enter the following URL in your browser address bar:

```
localhost/dir1
or if you utilize port 8080:
localhost:8080/dir1
```

A web page with the HTTP error message 403 appears, as displayed in Figure 5-4.



403 - Forbidden

Figure 5-4. *The HTTP 403 error status code displayed using the URL of a directory with no directory index and the directory listing disabled*

Open the configuration file for editing.

```
$ sudo gedit /etc/lighttpd/lighttpd.conf
```

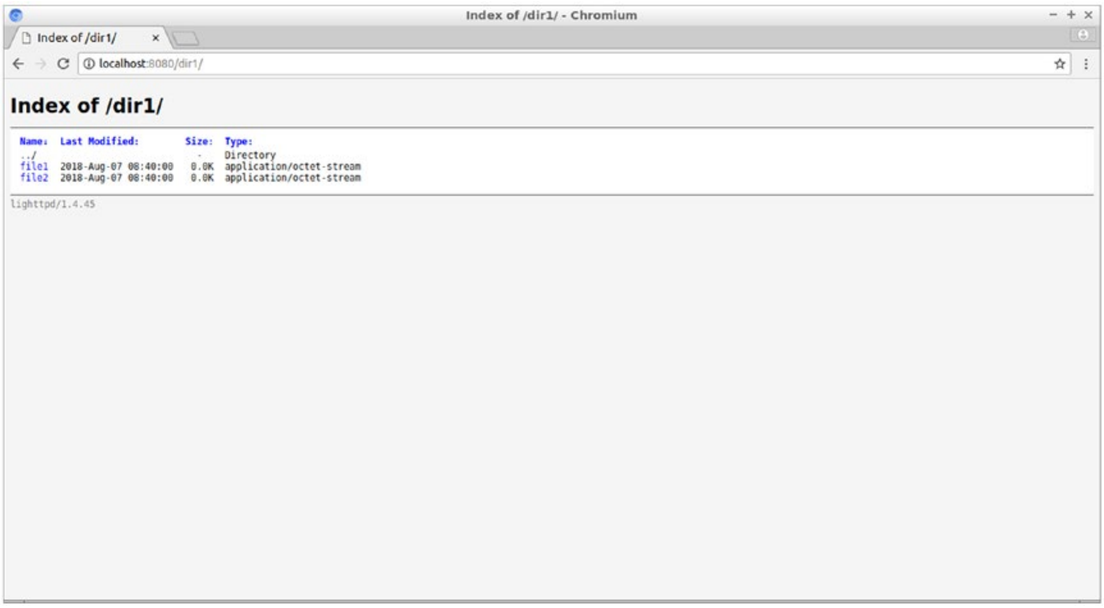
Enter the following line:

```
dir-listing.activate = "enable"
```

Save the configuration file and reload the server.

```
$ sudo service lighttpd force-reload
```

Figure 5-5 shows the directory contents, and the users can download the files included in this directory by clicking the file names.



Index of /dir1/

```
Name:  Last Modified:         Size:  Type:
../                              -   Directory
file1  2018-Aug-07 08:40:00   0.0K   application/octet-stream
file2  2018-Aug-07 08:40:00   0.0K   application/octet-stream
```

lighttpd/1.4.45

***Figure 5-5.** The directory contents listed using the URL of a directory lacking a directory index when the directory listing is enabled*

To restore the `dir-listing.activate` directive, switch its value in the configuration file from `enable` to `disable`, save the configuration file, and reload the web server.

Sending Custom-Made Error Replies to the Client

In the previous section, the web server sends the default message for the HTTP error status code 403. This is the message:

```
403 - Forbidden
```

To customize the content of the error message, open the configuration file for editing.

```
$ sudo gedit /etc/lighttpd/lighttpd.conf
```

With the following line, set the `server.errorfile-prefix` directive and save the file:

```
server.errorfile-prefix = "/srv/www/errors/status-"
```

Reload the web server.

```
$ sudo service lighttpd force-reload
```

Create the directory `www/errors` in `/srv`.

```
$ sudo mkdir -p /srv/www/errors
```

Here, the `-p` option creates parent directories (`www` in this case).

```
Create next in the errors directory your customized status code web pages
with the format:<errorfile-prefix><status-code>.html
```

`<errorfile-prefix>` is the value of the `server.errorfile-prefix` directive, and `<status-code>` is the specific error status code. For instance, for the HTTP error status code 403, create the file `/srv/www/errors/status-403.html`.

```
$ sudo gedit /srv/www/errors/status-403.html
```

Enter the following source code:

```
<!DOCTYPE html>
<html>
<head>
<style>
p{
color:red;
font-size:120px;
text-align:center;
text-decoration: underline overline;
}
img {
    display: block;
    margin-left: auto;
    margin-right: auto;
}
.top-right {
    position: absolute;
    top: 8px;
    right: 16px;
}
.top-left {
    position: absolute;
    top: 8px;
    left: 16px;
}
</style>
</head>
<body>
<div class="top-left">
<p>Error</p>
</div>
<div>
<img src="http://christos.ddns.net:8080/police.jpg">
</div>
<div class="top-right">
<p>403</p>
</div>
</body>
</html>
```

With the `dir-listing.activate` directive disabled, you can test the customized error page by using the URL of the directory `dir1`, created previously. Here's an example:

```
http://webtoolsonline.servehttp.com/dir1
```

Figure 5-6 displays the customized error page.

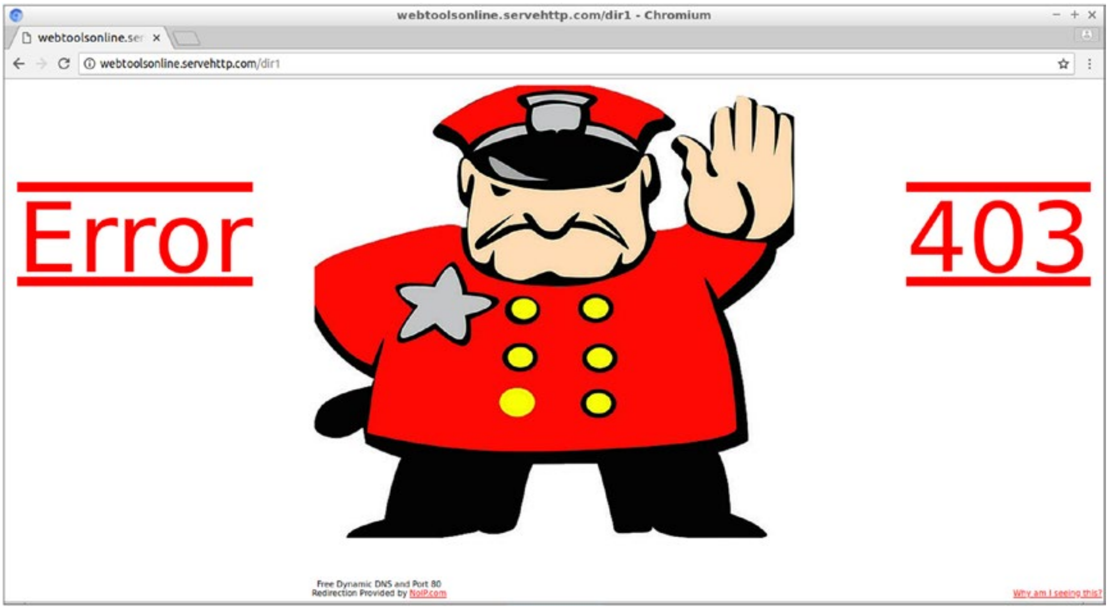

webtoolsonline.servehttp.com/dir1 - Chromium
webtoolsonline.ser
webtoolsonline.servehttp.com/dir1
Error
403
Free Dynamic DNS and Port 80
Redirection Provided by NoIP.com
Why am I seeing this?

Figure 5-6. *The custom error page for the 403 HTTP error status code*

Accessing the Lighttpd Log Files

Create and use Lighttpd log files to collect information about the visitors of your site. For instance, create a file called `access.log` in the `/var/log/lighttpd/` directory with the following command:

```
$ sudo touch /var/log/lighttpd/access.log
```

Using the `chown` command, I set the owner of the file access.log to the Lighttpd process using the chown command. At this command I use: `www-data:www-data` the first `www-data` is the username, the Lighttpd process assumes the second `www-data` is the group this user belongs.

```
$ sudo chown www-data:www-data /var/log/lighttpd/access.log
```

Edit the Lighttpd configuration file next.

```
$ sudo gedit /etc/lighttpd/lighttpd.conf
```

Include `mod_accesslog` in the group of modules to be loaded. It should appear after `mod_alias` since the order of the modules is the order they will be executed in. Include also the `accesslog.filename` directive to set the file name and path of the log file.

```
accesslog.filename          = "/var/log/lighttpd/access.log"
```

The configuration file is now as follows:

```
server.modules = (
      "mod_access",
      "mod_alias",
      "mod_accesslog",
      "mod_compress",
      "mod_redirect",
)

server.document-root        = "/var/www/html"
server.upload-dirs          = ( "/var/cache/lighttpd/uploads" )
server.errorlog             = "/var/log/lighttpd/error.log"
server.pid-file             = "/var/run/lighttpd.pid"
server.username             = "www-data"
server.groupname            = "www-data"
server.port                 = 8080
#server.bind                = "webtoolsonline.servehttp.com"
server.errorfile-prefix     = "/srv/www/errors/status-"

dir-listing.activate        = "disable"


accesslog.filename          = "/var/log/lighttpd/access.log"


index-file.names            = ( "index.php", "index.html", "index.lighttpd.
                              html" )
url.access-deny             = ( "~", ".inc" )
static-file.exclude-extensions = ( ".php", ".pl", ".fcgi" )
```

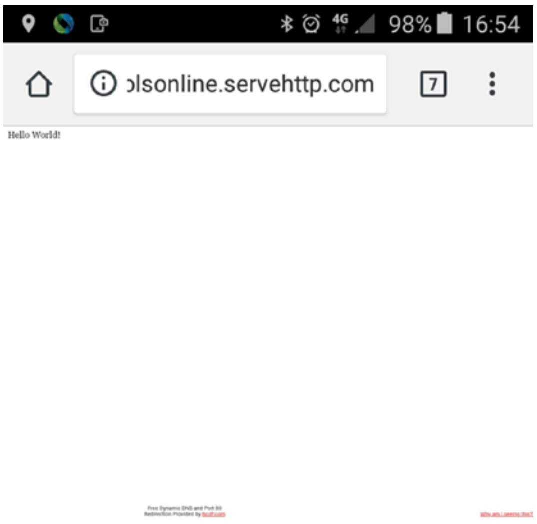
```
compress.cache-dir          = "/var/cache/lighttpd/compress/"
compress.filetype           = ( "application/javascript", "text/css",
                              "text/html", "text/plain" )

# default listening port for IPv6 falls back to the IPv4 port
## Use ipv6 if available
#include_shell "/usr/share/lighttpd/use-ipv6.pl " + server.port
include_shell "/usr/share/lighttpd/create-mime.assign.pl"
include_shell "/usr/share/lighttpd/include-conf-enabled.pl"
```

Reload the server to enable the changes in the configuration file.

```
$ sudo service lighttpd force-reload
```

To test the `access.log` file, first do a local client request, e.g., using `localhost:8080` from a browser on the web server, and then do another request from any other computer, external to your LAN. Probably the nearest computer is your mobile phone. Figure 5-7 displays a connection to `webtoolsonline.servehttp.com/index.html` from a Samsung Galaxy S3 using the Google Chrome browser.



Hello World!

Figure 5-7. Connecting from a mobile phone to test access.log

Read the contents of access.log using the following commands:

```
$ sudo su
# cat /var/log/lighttpd/access.log
```

The output from the previous commands in this example is as follows:

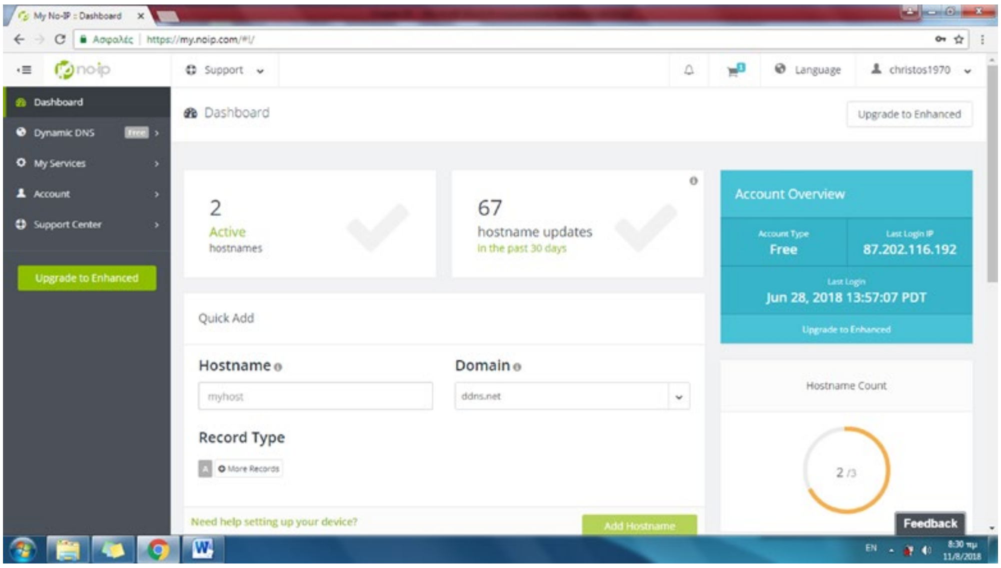
```
127.0.0.1 localhost:8080 - [10/Aug/2018:08:29:18 +0300] "GET /favicon.
ico HTTP/1.1" 404 345 "http://localhost:8080/" "Mozilla/5.0 (X11; Linux
x86_64) AppleWebKit/537.36 (KHTML, like Gecko) Ubuntu Chromium/67.0.3396.99
Chrome/67.0.3396.99 Safari/537.36"
66.249.81.241 christos.ddns.net:8080 - [10/Aug/2018:08:29:56 +0300]
"GET /index.html HTTP/1.1" 304 0 "http://webtoolsonline.servehttp.
com/index.html" "Mozilla/5.0 (Linux; Android 5.1.1; SM-J320FN Build/
LMY47V) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/68.0.3440.70 Mobile
Safari/537.36"
```

The first recording provides details for the local connection, issued from the web server computer, while the second provides details for the remote connection, issued from the mobile phone.

Using Virtual Hosts with Lighttpd

In Chapter 1 you used IP-based, port number–based, and name-based virtual hosts with Apache. Those features are also available with Lighttpd. The names used in the name-based Apache virtual host tests were hostnames, like myserver.com, that used only locally on the web server. In Chapter 4, you created FQDN hostnames like christos.ddns.net and webtoolsonline.servehttp.com that could be used universally, throughout the Internet. Next you can apply those DNS names to create two virtual hosts that run simultaneously on the web server, with each one dedicated to a completely different site. The names created in Chapter 4 are actually not different because with the DDNS configuration, the name webtoolsonline.servehttp.com redirects to christos.ddns.net.

This is your chance to create a third DDNS name using the steps for creating the other two. You can use the third name for the first one of the two virtual hosts. Log in to the DDNS server provider's web page, which is https://www.noip.com for the examples used in the book. Figure 5-8 shows the Dashboard web page.

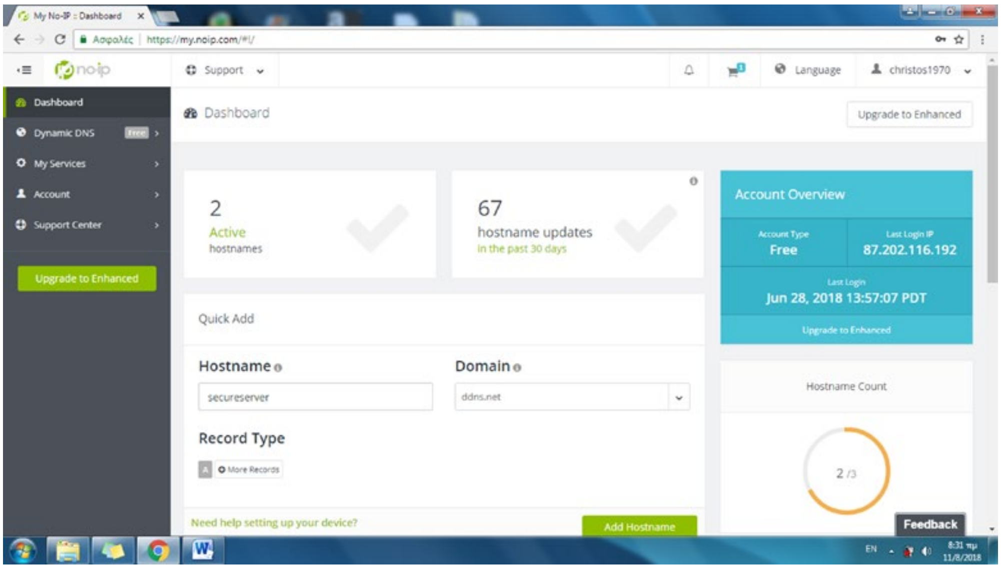


Hostname: myhost

Domain: ddns.net

Figure 5-8. *The Dashboard web page of no-IP*

Enter the name of a server that is available in the Hostname field, for instance **secureserver**. In the Domain drop-down list, select a second-level domain name, e.g., ddns.net, as shown in Figure 5-9.

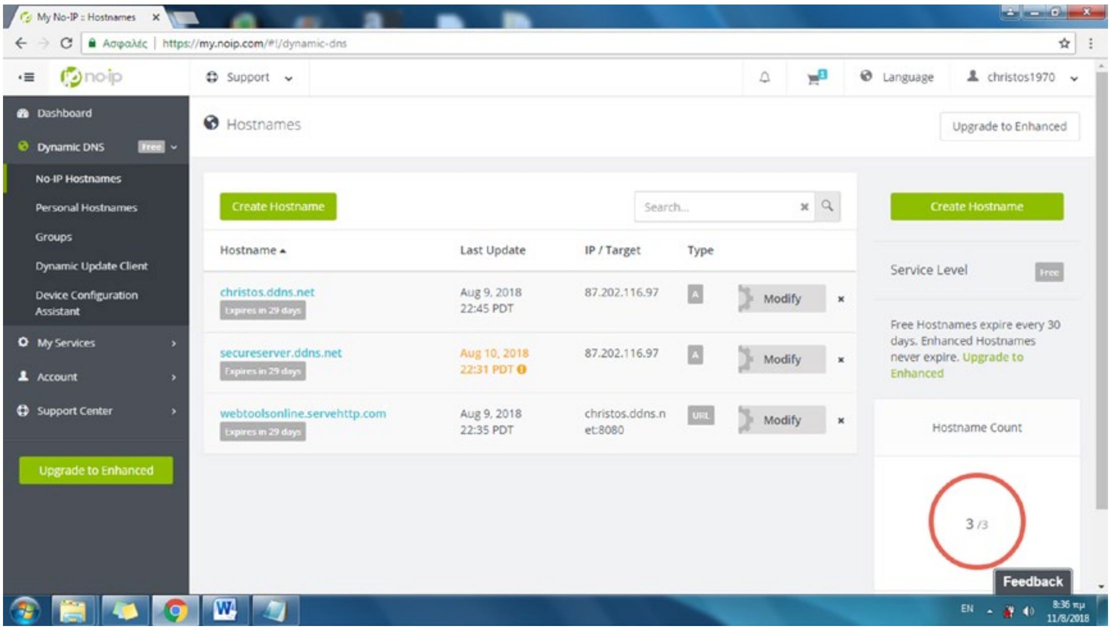


Hostname: secureserver

Domain: ddns.net

Figure 5-9. *The Dashboard web page with the user settings for creating a new hostname*

This name will also be used in Chapter 8, which is about cryptography and secure communication. Click the Add Hostname button to confirm your choice. Click also the Dynamic DNS menu on the left and then select the No-IP Hostnames option to view all the hostnames created so far. Figure 5-10 displays the Hostnames web page.



Hostname ▲	Last Update	IP / Target	Type		
christos.ddns.net Expires in 29 days	Aug 9, 2018 22:45 PDT	87.202.116.97	A	Modify	×
secureserver.ddns.net Expires in 29 days	Aug 10, 2018 22:31 PDT	87.202.116.97	A	Modify	×
webtoolsonline.servehttp.com Expires in 29 days	Aug 9, 2018 22:35 PDT	christos.ddns.net:8080	URL	Modify	×

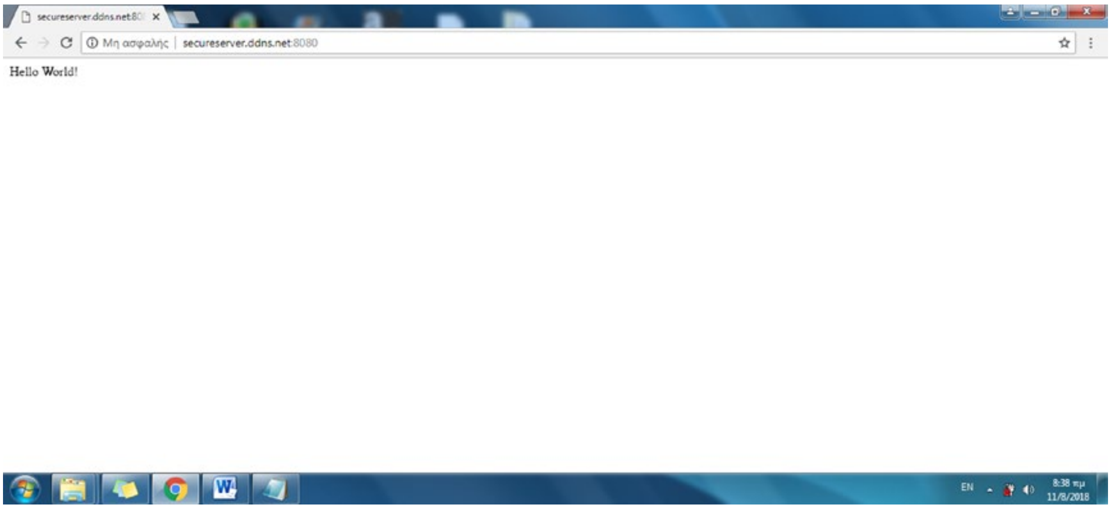
Free Hostnames expire every 30 days. Enhanced Hostnames never expire. Upgrade to Enhanced

Figure 5-10. *The Hostnames web page displays the hostnames already created*

You can test your new hostname instantly by entering the following URL:

```
secureserver.ddns.net
or if you have configured the web server to listen on port 8080:
secureserver.ddns.net:8080
```

As displayed in Figure 5-11, the web page is loaded in your browser's window.



Hello World!

Figure 5-11. Displaying a web page using the new hostname

To create two virtual hosts on Lighttpd, with each serving a different domain name, use the following steps.

Create two document root directories, one for each virtual host. Give the corresponding name of the domain name used to the document root directory.

```
$ cd /var/www
$ sudo mkdir secureserver.ddns.net christos.ddns.net
```

For each document root, change the owner from root (the Linux administrator is the owner because the directory was created with the `sudo` command) to `www-data`, the one Lighttpd assumes. This user belongs to the group `www-data` (`www-data:www-data`).

```
$ sudo chown www-data:www-data secureserver.ddns.net christos.ddns.net
```

Create one directory index named `index.html` for each virtual host. Use the following for the first virtual host:

```
$ sudo gedit /var/www/secureserver.ddns.net/index.html
```

Enter the following HTML source code and save the file:

```
<!DOCTYPE html>
<html>
<head>
```

```
<title>Welcome!</title>
<style>
body{
background-color:yellow;
}
p{
font-size:80px;
}
</style>
</head>
<body>
<p>
Hello from secureserver.ddns.net!
</p>
</body>
</html>
```

Do the same for the second virtual server.

```
$ sudo gedit /var/www/christos.ddns.net/index.html
```

Enter the following HTML source code and save the file:

```
<!DOCTYPE html>
<html>
<head>
<title>Welcome!</title>
<style>
body{
background-color:orange;
}
p{
font-size:80px;
}
</style>
</head>
```

```
<body>
<p>
Hello from christos.ddns.net!
</p>
</body>
</html>
```

Edit the Lighttpd configuration file.

```
sudo gedit /etc/lighttpd/lighttpd.conf
```

Append the following lines to the end of the file and save it:

```
$HTTP["host"] == " secureserver.ddns.net" {
    server.document-root = "/var/www/ secureserver.ddns.net"
}
$HTTP["host"] == "christos.ddns.net" {
    server.document-root = "/var/www/christos.ddns.net"
}
```

With the previous conditional configuration, you will provide the option of using a different document root for each one of the previous domain names. The condition of the first directive checks whether the value of the Host HTTP protocol header of the client request corresponds to `secureserver.ddns.net` , and if this matches, the document root is set to `/var/www/secureserver.ddns.net`. In the second directive, the value of the Host header is also checked against `christos.ddns.net`, and if this matches, the document root is set to `/var/www/christos.ddns.net`.

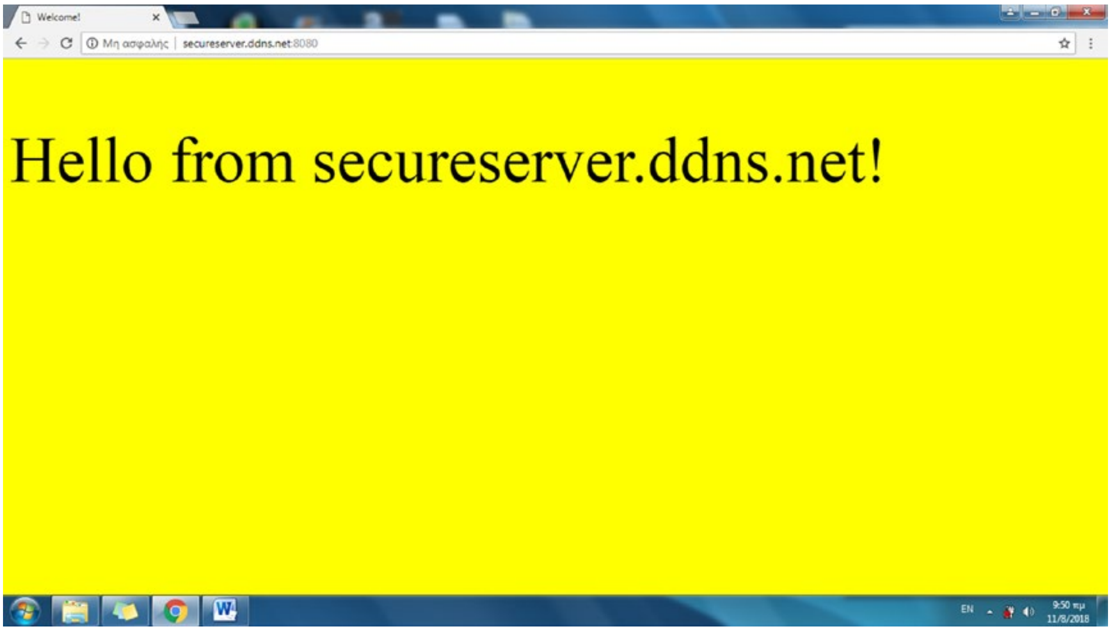
Save `lighttpd.conf` and reload the server.

```
 $ sudo service lighttpd force-reload
```

Test the two virtual servers from any computer on the Internet. For the first one, enter the following in your browser's address bar:

```
secureserver.ddns.net
or if for the if the port 8080 configuration is used:
secureserver.ddns.net:8080
```

Figure 5-12 displays the web page that loads.



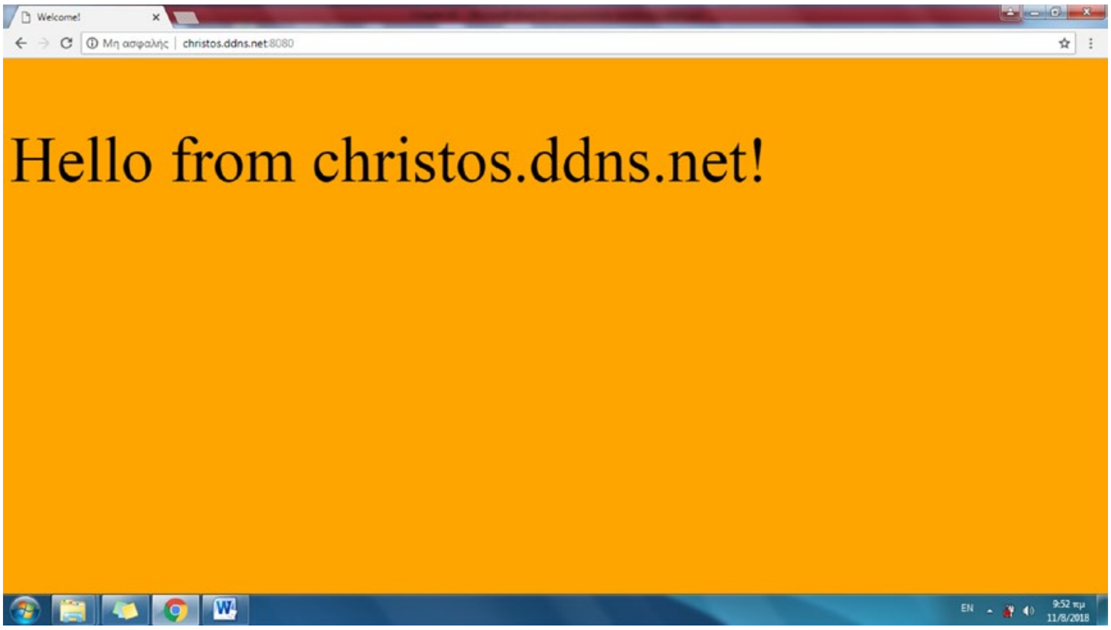
Hello from secureserver.ddns.net!

Figure 5-12. *The directory index of the first virtual host*

Use the URL of the second virtual host.

```
christos.ddns.net
or if the configuration for the 8080 port is used:
christos.ddns.net:8080
```

The web page displayed in Figure 5-13 loads in your browser.



Hello from christos.ddns.net!

Figure 5-13. *The directory index of the second virtual host*

Hint! A practical way to configure multiline options in `lighttpd.conf` is to create another file in the `/etc/lighttpd` directory and move the extra configuration there. Create, for instance, a second configuration file using the following:

```
$ sudo gedit /etc/lighttpd/vhost.conf
```

Cut the following conditional directives from `lighttpd.conf` and paste them into `vhost.conf`:

```
$HTTP["host"] == " secureserver.ddns.net" {

      server.document-root = "/var/www/ secureserver.ddns.net"

}

$HTTP["host"] == "christos.ddns.net" {

      server.document-root = "/var/www/christos.ddns.net"

}
```

In `lighttpd.conf`, to create a link to `vhost.conf`, append the following directive to the end of the file:

```
include "vhost.conf"
```

Reload the server to enable the changes in the configuration files.

```
$ sudo service lighttpd force-reload
```

Using PHP with Lighttpd

To use PHP with Lighttpd, assuming that PHP 7.0 is already installed on your server, enter the following command at the Linux terminal:

```
$ sudo apt-get install php7.0-cgi
```

Test the PHP instantly using the file `/var/www/html/info.php` created in Chapter 2 for Apache. Because the original document root `/var/www/html` is different from those used for the virtual hosts, you can restore the configuration file to exclude virtual hosts. At the end of `lighttpd.conf`, comment out the `include` directive.

```
#include "vhost.conf"
```

Reload the web server to enable the changes in the configuration file.

```
$ sudo service lighttpd force-reload
```

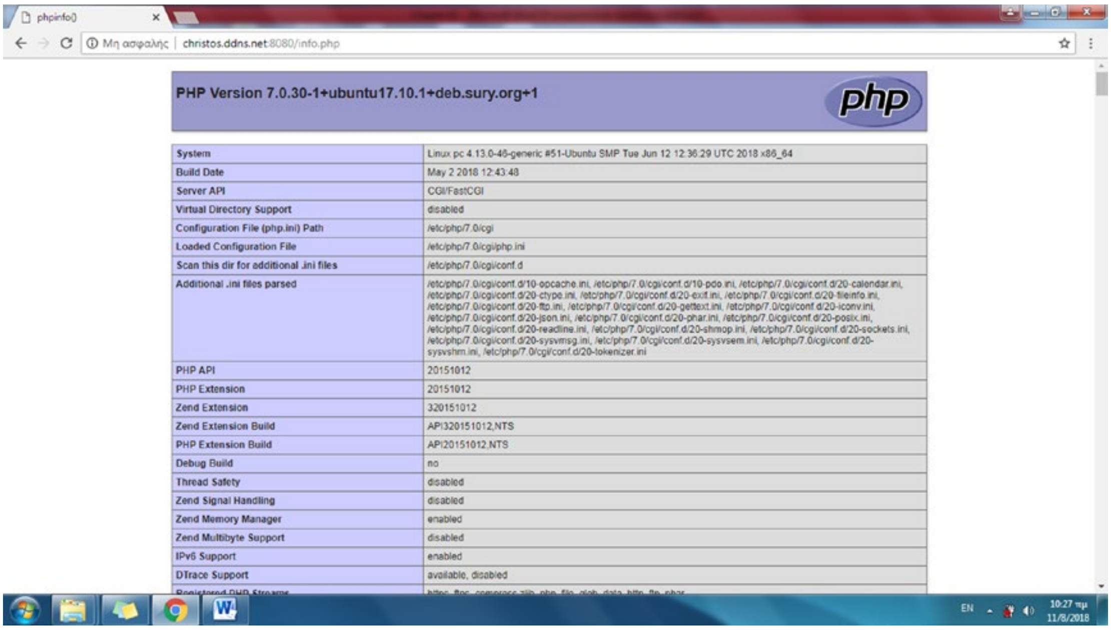
In your browser's address bar, enter the following:

```
http://christos.ddns.net/info.php
```

Or, if your server listens on port 8080, enter the following:

```
http://christos.ddns.net:8080/info.php
```

As shown in Figure 5-14, the web page that appears displays the output of the `phpinfo()` function, indicating that PHP is up and running.



PHP Version 7.0.30-1+ubuntu17.10.1+deb.sury.org+1

System	Linux pc 4.13.0-46-generic #51-Ubuntu SMP Tue Jun 12 12:36:29 UTC 2018 x86_64
Build Date	May 2 2018 12:43:48
Server API	CGI/FastCGI
Virtual Directory Support	disabled
Configuration File (php.ini) Path	/etc/php/7.0/cgi
Loaded Configuration File	/etc/php/7.0/cgi/php.ini
Scan this dir for additional .ini files	/etc/php/7.0/cgi/conf.d
Additional .ini files parsed	/etc/php/7.0/cgi/conf.d/10-opcache.ini, /etc/php/7.0/cgi/conf.d/10-pdo.ini, /etc/php/7.0/cgi/conf.d/20-calendar.ini, /etc/php/7.0/cgi/conf.d/20-ctype.ini, /etc/php/7.0/cgi/conf.d/20-exif.ini, /etc/php/7.0/cgi/conf.d/20-fileinfo.ini, /etc/php/7.0/cgi/conf.d/20-ftp.ini, /etc/php/7.0/cgi/conf.d/20-gettext.ini, /etc/php/7.0/cgi/conf.d/20-iconv.ini, /etc/php/7.0/cgi/conf.d/20-json.ini, /etc/php/7.0/cgi/conf.d/20-phar.ini, /etc/php/7.0/cgi/conf.d/20-posix.ini, /etc/php/7.0/cgi/conf.d/20-readline.ini, /etc/php/7.0/cgi/conf.d/20-shmop.ini, /etc/php/7.0/cgi/conf.d/20-sockets.ini, /etc/php/7.0/cgi/conf.d/20-sysvmsg.ini, /etc/php/7.0/cgi/conf.d/20-sysvsem.ini, /etc/php/7.0/cgi/conf.d/20-sysvshm.ini, /etc/php/7.0/cgi/conf.d/20-tokenizer.ini
PHP API	20151012
PHP Extension	20151012
Zend Extension	320151012
Zend Extension Build	API320151012,NTS
PHP Extension Build	API20151012,NTS
Debug Build	no
Thread Safety	disabled
Zend Signal Handling	disabled
Zend Memory Manager	enabled
Zend Multibyte Support	disabled
IPv6 Support	enabled
DTrace Support	available, disabled
Registered PHP Streams	https, ftps, compress.zlib, php, file, glob, data, http, ftp, phar

Figure 5-14. *The web page with the evaluated phpinfo() function*

With the basic Lighttpd server configuration options discussed in the previous sections, you can use Lighttpd in the following section to create your next online web service.

Creating Online Services with Lighttpd

In Chapters 3 and 4, you created online services with Apache. Here you'll use the Lighttpd server and the PHP and JavaScript languages to create another online service. The service will simulate online web services that test sites remotely like the `webpagetest.org` site utilized in Chapter 3. Similar to the other PHP projects, you will start by preparing two basic web pages.

- `index.php`, the web page that includes a form for submitting the URL of a site to the server.

  `screenshot.php`, the program referred to in the `action` attribute of the `index.php` form, which processes the URL sent by the client and returns to the client's browser an image of the corresponding web page. As shown in the Lighttpd configuration file, `lighttpd.conf`, the `index-file.names` directive has already set `index.php` as a directory index.

```
index-file.names            = ( "index.php", "index.html", "index.lighttpd.
                              html" )
```

The file name `index.php` has precedence over the `index.html` and `index.lighttpd.html` file names. This means that by default the Lighttpd web server will serve `index.php` if this file name exists in the directory specified by the URL, for instance:

```
http://webtoolsonline.servehttp.com
```

When the user enters the previous URL in the browser's address bar, `index.php` appears, as shown in Figure 5-15.

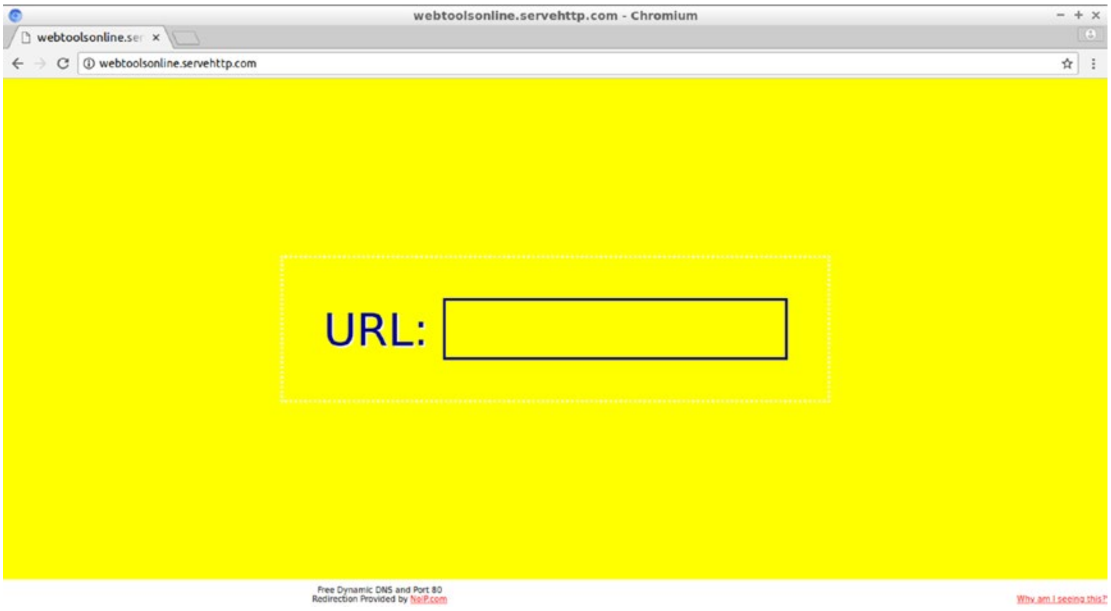

webtoolsonline.servehttp.com - Chromium
webtoolsonline.ser
webtoolsonline.servehttp.com
URL:
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Figure 5-15. *The home page of the online service*

The form in `index.php` includes just one textbox, without any submit button. As shown in Figure 5-16, the user inserts the URL of a site in the textbox and presses the Enter key to submit the data.

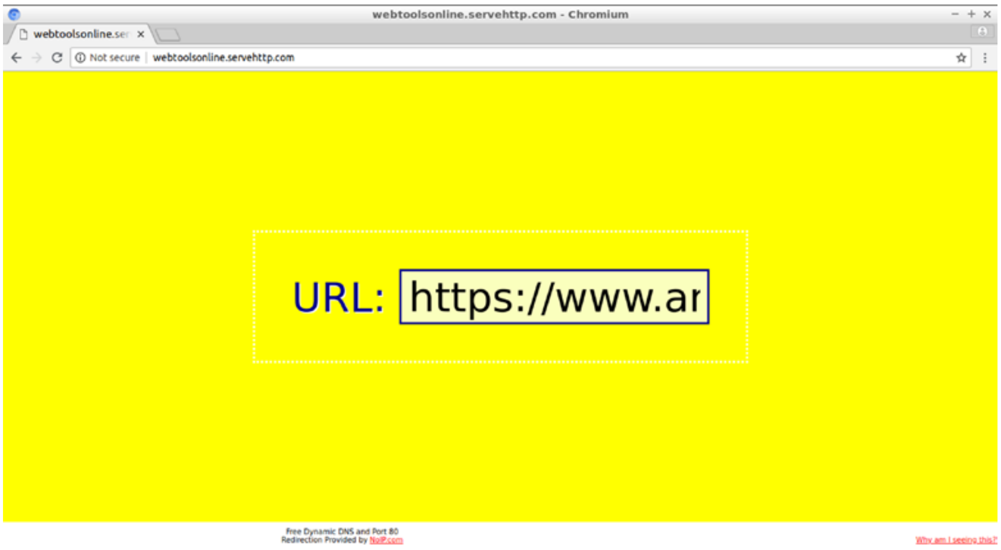

webtoolsonline.servehttp.com - Chromium
Not secure | webtoolsonline.servehttp.com
URL: https://www.ar
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Figure 5-16. *Inserting a URL to the form's textbox*

In the previous figure, the URL `https://www.amazon.com` was entered. The client request may take a few seconds to complete, so when the user presses the Enter key, the message "Please wait..." appears in the upper area of the browser's window, as shown in Figure 5-17.

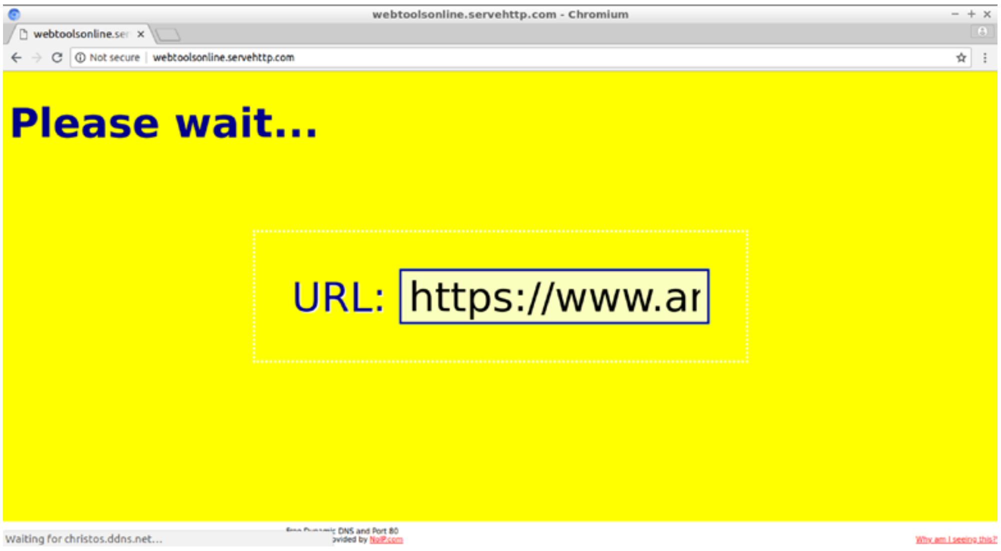

webtoolsonline.servehttp.com - Chromium
Not secure | webtoolsonline.servehttp.com
Please wait...
URL: https://www.ar
Waiting for christos.ddns.net...
Why am I seeing this?

Figure 5-17. *The message "Please wait..." appears when the user submits the data until the server responds*

When the web server finishes processing the request, the web page replies with the evaluated code of `screenshot.php`. This is the web page that is set as the value of the `action` argument of the `form` tag. As viewed in Figure 5-18, for any valid URL, the `screenshot.php` displays a small-sized capture of the home page of the corresponding site.

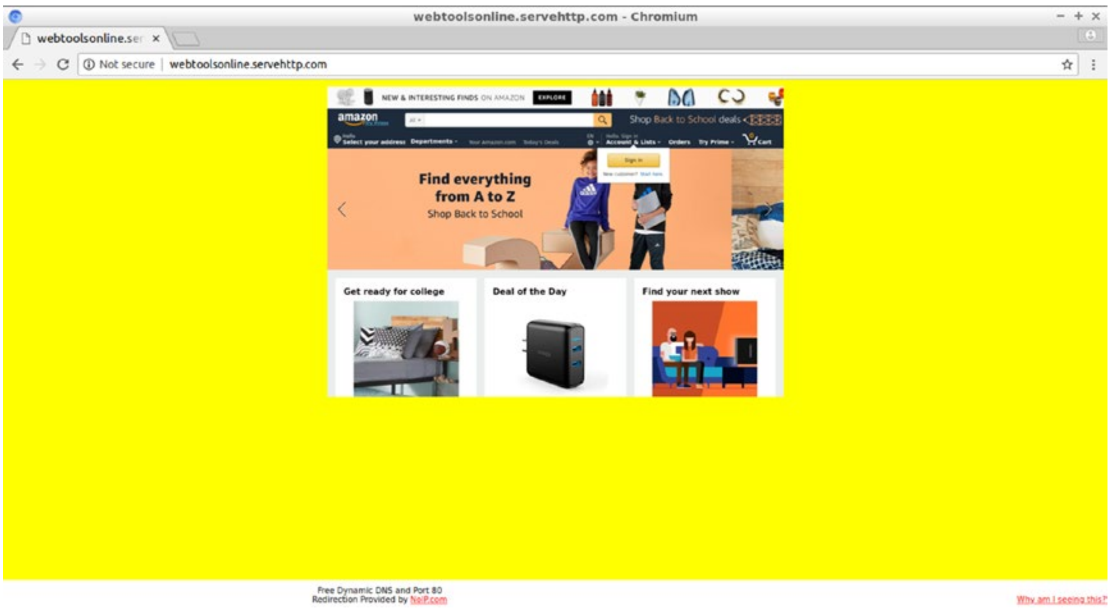

webtoolsonline.servehttp.com - Chromium
webtoolsonline.ser
Not secure
webtoolsonline.servehttp.com
Find everything from A to Z
Shop Back to School
Get ready for college
Deal of the Day
Find your next show
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Figure 5-18. *The web server responds to the client request by displaying a screenshot of the web page specified by the user*

The user may insert an erroneous URL, for instance `https://123www.amazon.com`, as shown in Figure 5-19.

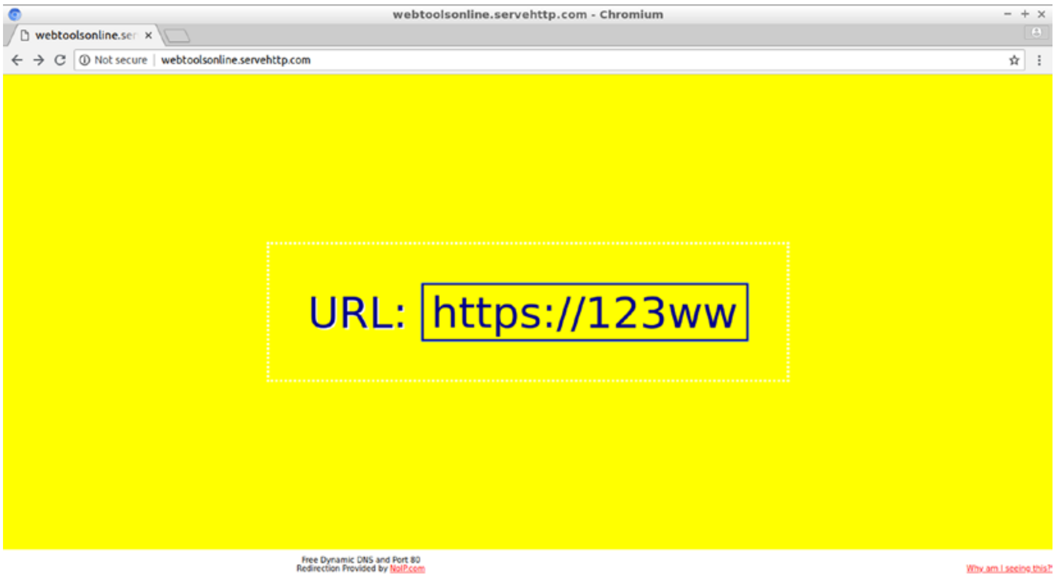

webtoolsonline.servehttp.com - Chromium
webtoolsonline.ser
Not secure
webtoolsonline.servehttp.com
URL:
https://123ww
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Figure 5-19. *Testing an invalid URL*

As shown in Figure 5-20, by pressing the Enter key, the `screenshot.php` code evaluates by displaying a message and a button instead of an image. These are used for getting back to the online service home.

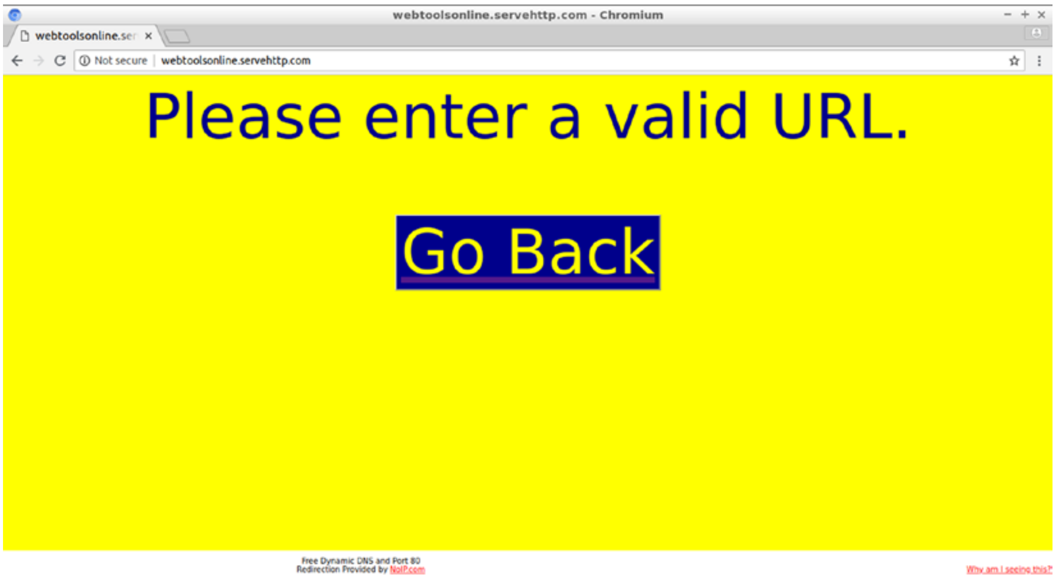

webtoolsonline.servehttp.com - Chromium
webtoolsonline.ser
Not secure
webtoolsonline.servehttp.com
Please enter a valid URL.
Go Back
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Figure 5-20. *The web server's response to an invalid URL*

Creating the Directory Index of the Online Service

Use the following commands at the Linux terminal to create `index.php`:

```
$ cd  /var/www/html
```

```
$ sudo gedit index.php
```

Insert the following lines for the `index.php` source code and save the file:

```
<!DOCTYPE html>
<html>
<head>
<style>
body{
background-color:yellow;
}
.center {
    background-color:yellow;
    padding: 50px 50px;
    border: 3px dotted white;
    text-align: center;
    font-size:56px;
    color:darkblue;
    text-shadow: 2px 2px #ffffff;
    position:absolute;
    top:50%;
    left:50%;
    -ms-transform: translateX(-50%) translateY(-50%);
    -webkit-transform: translate(-50%,-50%);
    transform: translate(-50%,-50%);
}
input[type=text] {
    width: 400px;
    height:50px;
    border: 3px solid darkblue;
    font-size:56px;
    color:darkblue;
    background-color:yellow;
    padding: 10px 10px;
}
h1{
color:darkblue;
font-size:56px;
}
</style>
</head>
<body>
<h1 id="id1"></h1>
<script>
function sub() {
document.getElementById("id1").innerHTML = "Please wait...";
}
</script>
<div class="center">
<form name="form1" method="post" action="screenshot.php" onsubmit="sub()">
  URL: <input type="text" name="url">
</form>
</div>
</body>
</html>
```

This PHP web page basically includes the form that submits a URL to the web server. It includes a CSS section for defining properties for styling the HTML elements. The basic content of this web page is a form that includes just one textbox named `url`. This is the object the client uses to submit the site's URL. The form's method is `POST`, and the action is set to the PHP file `screenshot.php`. Therefore, `screenshot.php` will take action to process the user request on the web server since no other directory path is included.

A JavaScript `onsubmit` type function, named `sub()`, is assigned to the `onsubmit` event of the form. Therefore, the function `sub()` will execute when the form is submitted. One line is included in this function, shown here:

```
document.getElementById("id1").innerHTML = "Please wait...";
```

The web page's HTML element with the value of the id (Identity) attribute equal to id1 is returned by `getElementById()`. `getElementById()` is a method of the document instance, and the document represents the current web page. The element of the current web page with `id` equal to `id1` is the header with size 1 (`<h1>`). For this element, the `innerHTML` property indicates the header text, which is the text included between the start and end `<h1>` tags. When the user presses the Enter key and before the new web page loads, the message "Please wait..." will fill the text between the start/end `<h1>` tags, which is initially empty.

Creating the Action File for the Online Service

To create `screenshot.php` in the document root of the Lighttpd server, enter the following commands at the Linux terminal:

```
$ cd /var/www/html

$ sudo gedit screenshot.php
```

Enter the following lines and save the file:

```
<!DOCTYPE html>
<html>
<head>
<style>
body {
background-color:yellow;
}
</style>
</head>
```

```
<body>
<?php
if(!empty($_POST['url'])){
$url = $_POST["url"];
$command = "xvfb-run --server-args=\"-screen 0, 1366x768x24\" wkhtmltoimage
--crop-w 1366 --crop-h 768 " . $url . " /var/www/html/screenshot/php.png";
exec($command, $out, $status);
if ($status===0) {
$command2 = "convert  -resize 50% /var/www/html/screenshot/php.png /var/
www/html/screenshot/php.png";
shell_exec($command2);
echo '<img style="display:block;margin-left:auto;margin-right:auto;"src="
screenshot/php.png">';
} else {
echo '<div><p style="font-size:80px;color:darkblue;text-
align:center;">Please enter a valid URL.</p></div>';
echo '<div><a href="index.php">';
echo '<button style="font-size:80px;color:yellow;background-color:darkblue;
margin:auto;display:block;">Go Back</button>';
echo '</a></div>';
}
}
?>
</body>
</html>
```

The PHP code accepts as `$_POST["url"]` the value submitted by the textbox named `url` in the form of `index.php`. This is then assigned as the value of the PHP variable `$url`. This value is the URL entered by the user, which may be valid or invalid, and it is the information that the web server requires to act. The PHP engine that evaluates the `screenshot.php` source code uses the URL to form the following string:

```
 xvfb-run --server-args=\"-screen 0, 1366x768x24\" wkhtmltoimage --crop-w
1366 --crop-h 768 " . $url . " /var/www/html/screenshot/php.png
```

This string consists of the command and the command arguments that the PHP engine has to pass to the Linux terminal to create an image of the web site corresponding to the URL.

This certainly looks like a long command that requires some explanation. It uses the `wkhtmltoimage` open source command-line tool, which renders a web page into an image file. To enable the PHP engine to use the previous command, you have to download and install `wkhtmltoimage` using the following command at the Linux terminal:

```
$ sudo apt-get install wkhtmltopdf
```

An example of running `wkhtmltoimage` from the Linux terminal is as follows:

```
$ wkhtmltoimage https://www.amazon.com amazon.png
```

This creates the image `amazon.png` that depicts the home page of amazon.com. This is a large image because the Amazon home page spans many computer screens, as viewed in Figure 5-21.

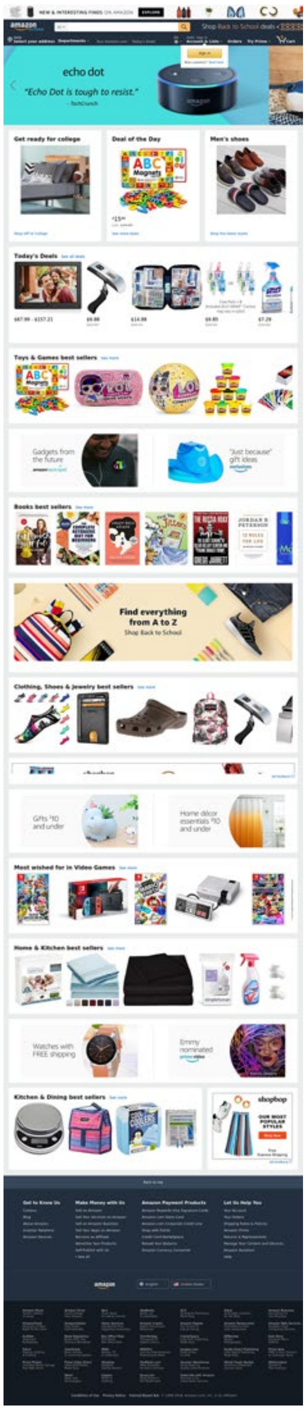


***Figure 5-21.** The large image created by wkhtmltoimage for Amazon.com*

To include only the upper part, the image must be cropped to the screen dimensions of the computer the program was used on, e.g., 1366×768, using the crop width (`crop-w`) and the crop height (`crop-h`) arguments.

```
$ wkhtmltoimage --crop-w 1366 --crop-h 768 https://www.amazon.com amazon.
png
```

Although the previous command runs if used directly at the command line, using it from the PHP engine may require an X Server specified for the graphics part. For this, you can download the Xvfb (X virtual framebuffer) server, which enables the PHP engine to run graphical applications without a display. Download and install Xvfb using the following at the Linux terminal:

```
$ sudo apt-get install xvfb
```

The following command, run from the PHP engine, starts `wkhtmltoimage` using the Xvfb server:

```
$command = "xvfb-run --server-args=\"-screen 0, 1366x768x24\" wkhtmltoimage
--crop-w 1366 --crop-h 768 " . $url . " /var/www/html/screenshot/php.png";
```

Notice that `$command` is the variable that stores the string of the command to run, and notice that escape characters (\) were used to retain the double quotes inside the string. Using the dot (.) notation, the `$url` variable (the URL sent by the client) is concatenated with two strings, i.e., the first part of the command and the file path of the image file, created by the command. To create the directory `screenshot`, use the following command:

```
$ sudo mkdir /var/www/html/screenshot
```

Because screenshot was created by the user root, with the previous `sudo` command, the screenshot's owner is user root. You can verify this using the `ls -l /var/www/html` command. You need to change the owner of the directory to enable Lighttpd and the PHP engine to access it in order to store the image files it creates. Use the following command:

```
$ sudo chown -R www-data:www-data /var/www/html/screenshot
```

This command sets the new owner of `/var/www/html/screenshot` to the user `www-data` that belongs to the group `www-data`. The recursive (`-R`) option is used for `www-data` to retain the ownership to all subdirectories of `screenshot`.

Next, the string value of the $command variable is passed to the exec() PHP function.

```
exec($command, $out, $status);
```

In Chapter 4, you used the function shell_exec() to run terminal commands from the PHP engine. This time, the function exec() is used, which returns the return status of the command to its third argument ($status in this example). By checking the value of $status, you can find out whether the $command execution succeeded or failed. You can use an if condition and replace the //SUCCESS and //FAILURE comments with the appropriate actions.

```
if ($status===0) {
//SUCCESS
} else {
//FAILURE
}
```

For the success case, you can use the following source code lines:

```
$command2 = "convert  -resize 50% /var/www/html/screenshot/php.png /var/
www/html/screenshot/php.png";
shell_exec($command2);
echo '<img style="display:block;margin-left:auto;margin-right:auto;"
src="screenshot/php.png">';
```

A second PHP variable, $command2, is used to store another command, convert, which is used to resize the image at a rate of 50 percent. The file path is used twice because using convert you have the option to convert the file format, such as from PNG to JPEG. For this, you would enter the following at the command line:

```
$ convert  -resize 50% /var/www/html/screenshot/php.png /var/www/html/
           screenshot/php.jpg
```

This time the function shell_exec() is used to execute the second command.

To use convert, download and install the imagemagik package using the following:

```
$ sudo apt-get install imagemagick
```

The final command of the success case creates an HTML image tag (`<img>`) that renders the previously created `php.png` image at the center of the screen.

```
echo '<img style="display:block;margin-left:auto;margin-right:auto;"
src="screenshot/php.png">';
```

For the failure case, you can use the following source code:

```
echo '<div><p style="font-size:80px;color:darkblue;text-
align:center;">Please enter a valid URL.</p></div>';
echo '<div><a href="index.php">';
echo '<button style="font-size:80px;color:yellow;background-color:darkblue;
margin:auto;display:block;">Go Back</button>';
echo '</a></div>';
```

This returns a web page with the message "Please enter a valid URL." to the client and also creates a button that, when clicked, returns the user to the site's home page.

Enabling the Site to Serve Multiple Client Requests

While the source code of `screenshot.php` works well for a single client request, as tested previously, the server cannot dispatch multiple client requests when they are issued simultaneously because two or more Xvfb simultaneously calls fail. To verify this, open two (or more) tabs in your browser, all using the URL `http://webtoolsonline.servehttp.com`. In the textbox of the first tab, insert a URL of a site for testing and press the Enter key. Switch quickly to the second tab and do the same. Notice that while the first client request is fulfilled, the second fails. Figure 5-22 displays two tabs, with the second one including the "failure" page.

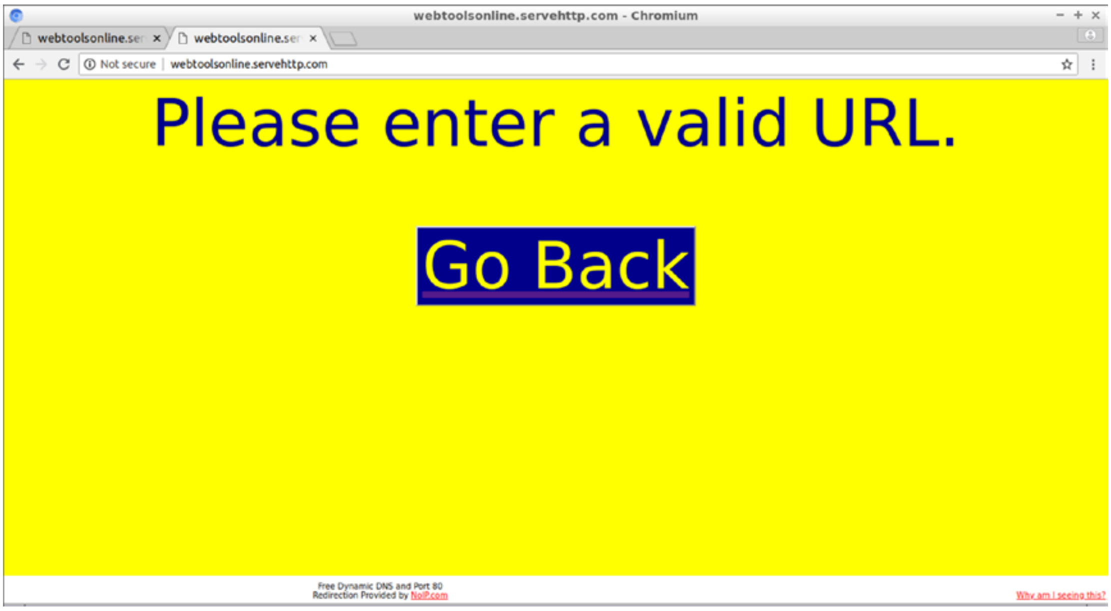

webtoolsonline.servehttp.com - Chromium
Not secure | webtoolsonline.servehttp.com
Please enter a valid URL.
Go Back
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Figure 5-22. *Issuing two simultaneous client requests to the site*

Hint! You can also test this from the command line by calling the `xvfb` command used in `screenshot.php` twice (as fast as you can). Enter the following, for instance, at the Linux terminal:

```
$ sudo xvfb-run --server-args="-screen 0, 1366x768x24"
wkhtmltoimage --crop-w 1366 --crop-h 768 https://www.amazon.
com /var/www/html/screenshot/php1.png &
```

Then enter at the same terminal a command like the following. By using the ampersand (&) symbol at the end of the command, you are running the command in the background and the terminal is released to wait for another command.

```
$ sudo xvfb-run --server-args="-screen 0, 1366x768x24"
wkhtmltoimage --crop-w 1366 --crop-h 768 https:// https://www.
barnesandnoble.com /var/www/html/screenshot/php2.png &
```

The following message is output to the terminal the second time:

```
xvfb-run: error: Xvfb failed to start
```

To solve this problem, create a second version of the site that will require replacing the action file `screenshot.php` with `screenshot2.php` in `index.php`. Use the following command to edit `index.php`:

```
$ sudo gedit /var/www/html/index.php
```

In the form tag, replace `screenshot.php` with `screenshot2.php`.

```
<form name="form1" method="post" action="screenshot2.php" onsubmit="sub()">
```

Save the file and create the new action file.

```
$ sudo gedit /var/www/html/screenshot2.php
```

In the new version, the PHP file locking mechanism will be used to block all other client requests when an initial one is served. Therefore, only one request each time will be enabled to use the PHP code that creates the PNG file from a given URL. You'll create a text file, e.g., `lock.txt`, to be used just for implementing the file locking mechanism, without serving any other purpose in the source code. At the Linux terminal, use the `touch` command to create the text file.

```
$ soudo touch /var/www/html/lock.txt
```

Also, use the `chown` command to set the new owner of the file to the user assumed by the web server and PHP, `www-data`.

```
$ sudo chown www-data:www-data /var/www/html/lock.txt
```

The new text file will be used from the `screenshot2.php` source code as follows:

```
$fp = fopen("lock.txt", "w");
if (flock($fp, LOCK_EX)) {

// PHP source Code that previously conflicted

    flock($fp, LOCK_UN);
}
fclose($fp);
```

In the previous lines, the file handle `fp` is created for writing (`w`) to `lock.txt` with a call to the function `fopen()`. Then comes a call to the function `flock()`, which locks the file exclusively (`LOCK_EX`). The PHP source code is therefore assured to be executed only from a single process. Other instances will find the file locked and will block until the file is unlocked. The role of this file is therefore to hand over permission to use the enclosed code from one process to the other, with the assurance that all other processes are waiting to take their turn and won't return without serving the client. With the next `flock()` call in the `LOCK_UN` argument, the file unlocks when the current process is done.

The complete source code of `screenshot2.php` is as follows:

```
<html>
<head>
<style>
body {
background-color:yellow;
}
</style>
</head>
<body>
<?php
if(!empty($_POST['url'])){
$url = $_POST["url"];
$fp = fopen("lock.txt", "w");
if (flock($fp, LOCK_EX)) {
$command = "xvfb-run --server-args=\"-screen 0, 1366x768x24\" wkhtmltoimage
--crop-w 1366 --crop-h 768 " . $url . " /var/www/html/screenshot/php2.png";
exec($command, $out, $status);
if ($status===0) {
$command2 = "convert  -resize 50% /var/www/html/screenshot/php2.png /var/
www/html/screenshot/php2.png";
shell_exec($command2);
echo '<img style="display:block;margin-left:auto;margin-right:auto;"
src="screenshot/php2.png">';
} else {
echo '<div><p style="font-size:80px;color:darkblue;text-
align:center;">Please enter a valid URL.</p></div>';
echo '<div><a href="index.php">';
echo '<button style="font-size:80px;color:yellow;background-color:darkblue;
margin:auto;display:block;">Go Back</button>';
echo '</a></div>';
}
flock($fp, LOCK_UN);
}
fclose($fp);
}
?>
</body>
</html>
```

Test the new version of the site by opening two (or more) tabs in your browser and entering a URL in each web page's textbox. As shown in Figure 5-23, all client requests are now dispatched.

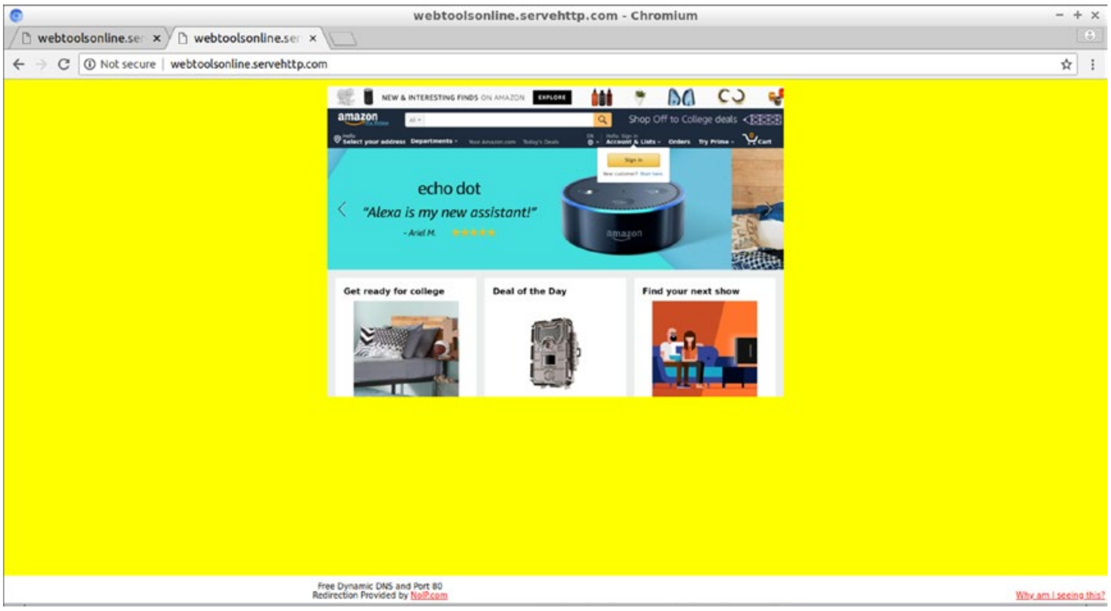

webtoolsonline.servehttp.com - Chromium
webtoolsonline.se
webtoolsonline.se
Not secure
webtoolsonline.servehttp.com
echo dot
"Alexa is my new assistant!"
Get ready for college
Deal of the Day
Find your next show
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Figure 5-23. *Testing the site with multiple client requests succeeds*

When you have issued the second request, switch to the Linux terminal and enter the following command:

```
$ sudo lslocks
```

This command displays information about the current file locks in the system. The output of the command includes two records about `lock.txt`, which means that there are currently two processes that lock or try to exercise a lock to the file `test.txt`. In this example, the records have the following form:

```
php-cgi          722 FLOCK   0B WRITE* 0          0          0 /var/www/
                                                             html/lock.txt
php-cgi          724 FLOCK   0B WRITE  0          0          0 /var/www/
                                                             html/lock.txt
```

Here, 722 and 724 are the process IDs (PIDs) of `php-cgi`, the process that executes the PHP source code. Use, for instance, the following command to verify this:

```
$ ps xa | grep 724
```

The command's output is as follows:

```
724 ?        S      0:00 /usr/bin/php-cgi
```

When the first client request is dispatched and the image of the test page is rendered to the web page, enter the `lslocks` command at the terminal another time:

```
$ sudo lslocks
```

As the command's output indicates, this time there is only one record about `lock.txt`, which means only one process locks `lock.txt`.

```
php-cgi          722 FLOCK   0B WRITE 0          0          0 /var/www/
                                                            html/lock.txt
```

When the second client request is fulfilled, try `lslocks` again. This time, as expected, no records are output about `lock.txt`.

Creating an Animated PNG Image

In the project of the previous section, it is a good idea to include an animated image that appears while the client's request is being processed to signify that the wait is because of the request processing and not because of any network latency or other problem. This improves the user's experience and makes the waiting time less boring.

You can create animated images using software applications on your PC or using online tools. In this example, you will use the online tool `https://ezgif.com/apng-maker` to create an animated PNG image. The procedure of making the animated PNG file is similar to using other online PNG animation tools.

To create the animated PNG image file, you need to create a number of PNG files used as frames that will be displayed consecutively and create the effect of animation. There is a basic option you have to configure, which is the time that should elapse between each frame. All PNG frames, along with the time lapse information, are then packaged into a final PNG file, in other words, the animated PNG file.

Use your favorite image editor to create a PNG image like file `0.png`, shown in Figure 5-24.

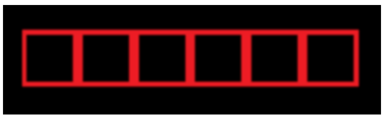


Figure 5-24. *The pattern for making the images for the animated PNG image*

This image will be used as a pattern that other PNGs will be based on. I purposely used black to paint the unused areas, because with the `ezgif.com` online service, it is easy to turn black to transparent. This means when the image is loaded in your web page, the black color will be replaced by the current background of the page. You can also use other colors for setting transparency, but because an RGB code is required, it is best to do this with black or with white.

Figure 5-25 displays the idea behind the animated PNG. You create six PNG files, file `1.png` up to file `6.png`, with each one lighting up a different square with a chosen color. For example, the first image lights up the first square, the second image lights up the second square, and so on. Rendering all images, one after the other, has the effect of moving the bright color from the first to the last square. Then just copy file `5.png` as `7.png`, `4.png` as `8.png`, `3.png` as `9.png`, and finally `2.png` as `10.png`. Therefore, after `6.png`, the sequence returns backward until file `10.png`, and then everything starts again from the beginning.

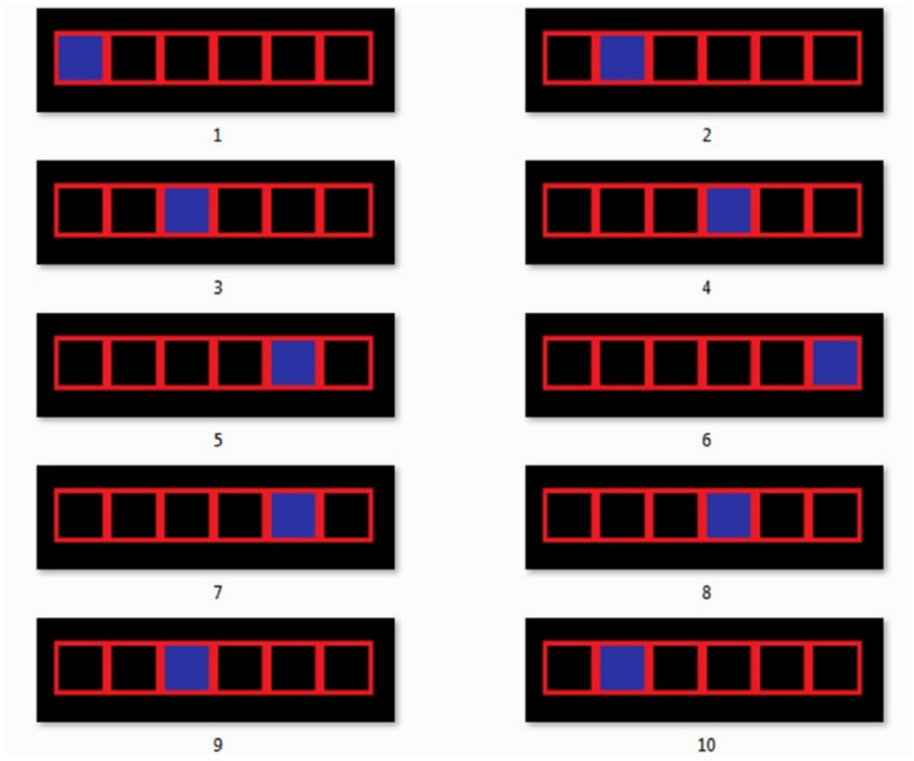


Figure 5-25. *The PNG images required for creating the animated PNG file*

Place files `1.png` up to `10.png` in the folder `png` and zip the files, creating a zipped file. Enter the URL `https://ezgif.com/apng-maker` in your browser's address bar to visit the web page, as shown in Figure 5-26. Click the Choose Files button and located the zipped folder with the PNG files in the directory tree of your computer. Click the Open button in the dialog and then click the Upload! button on the `ezgif.com` web page.

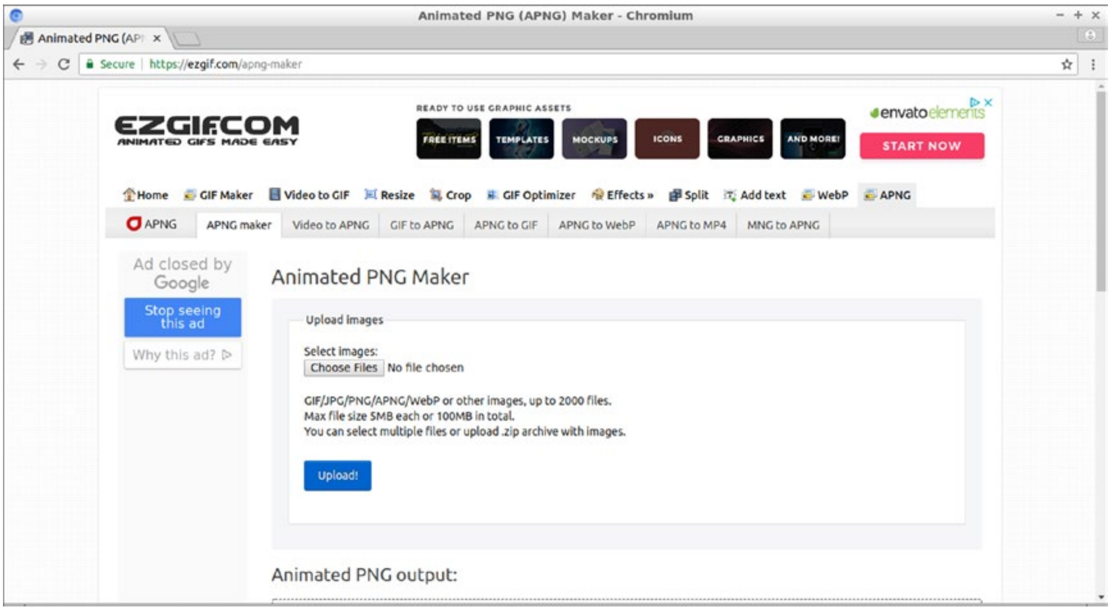

Animated PNG (APNG) Maker - Chromium
https://ezgif.com/apng-maker
EZGIF.COM
Home GIF Maker Video to GIF Resize Crop GIF Optimizer Effects Split Add text WebP APNG
APNG maker Video to APNG GIF to APNG APNG to GIF APNG to WebP APNG to MP4 MNG to APNG
Animated PNG Maker
Upload images
Select images:
Choose Files No file chosen
GIF/JPG/PNG/APNG/WebP or other images, up to 2000 files.
Max file size 5MB each or 100MB in total.
You can select multiple files or upload .zip archive with images.
Upload!
Animated PNG output:

Figure 5-26. The Animated PNG Maker web page

The uploaded zipped file is extracted, and all images are visible in your browser's window, as displayed in Figure 5-27.

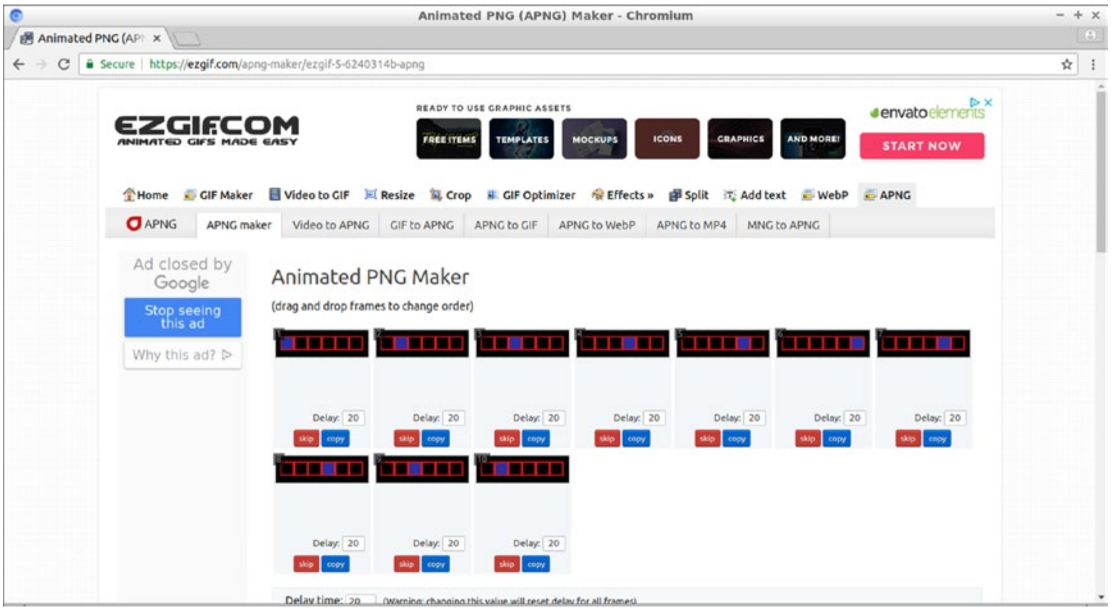
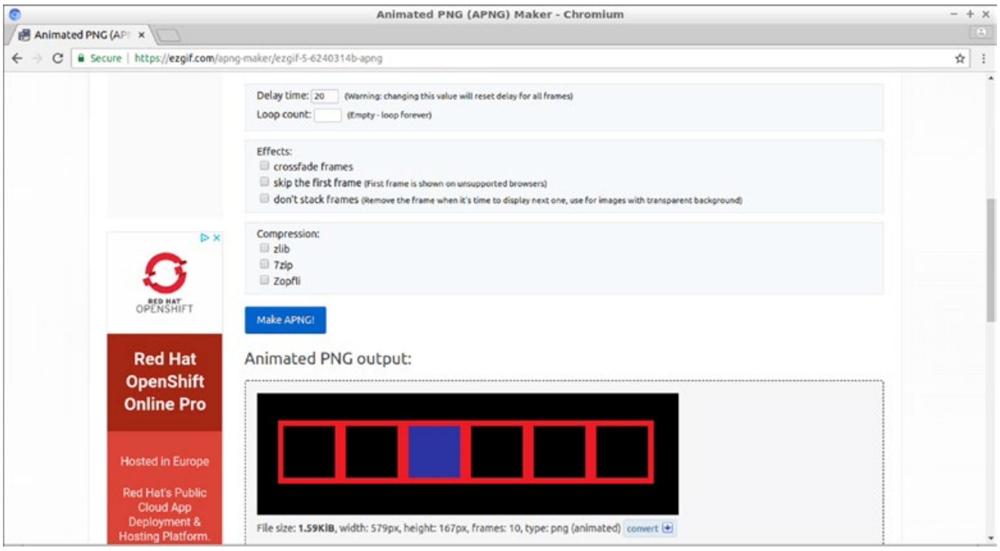

Animated PNG (APNG) Maker - Chromium
https://ezgif.com/apng-maker/ezgif-5-6240314b-apng
Animated PNG Maker
(drag and drop frames to change order)
Delay: 20
skip copy
Delay time: 20 (Warning: changing this value will reset delay for all frames)

Figure 5-27. The uploaded images to the Animated PNG Maker site

On this web page, you can set the delay time and also the loop count. You can leave those settings at their default values. Scroll down and click the Make APNG! button. As shown in Figure 5-28, the animated PNG file has been created under "Animated PNG output."


Animated PNG (APNG) Maker - Chromium
Animated PNG (AP
Secure
https://ezgif.com/apng-maker/ezgif-5-6240314b-apng
Red Hat OpenShift
Red Hat OpenShift Online Pro
Hosted in Europe
Red Hat's Public Cloud App Deployment & Hosting Platform.
Make APNG!
Animated PNG output:
convert

Delay time: 20 (Warning: changing this value will reset delay for all frames)
Loop count: (Empty - loop forever)

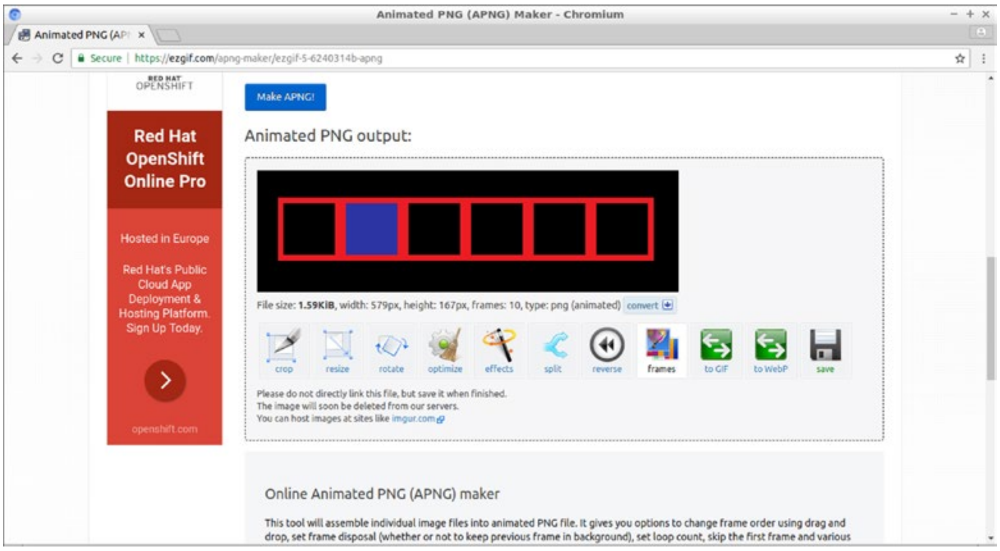
Effects:
- [ ] crossfade frames
- [ ] skip the first frame (First frame is shown on unsupported browsers)
- [ ] don't stack frames (Remove the frame when it's time to display next one, use for images with transparent background)

Compression:
- [ ] zlib
- [ ] 7zip
- [ ] Zopfli

File size: **1.59KiB**, width: 579px, height: 167px, frames: 10, type: png (animated)

Figure 5-28. *The Animated PNG file displayed on the ezgif.com web page*

Scroll down to view the toolbar, as displayed in Figure 5-29. Click the effects tool.


Animated PNG (APNG) Maker - Chromium
Animated PNG (AP
Secure
https://ezgif.com/apng-maker/ezgif-5-6240314b-apng
Red Hat OpenShift
Red Hat OpenShift Online Pro
Hosted in Europe
Red Hat's Public Cloud App Deployment & Hosting Platform. Sign Up Today.
openshift.com
Make APNG!
Animated PNG output:
convert
crop
resize
rotate
optimize
effects
split
reverse
frames
to GIF
to WebP
save

File size: **1.59KiB**, width: 579px, height: 167px, frames: 10, type: png (animated)

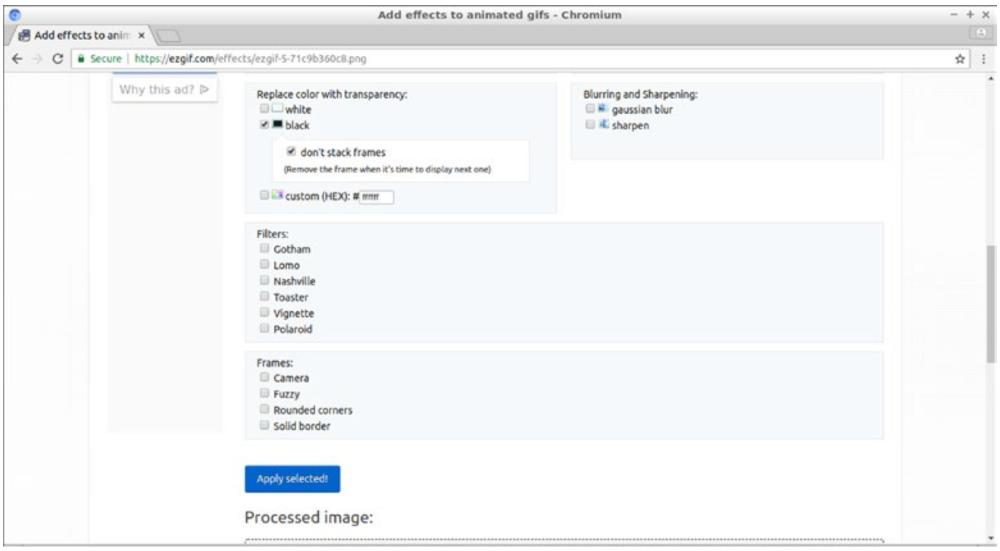
Please do not directly link this file, but save it when finished.
The image will soon be deleted from our servers.
You can host images at sites like imgur.com

Online Animated PNG (APNG) maker

This tool will assemble individual image files into animated PNG file. It gives you options to change frame order using drag and drop, set frame disposal (whether or not to keep previous frame in background), set loop count, skip the first frame and various

Figure 5-29. *The effects tool in the ezgif.com toolbar*

The web page displayed in Figure 5-30 appears. In the "Replace color with transparency" section, select the black box to turn all the black pixels of the PNG files transparent. Click the "Apply selected!" button.



https://ezgif.com/effects/ezgif-5-71c9b360c8.png

Replace color with transparency:
- ☐ white
- ☑ black
  - ☑ don't stack frames (Remove the frame when it's time to display next one)
- ☐ custom (HEX): # ffffff

Blurring and Sharpening:
- ☐ gaussian blur
- ☐ sharpen

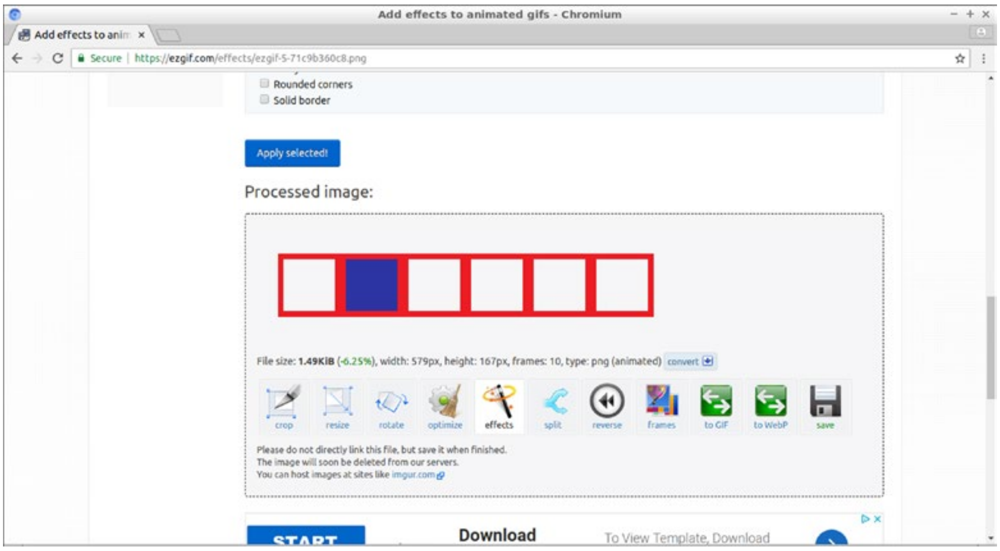
Filters:
- ☐ Gotham
- ☐ Lomo
- ☐ Nashville
- ☐ Toaster
- ☐ Vignette
- ☐ Polaroid

Frames:
- ☐ Camera
- ☐ Fuzzy
- ☐ Rounded corners
- ☐ Solid border

Processed image:

Figure 5-30. The ezgif.com web page buttons for setting color transparency

The new processed image with the transparency set renders in the "Processed image" section and starts animating, as shown in Figure 5-31.



https://ezgif.com/effects/ezgif-5-71c9b360c8.png

- ☐ Rounded corners
- ☐ Solid border

Processed image:

File size: 1.49KiB (-6.25%), width: 579px, height: 167px, frames: 10, type: png (animated)

Please do not directly link this file, but save it when finished.
The image will soon be deleted from our servers.
You can host images at sites like imgur.com

Figure 5-31. The processed image as viewed on the ezgif.com web page

Right-click the image, and in the pop-up menu that appears select “Save image as” (or your browser’s equivalent option). In the directory tree of the dialog that appears, set the destination of the home directory as `animation.png`. Use the following `sudo` command to enable copying the file to the document root of the site:

```
$ sudo mv ~/animation.png /var/www/html
```

Change the file owner (set with `sudo` to `root`) to `www-data`.

```
$ sudo chown www-data:www-data /var/www/html/animation.png
```

Use the animated PNG image instead of the “Please wait...” message. The source code of `index.php` is now as follows:

```
<!DOCTYPE html>
<html>
<head>
<style>

body{
background-color:yellow;
}

.center {
    background-color:yellow;
    padding: 50px 50px;
    border: 3px dotted white;
    text-align: center;
    font-size:56px;
    color:darkblue;
    text-shadow: 2px 2px #ffffff;
    position:absolute;
    top:50%;
    left:50%;
    -ms-transform: translateX(-50%) translateY(-50%);
    -webkit-transform: translate(-50%,-50%);
    transform: translate(-50%,-50%);
}
```

```
input[type=text] {
    width: 400px;
    height:50px;
    border: 3px solid darkblue;
    font-size:56px;
    color:darkblue;
    background-color:yellow;
    padding: 10px 10px;
}

#id1{
display:none;
margin-left: auto;
margin-right: auto;
}

</style>
</head>

<body>

<img id="id1" src="animation.png">

<script>
function sub() {
document.getElementById("id1").style.display = "block";
}
</script>

<div class="center">
<form name="form1" method="post" action="screenshot2.php" onsubmit="sub()">
  URL: <input type="text" name="url">
</form>
</div>

</body>
</html>
```

The function `getElementById()` in the JavaScript source code in this version of the function `sub()` accesses the element of the current web page (document) with a value for the attribute `id` equal to `id1`.

```
document.getElementById("id1").style.display = "block";
```

This `id` belongs to the image element. Its style is then accessed with the `style` property, which represents an element's style attribute. The display `style` property is set then to `block`. In the CSS section of the source code, the display for the element with the `id` equal to `id1` was previously set to `none`.

```
#id1{
display:none;
margin-left: auto;
margin-right: auto;
}
```

Therefore, by submitting the form, the function `sub()` runs, and this displays the animated PNG, which is the image with the `id` property equal to `id1`.

The new directory index when the user URL is processed looks like the one in Figure 5-32.

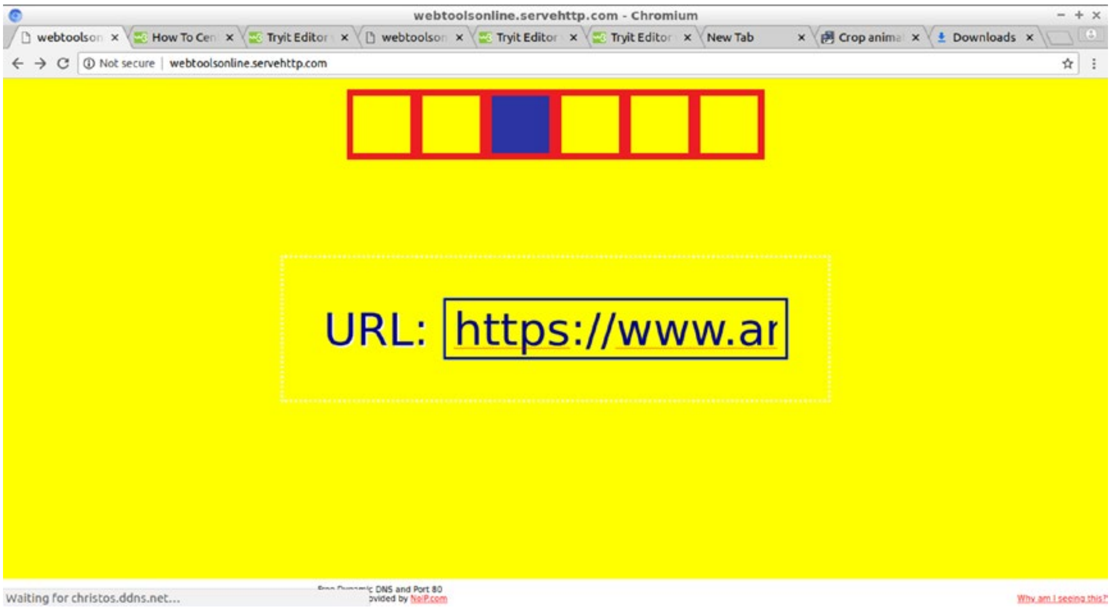


Figure 5-32. *The animated PNG runs while waiting for the web server to respond*

By creating an inspired animated PNG image, the waiting time is more fun.

Summary

In this chapter, you installed and set up Lighttpd, an open source web server. You had the chance to use features similar to Apache in another web server, and ideally this will make the transition to a third web server more straightforward. You mainly set the directory index, document root, listening port number, listening IP address or hostname, virtual servers, log files, and custom error reply web pages.

You also created another online web service that tests web pages remotely. In the following chapter, you will start using the MySQL database to take your online services to another level. With database queries enabled, your site's capabilities greatly increase.

CHAPTER 6

The MySQL Database Server

With PHP you can enable the web server to interface with any other program. One of the most commonly used applications for interfacing with a web server is a database server. With a database connection to the web server, your site can search the data of the database system and thus offer dynamic content. There is a large list of database systems to choose from. In this chapter, you will download and start using one of the most common ones, MySQL, which is a relational database that utilizes the Structured Query Language (SQL). SQL is the most widespread set of instructions used to set up and query a database system.

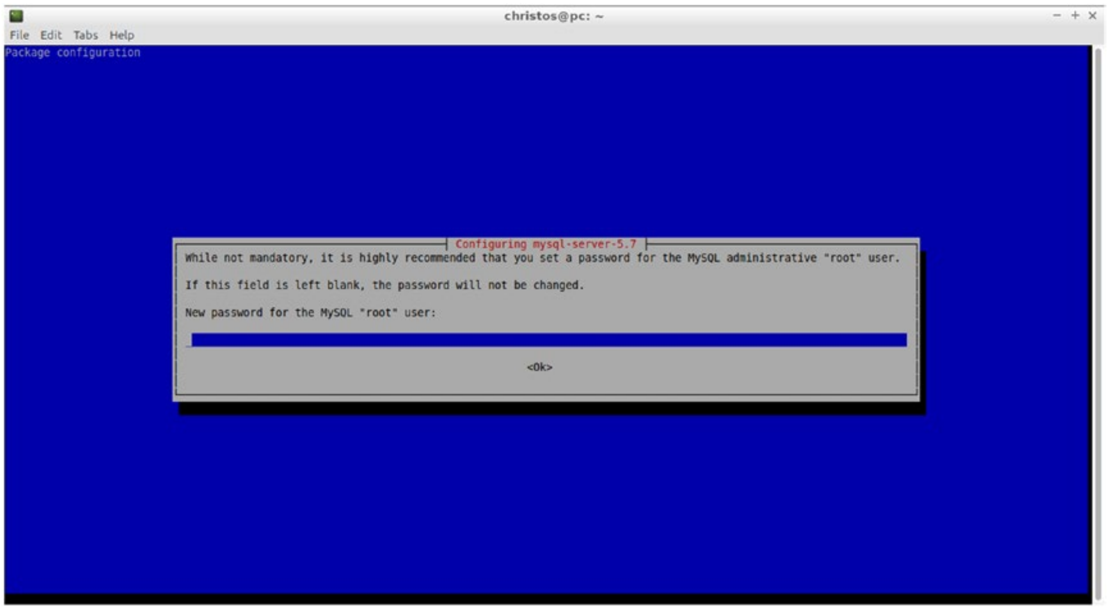
In this chapter, you will use some basic SQL commands to create and manage a MySQL database and to create a shell script to automatically feed a MySQL database with data collected from a web site, a process that is often called *web scraping*.

Installing and Testing MySQL

Use the following command at the Linux terminal to download the MySQL database system:

```
$ sudo apt-get install mysql-server mysql-client
```

The `mysql-server` package will install the MySQL database server, which you can interact with from the terminal by using the `mysql` command from the `mysql-client` package. During the installation process, the dialog shown in Figure 6-1 appears, and you are prompted to enter a password for the MySQL administrator user, named *root*. In the examples used in this book, no password was provided for accessing the MySQL server, and the password value in the source code examples is an empty string. Likewise, you can leave the password field blank and just press the Enter key.



```
While not mandatory, it is highly recommended that you set a password for the MySQL administrative "root" user.

If this field is left blank, the password will not be changed.

New password for the MySQL "root" user:
```

Figure 6-1. *The first dialog of the MySQL installation process prompts you for a password*

A second window appears for the password confirmation. If you did not enter a password previously, leave the field in this window empty and press Enter again.

The installation process continues, with information displayed in the terminal until completion.

To find out the status of the MySQL server, use the following command:

```
$ service mysql status
```

Some sample output of this command indicating that MySQL is up and running is shown here:

```
   Loaded: loaded (/lib/systemd/system/mysql.service; enabled; vendor
   preset: enabled)
   Active: active (running) since Sun 2018-08-19 13:23:05 EEST; 3min 3s ago
  Process: 662 ExecStartPost=/usr/share/mysql/mysql-systemd-start post
  (code=exited, status=0/SUCCESS)
  Process: 608 ExecStartPre=/usr/share/mysql/mysql-systemd-start pre
  (code=exited, status=0/SUCCESS)
```

```
 Main PID: 661 (mysqld)
    Tasks: 28 (limit: 4915)
   CGroup: /system.slice/mysql.service
           └─661 /usr/sbin/mysqld

Aug 19 13:22:50 pc systemd[1]: Starting MySQL Community Server...
Aug 19 13:23:05 pc systemd[1]: Started MySQL Community Server.
```

Press Q (quit) on the keyboard to exit the command and release the terminal.

Like with Apache and Lighttpd, to stop the MySQL server and then start it again, use the following commands at the terminal:

```
$ sudo service mysql stop
$ sudo service mysql start
```

To connect to the MySQL server, you can use the `mysql` client program. At the Linux terminal, enter the following command:

```
$ mysql -u root
```

A welcome message along with some basic information is output to the terminal. Also, the MySQL prompt appears instead of the shell's prompt, indicating that you are connected to the MySQL server, ready to send SQL commands.

```
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 36
Server version: 5.7.22-0ubuntu0.17.10.1 (Ubuntu)

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affiliates. Other names may be trademarks of their respective owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input
statement.

mysql>
```

This message notes that you can use the command `help` or its corresponding shortcut (`\h`) to list all the available commands. Run `help` as a first command.

```
mysql> help
```

The output of help displays the commands that mysql interprets, shown here:

```
List of all MySQL commands:
Note that all text commands must be first on line and end with ';'
?         (\?) Synonym for `help'.
clear     (\c) Clear the current input statement.
connect   (\r) Reconnect to the server. Optional arguments are db and host.
delimiter (\d) Set statement delimiter.
edit      (\e) Edit command with $EDITOR.
ego       (\G) Send command to mysql server, display result vertically.
exit      (\q) Exit mysql. Same as quit.
go        (\g) Send command to mysql server.
help      (\h) Display this help.
nopager   (\n) Disable pager, print to stdout.
notee     (\t) Don't write into outfile.
pager     (\P) Set PAGER [to_pager]. Print the query results via PAGER.
print     (\p) Print current command.
prompt    (\R) Change your mysql prompt.
quit      (\q) Quit mysql.
rehash    (\#) Rebuild completion hash.
source    (\.) Execute an SQL script file. Takes a file name as an
               argument.
status    (\s) Get status information from the server.
system    (\!) Execute a system shell command.
tee       (\T) Set outfile [to_outfile]. Append everything into given outfile.
use       (\u) Use another database. Takes database name as argument.
charset   (\C) Switch to another charset. Might be needed for processing
               binlog with multi-byte charsets.
warnings  (\W) Show warnings after every statement.
nowarning (\w) Don't show warnings after every statement.
resetconnection(\x) Clean session context.

For server side help, type 'help contents'
```

Test, for instance, the system command, which executes shell commands, with the terminal command clear.

```
mysql> system clear
```

The terminal clears with the `mysql` prompt ready to accept the next command.

To end the MySQL session and return to the Linux terminal, type the `exit` command.

```
mysql> exit
```

With these commands, you can start and exit the MySQL client and also view and run the set of the available commands that `mysql` interprets. Next, you will learn about the SQL statements that `mysql` issues to the MySQL server to create and manage a database.

Creating Your First MySQL Database

Start the `mysql` client to connect to the server so you can create and use your first database. In this section, you will design the tables included in this database, you will define the relationships between the tables, and then you will use the tables to enter your data. You will then be able to issue database queries on the table data and generate results.

First connect to the MySQL server by using `mysql` at the Linux terminal.

```
$ mysql -u root
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 3
Server version: 5.7.22-0ubuntu0.17.10.1 (Ubuntu)

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affiliates. Other names may be trademarks of their respective owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

mysql>
```

To create a new database named `library`, enter the following `create database` SQL statement and press Enter:

```
mysql> create database library;
```

MySQL server responds with the following message:

```
Query OK, 1 row affected (0.00 sec)
```

Hint! Each MySQL command requires a semicolon (`;`) to indicate the ending. Some SQL databases require the commands to be inserted in uppercase characters (e.g., `CREATE DATABASE library;`). The MySQL syntax used here does not require uppercase.

To view all the databases included so far, use the `show databases` statement.

```
mysql> show databases;
```

The command's output indicates that your new database is added in the default set of the five databases. The MySQL server already includes the following:

```
+--------------------+
| Database           |
+--------------------+
| information_schema |
| apress             |
| library            |
| mysql              |
| performance_schema |
| sys                |
+--------------------+
6 rows in set (0.00 sec)
```

You can delete the new database at any time, regardless of whether it is empty or filled with data, using the `drop database` statement.

```
 mysql> drop database library;
```

If you test `drop` at this time, make sure to repeat the previous `create` command to re-create the database.

Creating and Deleting Tables of Your Database

To start working with the new database, you have to define that the commands that will follow will refer to that specific database. The use SQL statement indicates the database that will be used for the commands that follow, up to the point where another use is typed.

```
mysql> use library;
```

You'll now create your first table for the database. For each table that will be included in the database, the column (field) names and the types of data inserted to the columns must be defined at creation time. For instance, for the first table of library, called author, the author's name and the author's country will be defined as the table's columns. To create table author, enter the following at the mysql prompt:

```
mysql> CREATE TABLE author (name VARCHAR(30), country CHAR(2));
```

The MySQL server responds with an OK message.

```
Query OK, 0 rows affected (0.43 sec)
```

The first column, called name, is of type VARCHAR, which means it's a string of characters with a variable length. You allocate the maximum number of characters for the value in parentheses. In this example, the author's name can be up to 30 characters. The second column is of type CHAR, also a string of characters but with a fixed length. The length in this example is specified in the parentheses as 2, which means the author's country will always be inserted as two characters. This is sufficient because the country column value will be provided as the ISO 3166-1 alpha two-character code, e.g., uk.

To print an overview of the table's structure, enter the following:

```
mysql> describe author;
```

MySQL responds with a description of the table's columns, shown here:

```
+---------+-------------+------+-----+---------+-------+
| Field   | Type        | Null | Key | Default | Extra |
+---------+-------------+------+-----+---------+-------+
| name    | varchar(30) | YES  |     | NULL    |       |
| country | char(2)     | YES  |     | NULL    |       |
+---------+-------------+------+-----+---------+-------+
2 rows in set (0.01 sec)
```

Because it's a relational database, MySQL allows you to connect two or more tables by *relating* their entries. This allows you to store data in multiple tables, instead of just a big one. This approach makes data more manageable and less error prone.

The queries you'll execute next will combine columns from both tables. In this example, details of the books written by the authors in the author's table will make up a second table called book. To connect the two tables and allow their data to be combined, a common column must be used from both tables. This column is defined as the *primary key* for the first table and the *foreign key* for the second. A primary key (and therefore a foreign key) must have a unique value in each table's record so that it discriminates this record from the others.

So far, no primary key was used for the author table. To correct this, you have two options: delete this table and re-create it or alter the existing table's structure. You can delete a table regardless of whether the table is empty or filled with data. Since you are in an early stages of the database's design, I'll display the table deletion here and leave the table modification for later. To delete table author, use the drop table statement as follows:

```
mysql> drop table author;
```

The MySQL server responds with an OK message.

```
Query OK, 0 rows affected (0.22 sec)
```

Re-create the table authors, this time including author_id, which is the column that will be the primary key of the table. The primary key constraint is the one that assigns author_id as the primary key. The auto_increment keyword defines that for each record (row) inserted in the table, the author_id value will receive automatically the next available integer, starting from 1. The data type of author_id is set to int (integer). At the mysql prompt, enter the following:

```
mysql> create table author (author_id int auto_increment, primary
key(author_id), name varchar(30), country char(2));
```

The MySQL server responds with an OK message.

```
Query OK, 0 rows affected (0.44 sec)
```

Use the describe SQL statement again to view the new table's structure.

```
mysql> describe author;
```

The MySQL server responds by displaying the following table, which describes the structure of author:

```
+-----------+------------+------+-----+---------+----------------+
| Field     | Type       | Null | Key | Default | Extra          |
+-----------+------------+------+-----+---------+----------------+
| author_id | int(11)    | NO   | PRI | NULL    | auto_increment |
| name      | varchar(30) | YES  |     | NULL    |                |
| country   | char(2)    | YES  |     | NULL    |                |
+-----------+------------+------+-----+---------+----------------+
3 rows in set (0.00 sec)
```

Notice that the author_id field is identified by the PRI value in the Key column as the primary key. In addition, as indicated by the NO value in the Null column field, author_id should not be empty for any record. Also, the auto_increment keyword for the primary key is shown in the Extra column.

Next, create book, the second table that will be used for the library database. Column book_id will be the primary key for the book table; column title will hold the book title, which will be up to 255 characters; column language will be the language the book is written to; and column author_id will be the foreign key from the author table, defining a connection among the two tables. The not null constraint is also set so that all author_id values are required to be filled. At the mysql prompt, enter the following create table command:

```
mysql> create table book (book_id char(13), primary key(book_id), title
varchar(255), language varchar(20), author_id int not null, foreign
key(author_id) references author(author_id));
```

The MySQL server responds with an OK message.

```
Query OK, 0 rows affected (0.57 sec)
```

Use the describe SQL statement for the second table to view its structure.

```
mysql> describe book;
```

The MySQL server responds with the following output:

```
+-----------+--------------+------+-----+---------+-------+
| Field     | Type         | Null | Key | Default | Extra |
+-----------+--------------+------+-----+---------+-------+
| book_id   | char(13)     | NO   | PRI | NULL    |       |
| title     | varchar(255) | YES  |     | NULL    |       |
| language  | varchar(20)  | YES  |     | NULL    |       |
| author_id | int(11)      | NO   | MUL | NULL    |       |
+-----------+--------------+------+-----+---------+-------+
4 rows in set (0.01 sec)
```

This time, two columns have a `NO` value in the `Null` column: `book_id`, which is the primary key, and `author_id`, the foreign key, which was explicitly set to not null. The `MUL` (multiple) key indicates that multiple rows may have the same value as the `author_id` column.

Inserting, Displaying, and Deleting Records

You can use the `insert into` SQL statement to enter a number of records in the `author` table. You don't have to specify the `author_id` value since it is automatically entered because of the `auto_increment` attribute. The following three commands are used, with their output shown here:

```
mysql>  insert into author (name, country) values(' Tolkien, John Ronald
        Reuel', 'UK');
Query OK, 1 row affected (0.07 sec)
mysql>  insert into author (name, country) values('Steinbeck, John Ernst
        Jr.', 'US');
Query OK, 1 row affected (0.07 sec)
mysql>  insert into author (name, country) values('Eco, Umberto', 'IT');
Query OK, 1 row affected (0.08 sec)
```

To view the records inserted into table author so far, use the select SQL statement, which is one of the most important statements used for SQL queries. In its simplest form, without any clause, select takes as argument the asterisk (*) wildcard, which corresponds to all columns, with no other condition. The following command therefore displays all elements of table author:

```
mysql> select * from author;
```

The command's output is as follows:

```
+-----------+----------------------------+---------+
| author_id | name                       | country |
+-----------+----------------------------+---------+
|         1 | Tolkien, John Ronald Reuel | UK      |
|         2 | Steinbeck, John Ernst Jr.  | US      |
|         3 | Eco, Umberto               | IT      |
+-----------+----------------------------+---------+
3 rows in set (0.01 sec)
```

Enter the last record another time.

```
mysql>  insert into author (name, country) values('Eco, Umberto', 'IT');
```

Use the SQL select statement to view the table records again.

```
mysql> select * from author;
```

The duplicated entry for the name is displayed next. In this case, this is an unwanted result, which can be corrected in the next section.

```
+-----------+----------------------------+---------+
| author_id | name                       | country |
+-----------+----------------------------+---------+
|         1 | Tolkien, John Ronald Reuel | UK      |
|         2 | Steinbeck, John Ernst Jr.  | US      |
|         3 | Eco, Umberto               | IT      |
|         4 | Eco, Umberto               | IT      |
+-----------+----------------------------+---------+
4 rows in set (0.00 sec)
```

Use the delete SQL statement to remove the fourth entry of the author table. In the following command, the fourth record is indicated with the where clause, which specifies the records to be deleted by setting the condition: author_id (the primary key) equal to 4.

```
mysql> delete from author where author_id=4;
```

The MySQL server responds with an OK message.

```
Query OK, 1 row affected (0.18 sec)
```

Display the remaining author records using the SQL select statement.

```
mysql> select * from author;
```

The command's output is as follows:

```
+-----------+----------------------------+---------+
| author_id | name                       | country |
+-----------+----------------------------+---------+
|         1 | Tolkien, John Ronald Reuel | UK      |
|         2 | Steinbeck, John Ernst Jr.  | US      |
|         3 | Eco, Umberto               | IT      |
+-----------+----------------------------+---------+
3 rows in set (0.01 sec)
```

Altering the Table's Structure

Even when a table is filled with data, it is not too late to modify the table's characteristics. In this section, you will make three alterations in a table's structure. The first one solves the problem of the duplicated entry shown in the previous section. The second modification will be to the data type, and the third will be to add a column.

First, by using the alter table statement with the add clause, you'll turn the column name into a unique key. This is a third kind of key category, with the others being the primary and foreign keys.

```
mysql>  alter table author add unique(name);
```

The MySQL server responds with an OK message.

```
Query OK, 0 rows affected (0.47 sec)
Records: 0  Duplicates: 0  Warnings: 0
```

To view the new table's structure and display the UNI (unique) key, use the describe SQL statement.

```
mysql> describe author;
+-----------+------------+------+-----+---------+----------------+
| Field     | Type       | Null | Key | Default | Extra          |
+-----------+------------+------+-----+---------+----------------+
| author_id | int(11)    | NO   | PRI | NULL    | auto_increment |
| name      | varchar(30) | YES  | UNI | NULL    |                |
| country   | char(2)    | YES  |     | NULL    |                |
+-----------+------------+------+-----+---------+----------------+
3 rows in set (0.00 sec)
```

To test the unique key, use the insert SQL statement with a value for the column name already entered.

```
mysql>  insert into author(name, country) values('Eco, Umberto', 'IT');
```

The duplicated record is not allowed in the table, and the web server responds with an error message.

```
ERROR 1062 (23000): Duplicate entry 'Eco, Umberto' for key 'name'
```

As the second example of the alter table statement, you will change the data type of a column. For the author table, try first to enter a record with a name value larger than 30 characters.

```
mysql>  insert into author (name, country) values('Solzhenitsyn, Aleksandr
        Isayevich', 'RU');
```

The MySQL server responds with an error message.

```
ERROR 1406 (22001): Data too long for column 'name' at row 1
```

Use the alter table SQL statement to modify the data type of the name column.

```
mysql> alter table author modify name varchar(255);
```

The MySQL server responds with an OK message.

```
Query OK, 0 rows affected (0.56 sec)
Records: 0  Duplicates: 0  Warnings: 0
```

Try to enter the previous entry again with the long name.

```
mysql>  insert into author (name, country) values(Solzhenitsyn, Aleksandr
        Isayevich', 'RU');
```

This time MySQL responds with an OK message.

```
Query OK, 1 row affected (0.07 sec)
```

With the select statement, you can view the previous entry of the author table.

```
mysql> select * from author;
```

MySQL displays the result.

```
+-----------+-----------------------------------+---------+
| author_id | name                              | country |
+-----------+-----------------------------------+---------+
|         1 | Tolkien, John Ronald Reuel        | UK      |
|         2 | Steinbeck, John Ernst Jr.         | US      |
|         3 | Eco, Umberto                      | IT      |
|         6 | Solzhenitsyn, Aleksandr Isayevich | RU      |
+-----------+-----------------------------------+---------+
4 rows in set (0.00 sec)
```

Use the describe SQL statement to view the new data type, reflected in the table's structure.

```
mysql> describe author;
```

The command's output displays a data type of varchar(255) instead of varchar(30).

```
+-----------+--------------+------+-----+---------+----------------+
| Field     | Type         | Null | Key | Default | Extra          |
+-----------+--------------+------+-----+---------+----------------+
| author_id | int(11)      | NO   | PRI | NULL    | auto_increment |
| name      | varchar(255) | YES  | UNI | NULL    |                |
| country   | char(2)      | YES  |     | NULL    |                |
+-----------+--------------+------+-----+---------+----------------+
3 rows in set (0.01 sec)
```

For the third modification, you will add a new column to the book table, for instance pub_date, corresponding to the publication date of each book. Like most modern programming environments, MySQL supports a large set of data types. Common values such as date, time, or year are expected to have their own type. This is the case with the year type that will be used next. At the mysql prompt, enter the following:

```
mysql> alter table book add pub_date year;
```

MySQL responds with an OK message.

```
Query OK, 0 rows affected (1.16 sec)
Records: 0  Duplicates: 0  Warnings: 0
```

To view the new book structure, use the describe statement.

```
mysql> describe book;
```

The MySQL server responds by displaying the new structure of the book table.

```
+-----------+--------------+------+-----+---------+-------+
| Field     | Type         | Null | Key | Default | Extra |
+-----------+--------------+------+-----+---------+-------+
| book_id   | char(13)     | NO   | PRI | NULL    |       |
| title     | varchar(255) | YES  |     | NULL    |       |
| language  | varchar(20)  | YES  |     | NULL    |       |
| author_id | int(11)      | NO   | MUL | NULL    |       |
| pub_date  | year(4)      | YES  |     | NULL    |       |
+-----------+--------------+------+-----+---------+-------+
5 rows in set (0.00 sec)
```

Testing the Table Connection

By using a foreign key, the two database tables are connected with a parent-child relationship. In this example, the parent table is author, which provides its primary key as a foreign key to the book table. You can't delete the author table if you have not already deleted the book table. Also, you can't insert a book entry with a foreign key value that does not exist.

In the following command, the nonexistent value 8 of the foreign key is used:

```
mysql> insert into book (book_id, title, language, author_id, pub_date)
values('9780743273565','The Great Gatsby', 'English',8,2004);
```

The MySQL server responds with an error message.

```
ERROR 1452 (23000): Cannot add or update a child row: a foreign key
constraint fails (`library`.`book`, CONSTRAINT `book_ibfk_1` FOREIGN KEY
(`author_id`) REFERENCES `author` (`author_id`))
```

Enter some records in the table book to be used in the query examples. For instance, run the following insert commands (the output of each command is also included):

```
mysql> insert into book (book_id, title, language, author_id, pub_date)
values('9780140177374','The Pearl','English',2,2000);
Query OK, 1 row affected (0.06 sec)

mysql> insert into book (book_id, title, language, author_id, pub_date)
values('9782806272836','De ratones y hombres','Spanish',2,2016);
Query OK, 1 row affected (0.07 sec)

mysql> insert into book (book_id, title, language, author_id, pub_date)
values('9780547928227','The Hobbit','English',1,2012);
Query OK, 1 row affected (0.06 sec)

mysql> insert into book (book_id, title, language, author_id, pub_date)
values('9780547928197','The Return of the King','English',1,2012);
Query OK, 1 row affected (0.07 sec)

mysql> insert into book (book_id, title, language, author_id, pub_
date) values('9780143105459','The Acts of King Arthur and His Noble
Knights','English',2,2008);
Query OK, 1 row affected (0.06 sec)
```

In the previous commands, since `book_id` is the primary key for book, the `book_id` values must be unique. For the values of the `book_id` column, the ISBN-13 of each book was chosen because it's unique to each book.

To view the book records, do a basic query by selecting all (*) records.

```
mysql> select * from book;
```

MySQL outputs the following result:

```
+---------------+-----------------------+----------+-----------+----------+
| book_id       | title                 | language | author_id | pub_date |
+---------------+-----------------------+----------+-----------+----------+
| 9780140177374 | The Pearl             | English  |         2 |     2000 |
| 9780143105459 | The Acts of King
                  Arthur and His Noble
                  Knights               | English  |         2 |     2008 |
| 9780547928197 | The Return of the King | English  |         1 |     2012 |
| 9780547928227 | The Hobbit            | English  |         1 |     2012 |
| 9782806272836 | De ratones y hombres  | Spanish  |         2 |     2016 |
+---------------+-----------------------+----------+-----------+----------+
5 rows in set (0.00 sec)
```

The two tables, connected now with a parent-child relationship and filled with records, are used in the following section for extracting information from the database. In other words, you'll next query the database.

Performing SQL Queries with the MySQL Server

You have used the `select` statement so far in its simplest form and with the asterisk wildcard. `select` can be combined with functions such as `avg` (average), `count`, `max`, `min`, `round`, etc. The `where` clause is used to filter records by providing a condition that must be met. For instance, to count the number of book records with the language set to English, use the following:

```
mysql> select count(book_id) from book where language='English';
```

The result is four books.

```
+----------------+
| count(book_id) |
+----------------+
|              4 |
+----------------+
1 row in set (0.00 sec)
```

You'll now use the `select` statement to execute a query that selects columns from both tables. To specify a column, the table's name must be prepended to the column's name, separated by a period. For instance, using this notation, `book.author_id` discriminates from `author.author_id`. The outcome of this combination is determined by the `join` clause. In the next example, the `inner join` clause is used, which selects for the output only records that have matching values in *both* tables.

```
mysql> select book.title, author.name, book.pub_date from author inner join
book on book.author_id=author.author_id where book.language='English';
```

The inner join includes records of the two tables that have the same value in their `author_id` columns. The columns for the records included are the title (from `book`), the name (from `author`), and the publication date (from `author`) where the language column in the book table is English.

MySQL displays the following output:

```
+----------------------------------+----------------------------+----------+
| title                            | name                       | pub_date |
+----------------------------------+----------------------------+----------+
| The Pearl                        | Steinbeck, John Ernst Jr.  |     2000 |
| The Acts of King Arthur and
  His Noble Knights                | Steinbeck, John Ernst Jr.  |     2008 |
| The Return of the King           | Tolkien, John Ronald Reuel |     2012 |
| The Hobbit                       | Tolkien, John Ronald Reuel |     2012 |
+----------------------------------+----------------------------+----------+
4 rows in set (0.00 sec)
```

The following variation of the previous command sorts the records according to the `pub_date` column in descending order:

```
mysql> select book.title, author.name, book.pub_date from author inner join
book on book.author_id=author.author_id where book.language='English' order
by book.pub_date desc;
```

```
+----------------------------------+----------------------------+----------+
| title                            | name                       | pub_date |
+----------------------------------+----------------------------+----------+
| The Return of the King           | Tolkien, John Ronald Reuel |     2012 |
| The Hobbit                       | Tolkien, John Ronald Reuel |     2012 |
| The Acts of King Arthur and
  His Noble Knights                | Steinbeck, John Ernst Jr.  |     2008 |
| The Pearl                        | Steinbeck, John Ernst Jr.  |     2000 |
+----------------------------------+----------------------------+----------+
4 rows in set (0.00 sec)
```

The following query includes a count function and an inner join clause. The group by clause groups the results by the column author.name.

```
mysql> select count(book.title), author.name from author inner join book on
book.author_id=author.author_id group by author.name;
```

As the output indicates, for the first author, three books are included in the database and for the second two books are included.

```
+-------------------+----------------------------+
| count(book.title) | name                       |
+-------------------+----------------------------+
|                 3 | Steinbeck, John Ernst Jr.  |
|                 2 | Tolkien, John Ronald Reuel |
+-------------------+----------------------------+
2 rows in set (0.00 sec)
```

In the following command, two columns participate in the group by clause.

```
mysql> select count(book.title), author.name, pub_date from author inner
join book on book.author_id=author.author_id group by author.name, pub_date;
```

The query's result is as follows:

```
+-------------------+----------------------------+----------+
| count(book.title) | name                       | pub_date |
+-------------------+----------------------------+----------+
|                 1 | Steinbeck, John Ernst Jr.  |     2000 |
|                 1 | Steinbeck, John Ernst Jr.  |     2008 |
|                 1 | Steinbeck, John Ernst Jr.  |     2016 |
|                 2 | Tolkien, John Ronald Reuel |     2012 |
+-------------------+----------------------------+----------+
4 rows in set (0.00 sec)
```

In the previous table, the output is grouped from right to left, first by publication date (two records have the value 2012) and then by author's name.

Modifying Records with the update Command

Use the following `update` and `set` statements to change an author's name:

```
mysql> update author set name='Tolkien, J.R.R.' where name='Tolkien, John
Ronald Reuel';
```

To view the changes, display the `author` table's contents.

```
mysql> select * from author;
```

The MySQL server displays the following result:

```
+-----------+------------------------------------+---------+
| author_id | name                               | country |
+-----------+------------------------------------+---------+
|         1 | Tolkien, J.R.R.                    | UK      |
|         2 | Steinbeck, John Ernst Jr.          | US      |
|         3 | Eco, Umberto                       | IT      |
|         6 | Solzhenitsyn, Aleksandr Isayevich  | RU      |
+-----------+------------------------------------+---------+
4 rows in set (0.01 sec)
```

Using the SQL like Operator

A useful operator, used with the where clause, is like. You can use it to query a database when the user wants to specify a keyword but recalls only part of it. With like, you can query for a pattern that is included in the value of a column. For instance, to look for the title, author, and publication date (year) of a book that includes the word *king* in its title, you can use the like clause as shown here:

```
mysql> select book.title, author.name, book.pub_date from author inner join
book on book.author_id=author.author_id where book.title like '%king%';
```

The command's output is as follows:

```
+-----------------------------------+----------------------------+----------+
| title                             | name                       | pub_date |
+-----------------------------------+----------------------------+----------+
| The Acts of King Arthur and
  His Noble Knights                 | Steinbeck, John Ernst Jr. |     2008 |
| The Return of the King            | Tolkien, J.R.R.            |     2012 |
+-----------------------------------+----------------------------+----------+
2 rows in set (0.00 sec)
```

Two wildcard characters are used with like.

- The percentage (%) wildcard matches any string of zero or more characters.
- The underscore (_) wildcard matches a single character.

You'll next use the previous command in another way. This time the title must end with the word *king*.

```
mysql> select book.title, author.name, book.pub_date from author inner join
book on book.author_id=author.author_id where book.title like '%king';
```

The command's output is as follows:

```
+-----------------------+---------------+---------+
| title                 | name          | pub_date |
+-----------------------+---------------+---------+
| The Return of the King | Tolkien, J.R.R. |    2012 |
+-----------------------+---------------+---------+
1 row in set (0.00 sec)
```

You can try to delete the two tables used so far. Try first to delete the parent table `author`.

```
mysql> drop table author;
```

MySQL displays the following error message:

```
ERROR 1217 (23000): Cannot delete or update a parent row: a foreign key
constraint fails
```

The constraint, which exists because of the parent-child relationship, does not allow the parent table to be deleted without previously deleting the child table. So, use the `drop table` statement to delete the child table, book.

```
mysql> drop table book;
```

The MySQL server responds with the following output:

```
Query OK, 0 rows affected (0.23 sec)
```

Now you can delete `author`.

```
mysql> drop table author;

The table is deleted this time with no complaints:
Query OK, 0 rows affected (0.17 sec)
```

Web Scraping with MySQL and the Linux Shell

In the previous examples, you manually inserted records into your database. Filling your database one record at a time is certainly tedious. For more realistic examples, you can use automated methods to transfer your data to one or more tables.

In this section, you will implement what is commonly called *web scraping*. This is the detection and collection of data from various web pages and inserting it into a file (e.g., a spreadsheet) or more appropriately into a database. The Bash shell scripting language and MySQL will be used for this project. Writing a Linux shell script that applies only to a certain web site may seem like overkill; however, this may help you process thousands of data records in some cases.

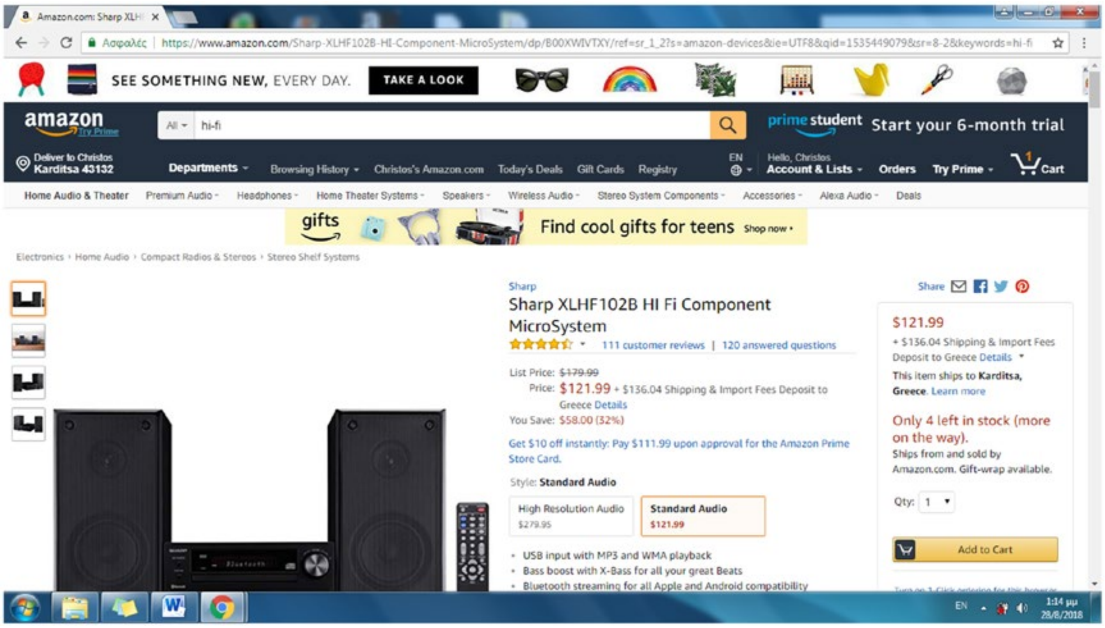
The URLs Describing the Resources

To start with web scraping, you have to identify the format in which the data is encoded for a specific portal. To search for data in specific web pages, you first have to describe their URLs in a systematic way. Consider, for instance, amazon.com. By visiting any product page, you can find that what uniquely identifies a product for Amazon is the Amazon Standard Identification Number (ASIN) code. This is a 10-charcter alphanumeric unique identifier.

The ASIN is included in the URL of the specific product. For example, here is one of the products returned from searching using the keyword `hi-fi`:

```
https://www.amazon.com/Sharp-XLHF102B-HI-Component-MicroSystem/dp/
B00XWIVTXY/ref=sr_1_2?s=amazon-devices&ie=UTF8&qid=1535449079&sr=8-
2&keywords=hi-fi
```

Figure 6-2 displays the web page with the previous URL.



Amazon.com: Sharp XLH

Ασφαλές | https://www.amazon.com/Sharp-XLHF102B-HI-Component-MicroSystem/dp/B00XWIVTXY/ref=sr_1_2?s=amazon-devices&ie=UTF8&qid=1535449079&sr=8-2&keywords=hi-fi

Sharp

Sharp XLHF102B HI Fi Component MicroSystem

111 customer reviews | 120 answered questions

List Price: ~~$179.99~~

Price: $121.99 + $136.04 Shipping & Import Fees Deposit to Greece Details

You Save: $58.00 (32%)

Get $10 off instantly: Pay $111.99 upon approval for the Amazon Prime Store Card.

Style: Standard Audio

- USB input with MP3 and WMA playback
- Bass boost with X-Bass for all your great Beats
- Bluetooth streaming for all Apple and Android compatibility

$121.99

+ $136.04 Shipping & Import Fees Deposit to Greece Details

This item ships to Karditsa, Greece. Learn more

Only 4 left in stock (more on the way).

Ships from and sold by Amazon.com. Gift-wrap available.

Figure 6-2. *The ASIN is included in the product's URL*

Usually an identifier like the ASIN in this example specifies the product's web page with a more straightforward URL. Try, for instance, the following:

```
https://www.amazon.com/dp/B00XWIVTXY/
```

The same web page is rendered with the simplified format, as shown in Figure 6-3.

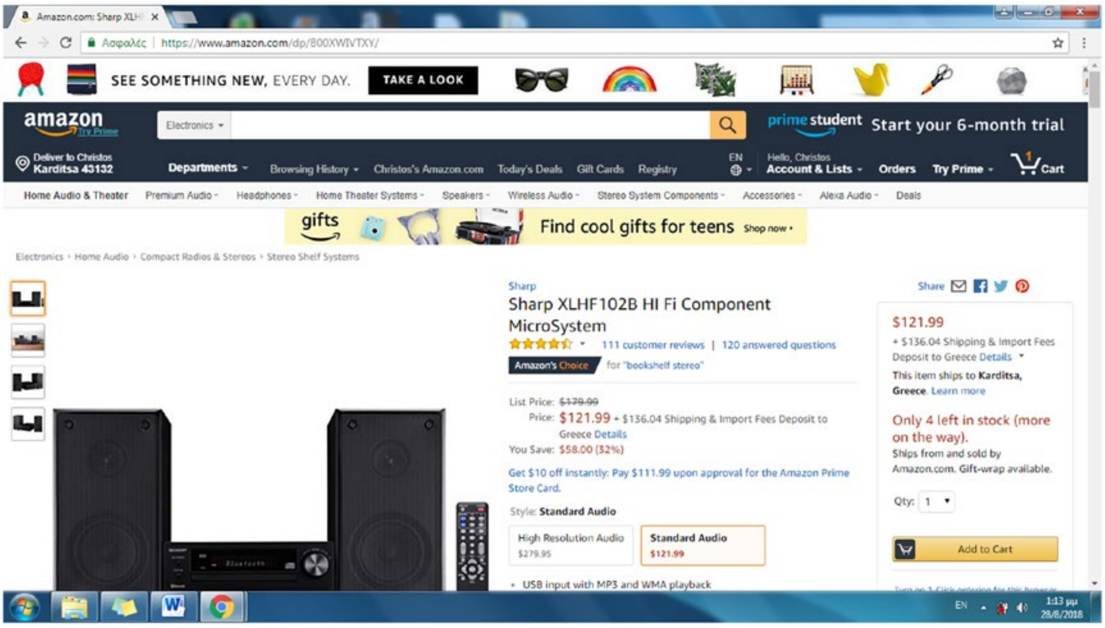

Amazon.com: Sharp XLH
Ασφαλές | https://www.amazon.com/dp/B00XWIVTXY/
SEE SOMETHING NEW, EVERY DAY.
TAKE A LOOK
amazon
Electronics
prime student Start your 6-month trial
Deliver to Christos Karditsa 43132
Departments
Browsing History
Christos's Amazon.com
Today's Deals
Gift Cards
Registry
Hello, Christos Account & Lists
Orders
Try Prime
Cart
Home Audio & Theater
Premium Audio
Headphones
Home Theater Systems
Speakers
Wireless Audio
Stereo System Components
Accessories
Alexa Audio
Deals
Find cool gifts for teens Shop now
Electronics › Home Audio › Compact Radios & Stereos › Stereo Shelf Systems
Sharp
Sharp XLHF102B HI Fi Component MicroSystem
111 customer reviews | 120 answered questions
Amazon's Choice for "bookshelf stereo"
List Price: $179.99
Price: $121.99 + $136.04 Shipping & Import Fees Deposit to Greece Details
You Save: $58.00 (32%)
Get $10 off instantly: Pay $111.99 upon approval for the Amazon Prime Store Card.
Style: Standard Audio
High Resolution Audio $279.95
Standard Audio $121.99
USB input with MP3 and WMA playback
Share
$121.99
+ $136.04 Shipping & Import Fees Deposit to Greece Details
This item ships to Karditsa, Greece. Learn more
Only 4 left in stock (more on the way).
Ships from and sold by Amazon.com. Gift-wrap available.
Qty: 1
Add to Cart
1:13 μμ 28/8/2018

Figure 6-3. *The ASIN included in the simplified URL format of a product*

A unique identifier is used in most commercial sites. For web sites that deal with books, there is no need to use any other product identifier because each book is already identified in a unique way with its ISBN. ISBN stands for International Standard Book Number and currently is used in two formats.

- A 13-digit ISBN, used for books released after the January 1, 2007
- A 10-digit ISBN, used for books released before January 1, 2007

Apress.com identifies its products with the 13-digit ISBN identifier. Visit the Apress home page at apress.com, displayed in Figure 6-4, and then click any link advertising an Apress book.

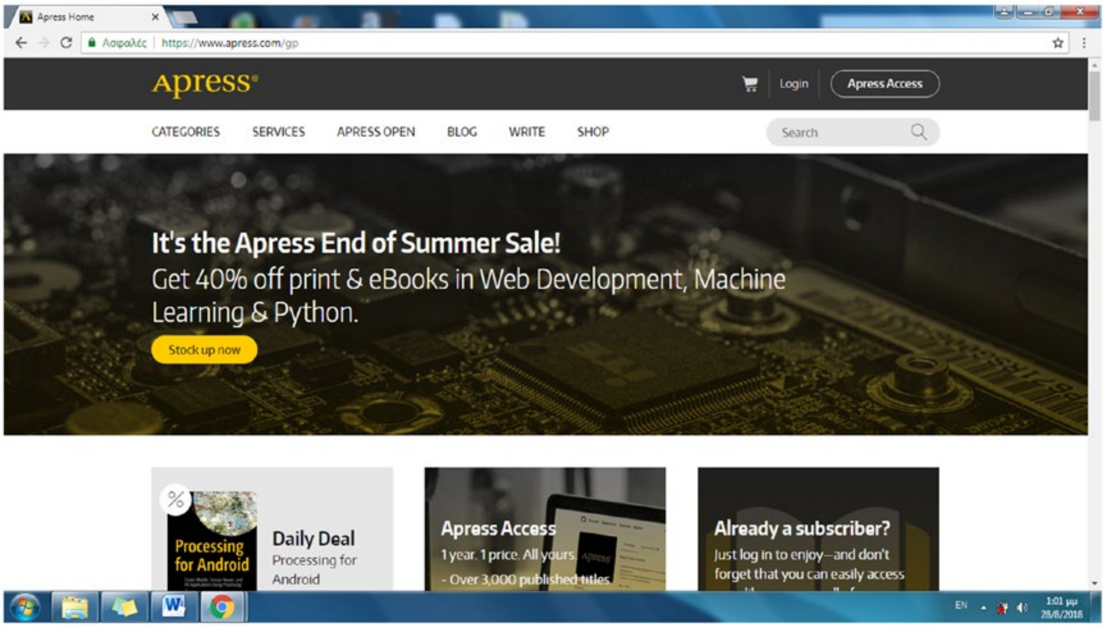
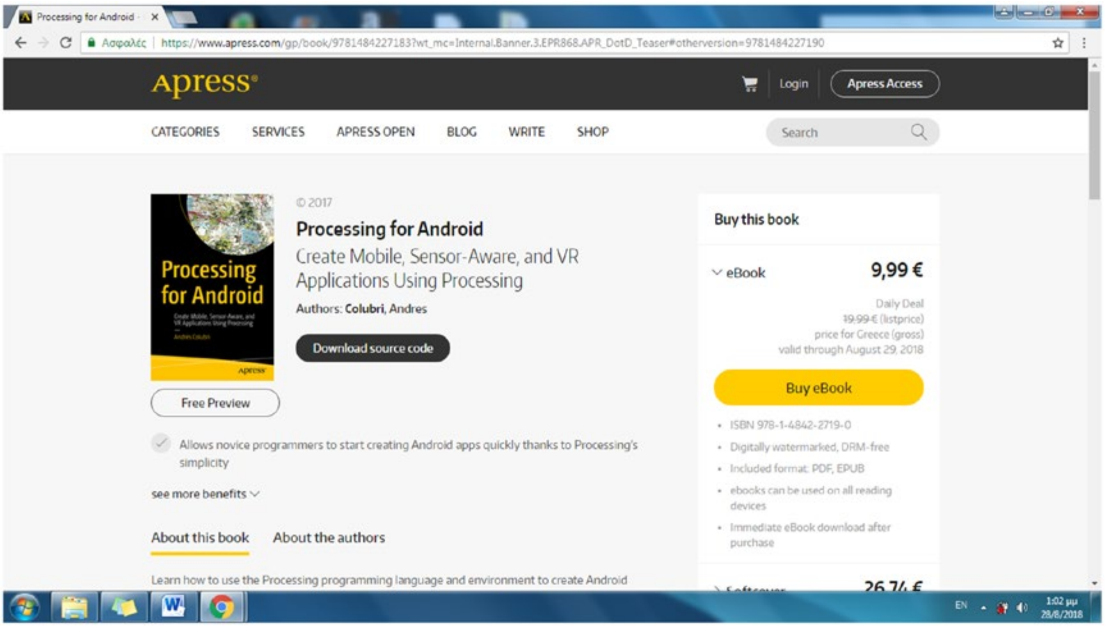

Apress Home
Ασφαλές | https://www.apress.com/gp
apress
Login
Apress Access
CATEGORIES SERVICES APRESS OPEN BLOG WRITE SHOP
Search
It's the Apress End of Summer Sale!
Get 40% off print & eBooks in Web Development, Machine Learning & Python.
Stock up now
Daily Deal
Processing for Android
Apress Access
1 year. 1 price. All yours.
- Over 3,000 published titles
Already a subscriber?
Just log in to enjoy—and don't forget that you can easily access

***Figure 6-4.** The Apress home page*

As viewed in Figure 6-5, the URL in the address bar for the specific example is as follows:

```
https://www.apress.com/gp/book/9781484227183?wt_mc=Internal.
Banner.3.EPR868.APR_DotD_Teaser#otherversion=9781484227190
```



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Processing for Android

Create Mobile, Sensor-Aware, and VR Applications Using Processing

Authors: Colubri, Andres

Download source code

Free Preview

Allows novice programmers to start creating Android apps quickly thanks to Processing's simplicity

see more benefits

About this book About the authors

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- Included format: PDF, EPUB
- ebooks can be used on all reading devices
- Immediate eBook download after purchase

Softcover 26,74 €

Figure 6-5. A product page on the Apress site identifies a book with the ISBN in the URL

Notice also that (similarly to the previous Amazon.com example) the URL can be simplified. For instance, the following URL leads to the same web page:

```
https://www.apress.com/gp/book/9781484227183
```

The next step is to locate and extract the data format used in the HTML source code of each product web page. For e-commerce sites, the data format is stored in a consistent way by implementing a data layer. The structure that defines the data layer for this example, the `appDataLayer` struct, is discussed in the following section.

Designing the Web Scraping Project

The following is the plan for creating the scrapping project: The web scraping shell script receives as an argument the URL of an Apress web page, which includes books of a certain category. It downloads this web page and then searches in the HTML source code of this web page for URLs of web pages that represent certain books. For each URL, the Bash shell script will perform an HTTPS connection to download the corresponding web page. The shell script will examine the web page's data layer, found behind the scenes, in the HTML source code for values of specific book attributes such as for the title, ISBN, and price. These values will be stored in a MySQL database table that will be created for gathering the data acquired with the previous web scraping technique.

Visit first the Apress home page and hover your mouse over the Categories menu at the top of the web page. As shown in Figure 6-6, a number of menu choices appear, with each one corresponding to a specific book category.

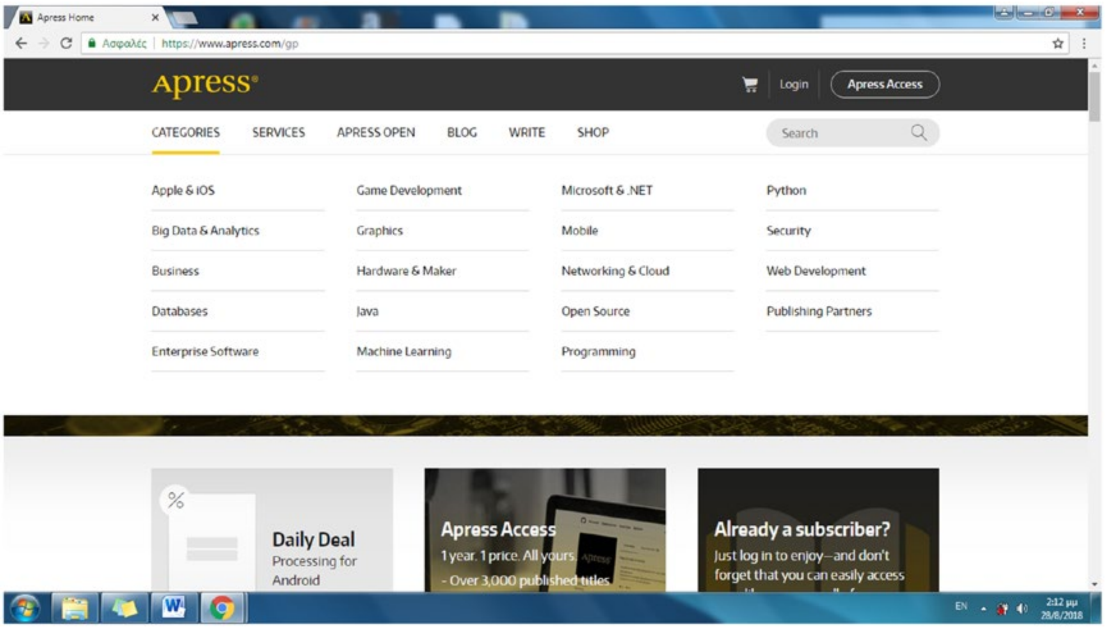


Figure 6-6. *The Categories menu on the Apress home page*

For this project, you can run the script for some (or even one) of these categories and collect the attributes of the books appearing in each category. Let's visit one of those categories, for instance, Web Development. By clicking this category's link, the web page displayed in Figure 6-7 appears.

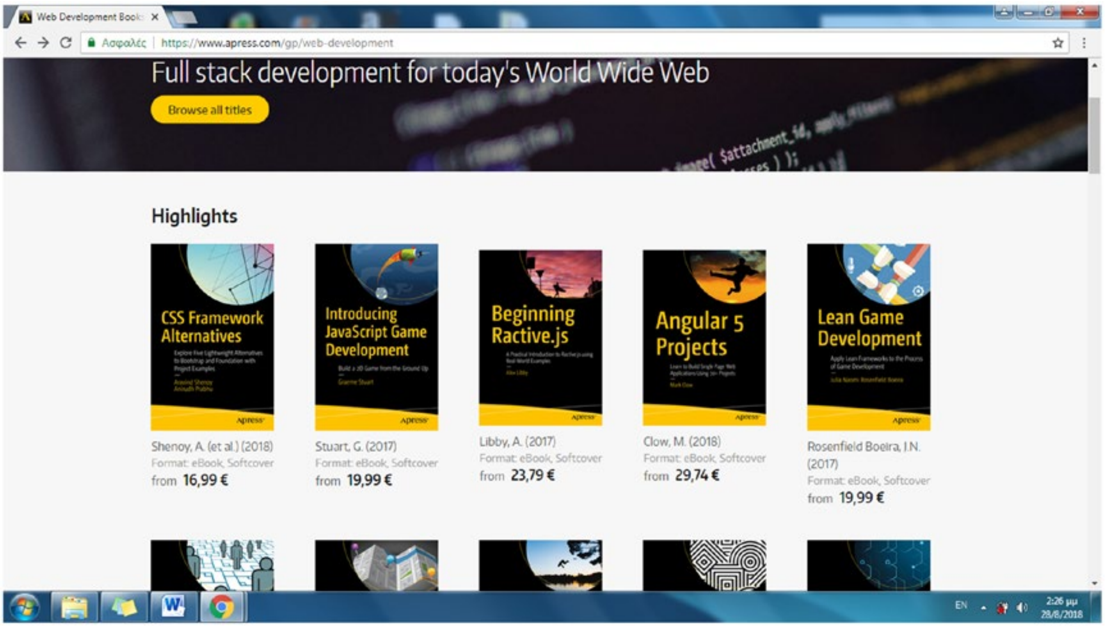


***Figure 6-7.** The books included in the Web Development category of Apress*

On this web page, a number of images representing the books appear. Those images are links to web pages that provide descriptions to the corresponding books.

Hint! Each option in the Categories menu leads to a web page that includes only a portion of the category's books. It is, however, sufficient for examining the web scraping method here. To view all the books in each category, follow the "Browse all titles" link in each category.

Notice the URL of the category in the address bar.

```
https://www.apress.com/gp/web-development
```

Similarly, the URL is formed for any other category by concatenating two parts.

```
https://www.apress.com/gp/
```

It uses the category name, in lowercase, with the space between the words substituted by a hyphen (-).

For instance, for the Open Source category, the URL is as follows:

```
https://www.apress.com/gp/open-source
```

This consistency can be used to further automate the process and use the script to search multiple categories; however, to simplify the shell script for this example, one category will be used to feed the script each time it runs. The following command will be used at the Linux terminal for the web scraping process:

```
$ ./shell.sh https://www.apress.com/gp/web-development apress book
pPriceGross fn isbn
```

The following are the parts that make up the command:

- `shell.sh` is the name of the shell script that performs the web scraping.
- `https://www.apress.com/gp/web-development` is the URL of the category web page, used to provide the URLs of the books included in the category web page, which finally will be downloaded and searched for the `pPriceGross`, `fn`, and `isbn` values of each book.
- `apress` is the database name that will be used to store the information.
- `book` is the `apress` database's table that includes the `pPriceGross`, `fn`, and `isbn` fields.
- `pPriceGross`, `fn`, and `isbn` are three fields found in the data layer of each page that provide values for the price, the name, and the ISBN, respectively. The number of fields this script supports is variable, which means that the same script can also run for two or five fields without changing any part of the source code.

The web page of the URL provided to the shell script command is the category page that includes a number of URLs leading to product web pages, each one dedicated to a single book. The product URLs have to be retrieved by the script and to be visited to extract the values of the `pPriceGross`, `fn`, and `isbn` fields of the data layer struct.

On the category page, all product pages are included between the start and ending `<h3>` tags. For instance, a product page link is as follows:

```
#<h3><a href="/gp/book/9781484233986" onmousedown="wt.sendinfo({linkId:
&#039;recommendation&#039;, customClickParameter : { 2 : &#039;shoppage.
recommendedproducts - 1&#039;}});" data-baynote-pid="978-1-4842-3398-6">CSS
Framework Alternatives</a></h3>
```

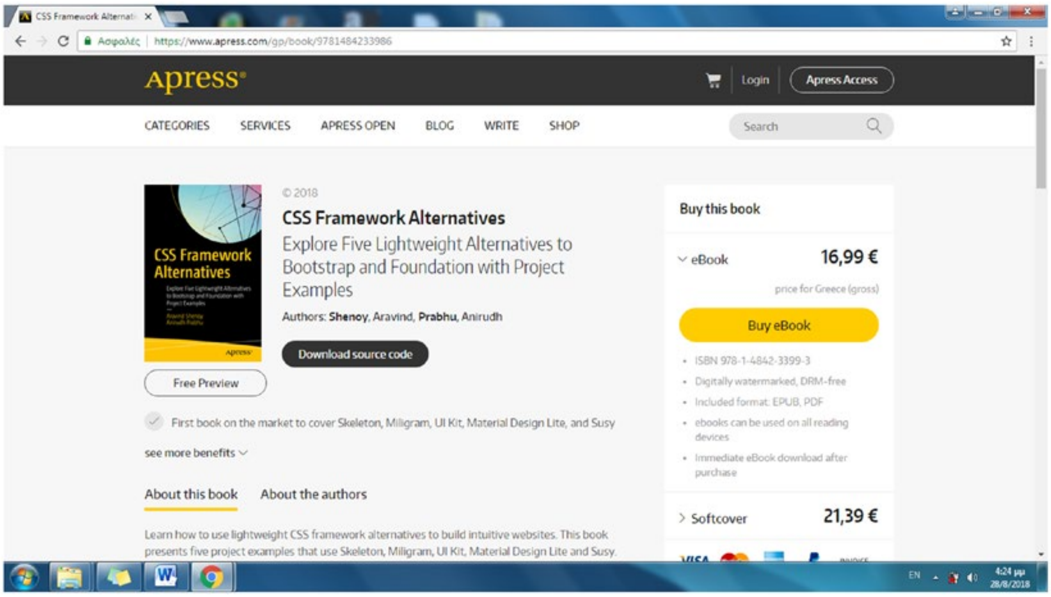
By including product links in the heading tags of a specific size, size 3 in this case, the designer of the site separated them from other links that appear in the page. For each product, the shell script extracts the ISBN, found after the `/gp/book/` directory in the URL, and then uses this ISBN to form the product's simplified URL. As you recall from the previous section, this has the following form:

```
https://www.apress.com/gp/book/{ISBN}
```

Here's an example:

```
https://www.apress.com/gp/book/9781484233986
```

Collecting the URLs of the products included in the category page is the first part of the script's functionality. The second part is visiting all those URLs and extracting from the HTML source code of the web pages the information about the specified fields (`pPriceGross`, `fn`, and `isbn` in this example). To locate where those fields are stored in each product page, visit a book's URL from `https://www.apress.com/gp/web-development`. For instance, visit `https://www.apress.com/gp/book/9781484233986`, which is shown in Figure 6-8.



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CSS Framework Alternatives

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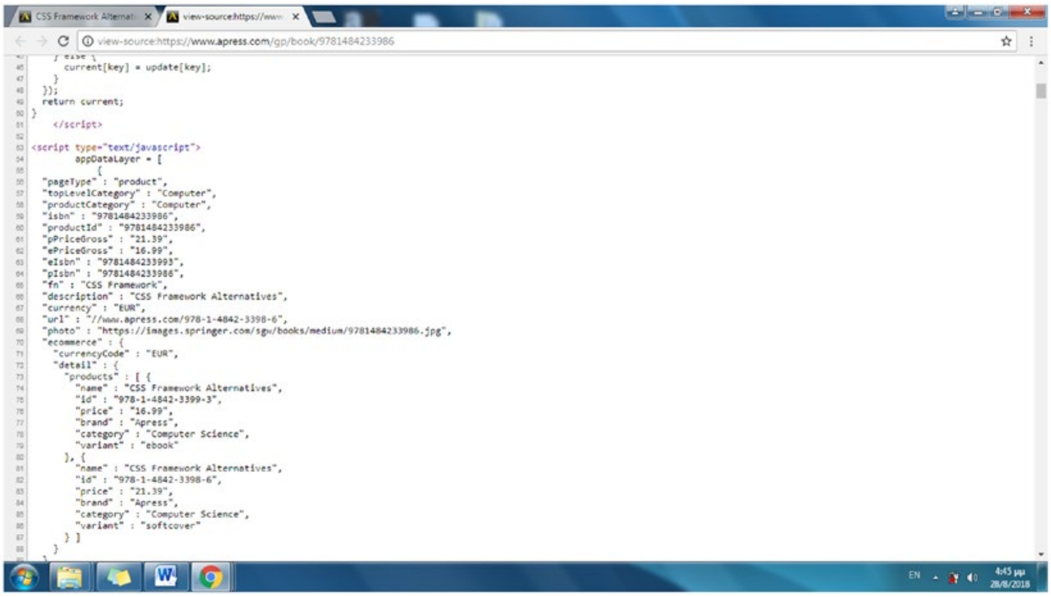
Figure 6-8. *Visiting an Apress book web page to view the HTML source code and locate the fields required for the shell script*

Right-click the web page and choose View Page Source from the pop-up menu. As shown in Figure 6-9, the web page's source code appears on a new tab in your browser.



view-source:https://www.apress.com/gp/book/9781484233986

```
    } else {
      current[key] = update[key];
    }
  });
  return current;
}
    </script>

<script type="text/javascript">
        appDataLayer = [
            {
  "pageType" : "product",
  "topLevelCategory" : "Computer",
  "productCategory" : "Computer",
  "isbn" : "9781484233986",
  "productId" : "9781484233986",
  "pPriceGross" : "21.39",
  "ePriceGross" : "16.99",
  "eIsbn" : "9781484233993",
  "pIsbn" : "9781484233986",
  "fn" : "CSS Framework",
  "description" : "CSS Framework Alternatives",
  "currency" : "EUR",
  "url" : "//www.apress.com/978-1-4842-3398-6",
  "photo" : "https://images.springer.com/sgw/books/medium/9781484233986.jpg",
  "ecommerce" : {
    "currencyCode" : "EUR",
    "detail" : {
      "products" : [ {
        "name" : "CSS Framework Alternatives",
        "id" : "978-1-4842-3399-3",
        "price" : "16.99",
        "brand" : "Apress",
        "category" : "Computer Science",
        "variant" : "ebook"
      }, {
        "name" : "CSS Framework Alternatives",
        "id" : "978-1-4842-3398-6",
        "price" : "21.39",
        "brand" : "Apress",
        "category" : "Computer Science",
        "variant" : "softcover"
      } ]
    }
```

Figure 6-9. *The HTML source code of an Apress web page for a specific book*

In the first lines of the source code, you can detect the appDataLayer struct. It looks like the following:

```
<script type="text/javascript">
        appDataLayer = [
            {
  "pageType" : "product",
  "topLevelCategory" : "Computer",
  "productCategory" : "Computer",
  "isbn" : "9781484233986",
  "productId" : "9781484233986",
  "pPriceGross" : "21.39",
  "ePriceGross" : "16.99",
  "eIsbn" : "9781484233993",
  "pIsbn" : "9781484233986",
  "fn" : "CSS Framework",
  "description" : "CSS Framework Alternatives",
  "currency" : "EUR",
  "url" : "//www.apress.com/978-1-4842-3398-6",
  "photo" : "https://images.springer.com/sgw/books/medium/9781484233986.jpg",
  "ecommerce" : {
    "currencyCode" : "EUR",
    "detail" : {
      "products" : [ {
        "name" : "CSS Framework Alternatives",
        "id" : "978-1-4842-3399-3",
        "price" : "16.99",
        "brand" : "Apress",
        "category" : "Computer Science",
        "variant" : "ebook"
      }, {
        "name" : "CSS Framework Alternatives",
        "id" : "978-1-4842-3398-6",
        "price" : "21.39",
        "brand" : "Apress",
        "category" : "Computer Science",
        "variant" : "softcover"
      } ]
    }
  },
  "content" : {
    "authorization" : {
      "status" : false
    }
  }
}
        ];
```

The data layer is a collection of information required to pass data to other systems or software. The data layer is included in the source code of the web page, and more specifically to the JavaScript source code, usually as an object or a variable and therefore is hidden from the user. The format of the data layer can be considered as variable-value pairs (for instance, variable `description` and value `CSS Framework Alternatives`).

This data layer struct, found in each product page, is the resource for the information that the web scraping script will gather. In the current example, the values of the three fields retrieved (`pPriceGross`, `fn`, and `isbn`) will be stored in a database table, which is created in the following section.

Creating the MySQL Database Used for the Web Scraping Project

To connect to the MySQL server with `mysql`, assuming that no MySQL password was set, use the following at the Linux terminal:

```
$ mysql -u root
```

The `mysql>` prompt appears to receive MySQL commands. To create a new database called `apress`, use the following command:

```
mysql> create database apress;
```

Select the specific database to apply the commands that will follow by entering the following:

```
mysql> use apress;
```

With the following command, you create a table called `book`, which has three fields.

- `isbn`, which is of type `CHAR` with a length of 13 characters
- `fn`, which is of type `VARCHAR` with a length up to 40 characters
- `pPriceGross`, of type `DECIMAL`, with four digits and two decimal places

```
mysql> create table book (isbn CHAR(13), fn VARCHAR(40), pPriceGross
DECIMAL(4,2));
```

You can view the table created previously by displaying all the database tables with the `show tables` statement.

```
mysql> show tables;
```

The command's output is as follows:

```
+------------------+
| Tables_in_apress |
+------------------+
| book             |
+------------------+
1 row in set (0.01 sec)
```

To view details about the table's format, use the following command:

```
mysql> describe book;
```

The command's output is as follows:

```
+-------------+--------------+------+-----+---------+-------+
| Field       | Type         | Null | Key | Default | Extra |
+-------------+--------------+------+-----+---------+-------+
| isbn        | char(13)     | YES  |     | NULL    |       |
| fn          | varchar(40)  | YES  |     | NULL    |       |
| pPriceGross | decimal(4,2) | YES  |     | NULL    |       |
+-------------+--------------+------+-----+---------+-------+
3 rows in set (0.00 sec)
```

In the following section, you will create a Bash shell script that runs the web scraping project to download the web content, search for the specified fields, and fill the database.

Implementing the Web Scraping Project

`shell.sh` is the shell script, implemented with the Bash scripting language, that will be used for the web scraping project. It is roughly separated into two parts. The first finds all hyperlinks included between the `<h3>` and `</h3>` tags and extracts the ISBN, e.g., 9781484233986 in this example:

```
<h3><a href="/gp/book/9781484233986" onmousedown="wt.sendinfo({linkId:
&#039;recommendation&#039;, customClickParameter : { 2 : &#039;shoppage.
recommendedproducts - 1&#039;}});" data-baynote-pid="978-1-4842-3398-6">CSS
Framework Alternatives</a></h3>
```

The ISBNs from all links are stored in the file `file.txt`. Then, in the second part of the shell code, the ISBNs are used to form the simplified product URLs like the following:

```
https://www.apress.com/gp/book/9781484233986
```

All URLs are then visited, and the `appDataLayer` array in each web page is used to provide the values for the `isbn`, `fn`, and `pPriceGross` fields. Finally, the fields are stored in a database table.

To create the file `shell.sh` in your home directory, enter the following in the Linux terminal:

```
$ cd ~
$ gedit shell.sh
```

Insert the following lines in `shell.sh`:

```
#!/bin/bash
# USAGE:
# ./shell.sh https://www.apress.com/gp/web-development apress book
pPriceGross fn isbn

# 1st PART
# store arguments in a special array
args=("$@");
# get number of elements
ELEMENTS=$#;

# connect to the URL indicated by the 2nd argument, argument $1 (the first,
$0, is the script name)
# fill file.txt with ISBNs of the books
wget -q -O - $1 | \
grep '<h3><a href="/gp/book/'  | \
sed 's:.*<a href="/gp/book/::'  | \
awk -F'"' '{print $1}' > file.txt;

# 2nd PART
# get all book urls of a web page
for line in `cat file.txt`;
do

echo -e "\n---------------------------\n";
a="https://www.apress.com/gp/book/";
b=$a$line;
echo $b;

# for the number of fields to be retrieved
for ((i=3;i<$ELEMENTS;i++)); do
output=$( \
wget -q -O - $b | \
grep -m 1 ${args[${i}]} | \
awk -F ":" '{print $2}' | \
sed 's/,//g' | \
sed 's/\"//g');
args2[${i}]=$output;
done

mysql=${args[3]};
for ((i=3+1;i<$ELEMENTS;i++)); do
sql=${args[${i}]};
mysql="$mysql, $sql";
done
echo $mysql;

mysql2="'${args2[3]}'";
mysql2="$(echo $mysql2 | sed 's/ //')";
for ((i=3+1;i<$ELEMENTS;i++)); do
sql2=${args2[${i}]};
sql2="$(echo $sql2 | sed 's/ //')";
mysql2="$mysql2, '$sql2'";
done
echo -e "$mysql2\n";

sqlstring="INSERT INTO $3 ($mysql) VALUES($mysql2);";
mysql --user="root" --database="$2" -e "$sqlstring";
echo $sqlstring;

done

echo -e "\n---------------------------\n";
rm -f file.txt;
```

To provide execute (x) file permission to yourself as the owner user (u) of the shell script so that you can execute it like any other program at the terminal, use the chmod (change mode) command. If your shell file is located in your home directory, enter the following at the Linux terminal:

```
$ sudo chmod u+x ~/shell.sh
```

The `shell.sh` script makes use of two classic but still powerful Unix tools used for text manipulation: `awk` and `sed`. It utilizes also the commands `grep` and `cat` and the `wget` program. A short intro to those commands follows:

- `awk` takes its name from the initials of its developers Aho, Weinberger, and Kernighan. It is a utility language used for data extraction from text. `awk` is often combined with `sed`, and the most common usage is to extract a column from text.
- `sed` stands for Stream Editor and is capable of receiving text and performing operations such as appending, inserting, deleting, or substituting text. The latter is one of the most commonly used operations of `sed` and is the one applied in the current example.
- `grep` is a command-line utility for searching text for lines that match a regular expression (or just a piece of text). Its name comes from the text editor command `g/re/p` that means to globally (`g`) search a regular expression (`re`) and print (`p`).
- `cat` is used to read content of files or concatenate (hence the command's name) files.
- `wget` (web get) is used to fetch content of the web servers it connects to from the command line.

The Script's First Part

The first line of `shell.sh` sets Bash as the scripting language that will be used in this shell program:

```
#!/bin/bash
```

The next lines starting with a hash (#) are just comments. The comment illustrates by example the syntax of the `shell.sh` command.

```
# USAGE:
# ./shell.sh https://www.apress.com/gp/web-development apress book
  pPriceGross fn isbn
```

Notice that the command in the previous comment is executed from the same directory where the shell script is located (`./`). When executing a Linux program, a relative or absolute directory path must be prepended, as shown here:

```
/home/christos/shell.sh https://www.apress.com/gp/web-development apress
book pPriceGross fn isbn
```

In the next section, you will enable `shell.sh` to run from any directory at the terminal with only its name provided.

The script starts with the following lines:

```
# 1st PART
# store arguments in a special array
args=("$@");
# get number of elements
ELEMENTS=$#;
```

In Bash, variable `$0` indicates the script's name, `$1` is the first argument of the command, `$2` is the second, and so on. The special variable `$@` indicates all arguments passed to the script. The arguments are stored in the `args` array with the following instruction:

```
args=("$@");
```

The `ELEMENTS` variable is assigned the number of arguments, indicated by the special variable $#:

```
ELEMENTS=$#;
```

This also could be indicated as `ELEMENTS=${#args[@]}`.

The next part of the code uses the Unix pipe (`|`) symbol to apply the Unix piping technique to a number of commands. By piping the output of the command, the left side of the symbol becomes input to the command on the right side. The backslash (`\`) is also used to indicate that the command is continued to the next line.

```
wget -q -O - $1 | \
grep '<h3><a href="/gp/book/'  | \
sed 's:.*<a href="/gp/book/::'  | \
awk -F'"' '{print $1}' > file.txt;
```

In the first command, wget runs in quiet (flag -q) mode, outputs the content retrieved to stdout (flag -O), and connects to the URL indicated with the first argument ($1) of the shell program (the URL of the category web page).

The source code of the web page downloaded with wget is passed therefore to the grep command to extract the line including the string <h3><a href="/gp/book/, the fixed part of the hyperlink inserted in the <h3> header, which is the format of the links for products included in this web page.

The previous line is passed next as input to sed. The default symbol used as a delimiter in the sed command is the forward slash (/), but since this character is included in the string, any other symbol can be used instead, for instance a colon (:). The sed substitution (s) command has, with the colon delimiter, the following syntax:

```
sed 's:text_to_be_substituted:text_that_replaces_the_original:'
```

In this example, this applies as follows:

```
sed 's:.*<a href="/gp/book/::'  | \
```

In the output provided by grep, the text <a href="/gp/book/ with zero or more characters to the left (.*) is therefore substituted with empty text. Therefore, this text is deleted. Consider, for instance, the following line with the three dots indicating extra text to the left:

```
. . .<h3><a href="/gp/book/9781484233986" onmousedown="wt.sendinfo({linkId:
&#039;recommendation&#039;, customClickParameter : { 2 : &#039;shoppage.
recommendedproducts - 1&#039;}});" data-baynote-pid="978-1-4842-3398-6">CSS
Framework Alternatives</a></h3>
```

When the previous sed command is fed this line, it outputs the following:

```
9781484233986" onmousedown="wt.sendinfo({linkId:
&#039;recommendation&#039;, customClickParameter : { 2 : &#039;shoppage.
recommendedproducts - 1&#039;}});" data-baynote-pid="978-1-4842-3398-6">CSS
Framework Alternatives</a></h3>
```

This output is then passed as input to awk, which with the -F option defines the double quotes (") that follow -F as the column separator. It then prints the first column, and the output is redirected with the greater-than symbol (>) from standard output to the file file.txt. The first column separated from the second with double quotes is the ISBN.

```
9781484233986
```

Therefore, when the script runs, `file.txt` includes a number of ISBNs, with each one placed on its own line.

The Script's Second Part

The second part of the script reads each line of `file.txt` using a `for` loop and assigns it during each iteration to the variable `line`. The variable `line` holds therefore an ISBN identifier.

```
# 2nd PART
# get all book urls of a web page
for line in `cat file.txt`;
do
```

In the `for` loop, each ISBN value is concatenated to the fixed string `https://www.apress.com/gp/book/` to form the simplified URL of the products pages. Here's an example:

`https://www.apress.com/gp/book/9781484233986`

In the following lines of the Bash code, variable `a`, which holds the fixed part of the URL, is concatenated with the variable `line`, which holds the specific ISBN to form the value of variable `b`, which is the product's URL:

```
a="https://www.apress.com/gp/book/";
b=$a$line;
echo $b;
```

Notice that the value of `b` is output to the terminal with the `echo` Bash command. The `echo` commands in the program are used to display the connections performed by the shell script while the script runs.

The code snippet that follows uses a `for` loop to make one iteration for any field entered as a shell argument:

```
for ((i=3;i<$ELEMENTS;i++)); do

output=$( \
wget -q -O - $b | \
grep -m 1 ${args[${i}]} | \
awk -F ":" '{print $2}' | \
sed 's/,//g' | \
sed 's/\"//g');

args2[${i}]=$output;

done
```

Consider, for instance, the case that the `shell.sh` runs with the following command:

```
# ./shell.sh https://www.apress.com/gp/web-development apress book
  pPriceGross fn isbn
```

In this case, the number of fields to be filled in the database is three (pPriceGross, fn, and `isbn`), and the loop iterates three times. The loop starts from number 3 because array `args[]` includes the following elements for the current example:

```
args[0] : https://www.apress.com/gp/web-development
args[1] : apress
args[2] : book
args[3] : pPriceGross
args[4] : fn
args[5] : isbn
```

For each field (arguments 3 to 5), a `wget` connection is created to the product's URL, and the source code of the web page fetched is searched with `grep` for the specific field (e.g., `pPriceGross`). The lines returned by `grep` are passed next to `awk`, which uses a colon (:) as the delimiter symbol to print the second column. Recall that the fields are found in the `appDataLayer[]` array of each page, which has the following format:

```
<script type="text/javascript">
        appDataLayer = [
            {
  "pageType" : "product",
  "topLevelCategory" : "Computer",
  "productCategory" : "Computer",
  "isbn" : "9781484233986",
  "productId" : "9781484233986",
  "pPriceGross" : "21.39",
  "ePriceGross" : "16.99",
  "eIsbn" : "9781484233993",
  "pIsbn" : "9781484233986",
  "fn" : "CSS Framework",
  . . .
```

The second column therefore consists of the values of the fields, with the field names consisting of the first column and with the two columns separated by colons. The values are included in double quotes and are suffixed with commas. For instance, when `grep` searches for the field `fn`, the second column of the line returned is as follows:

```
"CSS Framework",
```

The following two `sed` commands strip off the double quotes and the commas:

```
sed 's/,//g' | \
sed 's/\"//g');
```

The output is assigned to variable `output`. In this example, this is as follows:

```
CSS Framework
```

The value of `output` fills the corresponding element of a new array called `args2[]`.

```
args2[${i}]=$output;
```

Therefore, if `args[4]` currently has the value `fn`, `args2[4]` has the value of the field `fn`, in this example `CSS Framework`.

For each line of `file.txt`, the `args2[3]`, `args2[4]`, and `args2[5]` elements are filled.

The following code snippet concatenates the `args[]` elements with the field names `args[3]`, `args[4]`, and `args[5]` using commas:

```
mysql=${args[3]};
for ((i=3+1;i<$ELEMENTS;i++)); do
sql=${args[${i}]};
mysql="$mysql, $sql";
done
```

`shell.sh` was used here with three fields, but it works equally for any number of fields. For example, if four fields were used, the previous code snippet would concatenate the elements `args[3]`, `args[4]`, `args[5]`, and `args[6]` (the new field) using commas.

The code runs recursively and assigns the first field name to variable mysql, finds the next and concatenates the two fields with commas as mysql again, and repeats until all fields are included.

For the current example, the elements are pPriceGross, fn, and isbn. The variable mysql after the concatenation has the following value:

```
pPriceGross, fn, isbn
```

This string will be used to form the sqlstring, the 'INSERT INTO' SQL command, that will be used on the MySQL server to insert the data into the database's book table. An example of sqlstring is as follows:

```
INSERT INTO book (pPriceGross, fn, isbn) VALUES('35.3', 'Mastering Zoho
Creator', '9781484229064');
```

To form the values part of the fields for the sqlstring, the values of the fields, previously placed in args2[3], args2[4], and args2[5] elements, must be enclosed in single quotes and be separated by commas. Here's an example:

```
'35.3', 'Mastering Zoho Creator', '9781484229064'
```

The following code snippet does this:

```
mysql2="'${args2[3]}'";
mysql2="$(echo $mysql2 | sed 's/ //')";
for ((i=3+1;i<$ELEMENTS;i++)); do
sql2=${args2[${i}]};
sql2="$(echo $sql2 | sed 's/ //')";
mysql2="$mysql2, '$sql2'";
done
```

In the previous source code, mysql2 forms the string of all field values separated by commas with a recursive process. The reason the spaces need to be removed from the mysql2 and sql2 variables is that Bash currently prepends a space character to elements, which are read using a for loop from an array.

With the following code line, the MySQL query string, held in variable sqlstring, is finally formed:

```
sqlstring="INSERT INTO $3 ($mysql) VALUES($mysql2);";
```

For instance, the `sqlstring` may hold this value:

```
INSERT INTO book (pPriceGross, fn, isbn) VALUES('35.3', 'Mastering Zoho
Creator', '9781484229064');
```

For this example, statement `INSERT INTO` inserts a record into the book table by entering value `35.3` in the `pPriceGross` field, value `Mastering Zoho Creator` in the `fn` field, and value `9781484229064` in the `isbn` field.

To issue the previous command, a connection is created with the `mysql` server. The value `root` is provided to the argument `--user`, and the value `apress` (the value of variable `$2`) is provided as the `--database` argument. The execution command (`-e`) is the value of the `sqlstring`.

```
mysql --user="root" --database="$2" -e "$sqlstring";
```

The previous command runs a number of times equal to the number of books included in the web page source of the URL provided as the first argument of the shell (`$1`).

The text file used in this shell program is deleted at the end of the script.

```
rm -f file.txt;
```

Testing the Web Scraping Shell Program

After creating the `shell.sh` script and the book table in the `apress` database, you can use your web scraping shell script to complete the table. At the Linux terminal, change the working directory to the one that includes the shell script, in this example the home directory, and enter the `shell.sh` command with the required arguments.

```
$ cd ~
$ ./shell.sh https://www.apress.com/gp/web-development apress book
pPriceGross fn isbn
```

Hint! To run the shell script from any working directory, copy the `shell.sh` file to `/usr/local/bin`.

```
$ sudo cp ~/shell.sh /usr/local/sbin
```

Execute it then from any working directory as follows:

```
$ sudo shell.sh https://www.apress.com/gp/web-development
apress book pPriceGross fn isbn
```

In `shell.sh`, all programs run in silent mode; therefore, the only messages printed to the output are the echo command messages printed at the terminal. The message displayed in each iteration has the following format:

```
---------------------------


https://www.apress.com/gp/book/9781484237144
pPriceGross, fn, isbn
'35.3', 'RESTAPI Development with Node.js', '9781484237144'

INSERT INTO book (pPriceGross, fn, isbn) VALUES('35.3', 'RESTAPI
Development with Node.js', '9781484237144');


---------------------------
```

When the `shell.sh` script ends, open the `apress` database and print the book table contents. Use Ctrl+Alt+T to open a second terminal window. At the command line, enter the following:

```
$ mysql -u root
```

The MySQL server connects, and the `mysql>` prompt appears.

Enter the following commands to select the `apress` database and also view all the records of the table book.

```
mysql>use apress;

mysql>select * from book;
```

The following is the output of the select command:

```
+---------------+-----------------------------------+-------------+
| isbn          | fn                                | pPriceGross |
+---------------+-----------------------------------+-------------+
| 9781484233986 | CSSFramework                      |       21.39 |
| 9781484232514 | IntroducingJavaScript Game        |       26.74 |
| 9781484230923 | Beginning                         |       32.09 |
| 9781484232781 | Angular5                          |       39.58 |
| 9781484232156 | LeanGame Development              |       26.74 |
| 9781484232668 | Discussionsin User Experience     |       29.95 |
| 9781484232811 | IntroducingArcGIS API 4 for       |       32.09 |
| 9781484230268 | Beginning                         |       37.44 |
| 9781484229361 | TheDefinitive Guide to            |       40.65 |
| 9781484228258 | Electron                          |       37.44 |
| 9781484239216 | UsingYour Web Skills To Make      |       26.74 |
| 9781484238639 | HTML5and JavaScript               |       40.65 |
| 9781484226094 | WebApplications with              |       24.60 |
| 9781484210741 | Scalability                       |       24.56 |
| 9781484237144 | RESTAPI Development with Node.js |       35.30 |
| 9781484238639 | HTML5and JavaScript               |       40.65 |
| 9781484236963 | Programming                       |       35.30 |
+---------------+-----------------------------------+-------------+
17 rows in set (0.00 sec)
```

Run the script a second time, using another URL from the ones included in the Categories link of the www.apress.com home page. For instance, use the following:

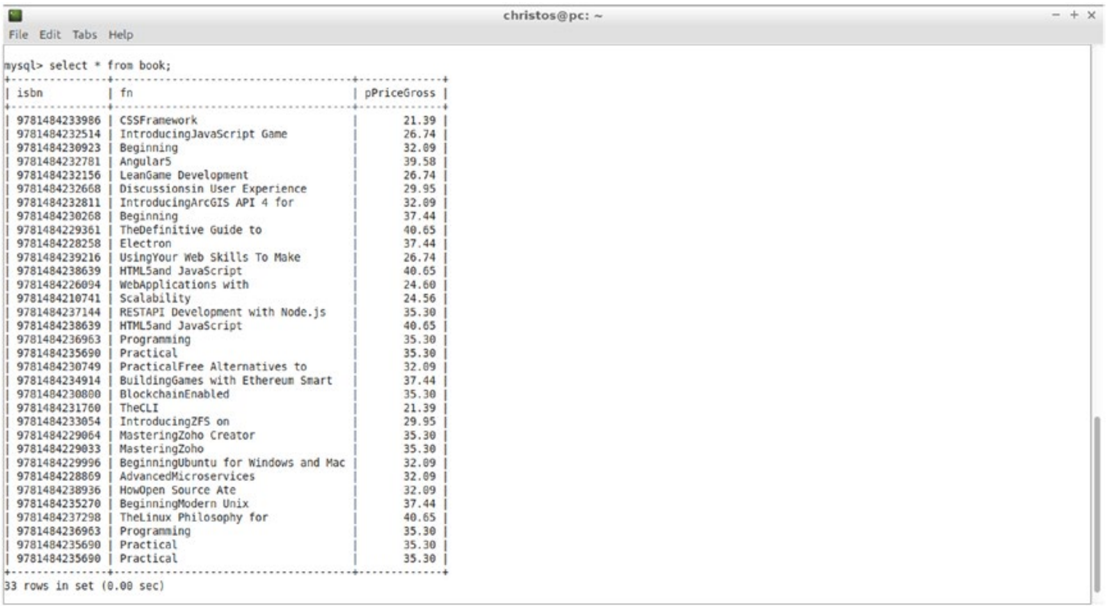
```
$ ./shell.sh https://www.apress.com/gp/open-source apress book pPriceGross
fn isbn
```

At the second terminal, enter again the last used command.

```
mysql>select * from book;
```

As indicated by the following output, more records are added to the database table (see Figure 6-10):

```
+---------------+-------------------------------------+-------------+
| isbn          | fn                                  | pPriceGross |
+---------------+-------------------------------------+-------------+
| 9781484233986 | CSSFramework                        |       21.39 |
| 9781484232514 | IntroducingJavaScript Game          |       26.74 |
| 9781484230923 | Beginning                           |       32.09 |
| 9781484232781 | Angular5                            |       39.58 |
| 9781484232156 | LeanGame Development                |       26.74 |
| 9781484232668 | Discussionsin User Experience       |       29.95 |
| 9781484232811 | IntroducingArcGIS API 4 for         |       32.09 |
| 9781484230268 | Beginning                           |       37.44 |
| 9781484229361 | TheDefinitive Guide to              |       40.65 |
| 9781484228258 | Electron                            |       37.44 |
| 9781484239216 | UsingYour Web Skills To Make        |       26.74 |
| 9781484238639 | HTML5and JavaScript                 |       40.65 |
| 9781484226094 | WebApplications with                |       24.60 |
| 9781484210741 | Scalability                         |       24.56 |
| 9781484237144 | RESTAPI Development with Node.js    |       35.30 |
| 9781484238639 | HTML5and JavaScript                 |       40.65 |
| 9781484236963 | Programming                         |       35.30 |
| 9781484235690 | Practical                           |       35.30 |
| 9781484230749 | PracticalFree Alternatives to       |       32.09 |
| 9781484234914 | BuildingGames with Ethereum Smart   |       37.44 |
| 9781484230800 | BlockchainEnabled                   |       35.30 |
| 9781484231760 | TheCLI                              |       21.39 |
| 9781484233054 | IntroducingZFS on                   |       29.95 |
| 9781484229064 | MasteringZoho Creator               |       35.30 |
| 9781484229033 | MasteringZoho                       |       35.30 |
| 9781484229996 | BeginningUbuntu for Windows and Mac |       32.09 |
| 9781484228869 | AdvancedMicroservices               |       32.09 |
| 9781484238936 | HowOpen Source Ate                  |       32.09 |
| 9781484235270 | BeginningModern Unix                |       37.44 |
| 9781484237298 | TheLinux Philosophy for                 |      40.65 |
| 9781484236963 | Programming                             |      35.30 |
| 9781484235690 | Practical                               |      35.30 |
| 9781484235690 | Practical                               |      35.30 |
+---------------+-----------------------------------------+------------+
33 rows in set (0.01 sec)
```



```
mysql> select * from book;
+---------------+-----------------------------------------+------------+
| isbn          | fn                                      | pPriceGross |
+---------------+-----------------------------------------+------------+
| 9781484233986 | CSSFramework                            |      21.39 |
| 9781484232514 | IntroducingJavaScript Game              |      26.74 |
| 9781484230923 | Beginning                               |      32.09 |
| 9781484232781 | Angular5                                |      39.58 |
| 9781484232156 | LeanGame Development                    |      26.74 |
| 9781484232668 | Discussionsin User Experience           |      29.95 |
| 9781484232811 | IntroducingArcGIS API 4 for             |      32.09 |
| 9781484230268 | Beginning                               |      37.44 |
| 9781484229361 | TheDefinitive Guide to                  |      40.65 |
| 9781484228258 | Electron                                |      37.44 |
| 9781484239216 | UsingYour Web Skills To Make            |      26.74 |
| 9781484238639 | HTML5and JavaScript                     |      40.65 |
| 9781484226094 | WebApplications with                    |      24.60 |
| 9781484210741 | Scalability                             |      24.56 |
| 9781484237144 | RESTAPI Development with Node.js        |      35.30 |
| 9781484238639 | HTML5and JavaScript                     |      40.65 |
| 9781484236963 | Programming                             |      35.30 |
| 9781484235690 | Practical                               |      35.30 |
| 9781484230749 | PracticalFree Alternatives to           |      32.09 |
| 9781484234914 | BuildingGames with Ethereum Smart       |      37.44 |
| 9781484230800 | BlockchainEnabled                       |      35.30 |
| 9781484231760 | TheCLI                                  |      21.39 |
| 9781484233054 | IntroducingZFS on                       |      29.95 |
| 9781484229064 | MasteringZoho Creator                   |      35.30 |
| 9781484229033 | MasteringZoho                           |      35.30 |
| 9781484229996 | BeginningUbuntu for Windows and Mac     |      32.09 |
| 9781484228869 | AdvancedMicroservices                   |      32.09 |
| 9781484238936 | HowOpen Source Ate                      |      32.09 |
| 9781484235270 | BeginningModern Unix                    |      37.44 |
| 9781484237298 | TheLinux Philosophy for                 |      40.65 |
| 9781484236963 | Programming                             |      35.30 |
| 9781484235690 | Practical                               |      35.30 |
| 9781484235690 | Practical                               |      35.30 |
+---------------+-----------------------------------------+------------+
33 rows in set (0.00 sec)
```

Figure 6-10. *The output*

You can add even more records by using the rest of the Categories menu links.

Summary

In this chapter, you used the MySQL server to create, manage, and query databases using SQL commands. You inserted records into the database tables manually and also used the web scraping technique to fill the database automatically by collecting data provided by a site.

In the following chapter, you will run PHP programs that connect to the MySQL server, enabling the web server to provide a search capability and therefore offer dynamic web content to its sites.

CHAPTER 7

Creating a Dynamic Content Web Site

In this chapter, you'll create a site that provides a form for the user to submit keywords to the web server, query a database, and view the results. The results page will list hyperlinks that lead to web pages related to the keywords entered.

To do this, you will utilize the PHP language to make the connection to the MySQL server via the MySQL-PHP interface routines.

Instead of having the query results appear on a single page, you'll implement pagination to group the results on separate web pages, with images (buttons) used to switch back or forth from one web page to another.

Also, you'll implement an automated procedure, based on the `cron` daemon, that executes scheduled commands to update the MySQL database with the contents of the web pages included in the site.

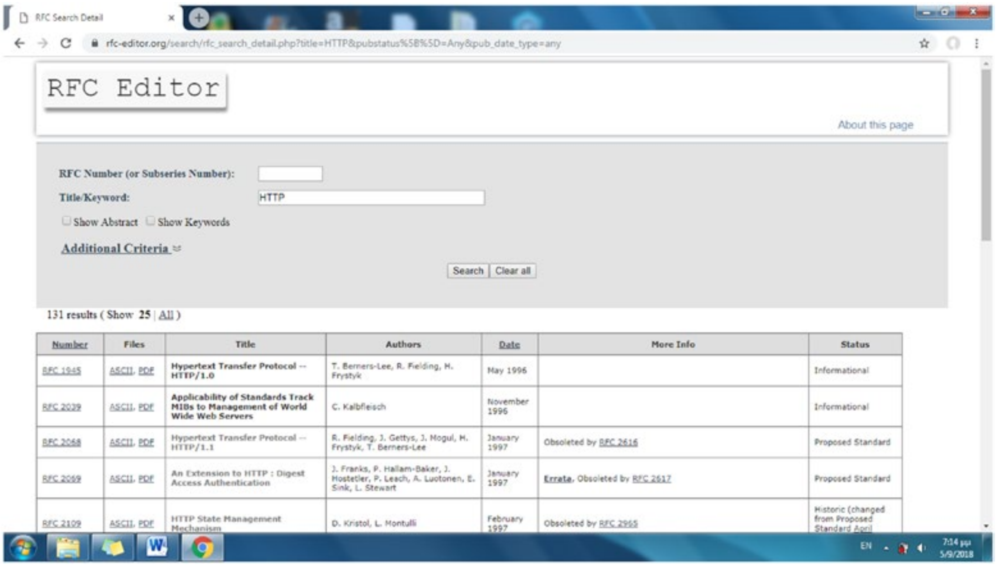
Search-Enabled Site Overview

As discussed, in this project you'll create a search-enabled site. Allowing a user to perform queries remotely in a web environment is a feature commonly found on e-commerce sites, search engines, wikis, and online academic databases. You will create next a site that provides similar services as the `rfc-editor.org` site and also you can borrow RFCs for your site's content. Requests for Comments (RFCs) are the content offered from this site that the user will query. (RFCs are papers describing Internet protocols and technologies.)

The following is the URL to search RFCs at `rfc-editor.org`:

```
https://www.rfc-editor.org/search/rfc_search.php
```

Figure 7-1 displays results for using the *HTTP* keyword in the RFC Editor. The results are links that lead to the corresponding RFCs. Pagination is also implemented to group them into 25 results per web page.


RFC Search Detail
rfc-editor.org/search/rfc_search_detail.php?title=HTTP&pubstatus%5B%5D=Any&pub_date_type=any
RFC Editor
About this page
Additional Criteria
Search
Clear all

RFC Number (or Subseries Number):

Title/Keyword: HTTP

Show Abstract Show Keywords

131 results (Show 25 | All)

Number	Files	Title	Authors	Date	More Info	Status
RFC 1945	ASCII, PDF	**Hypertext Transfer Protocol -- HTTP/1.0**	T. Berners-Lee, R. Fielding, H. Frystyk	May 1996		Informational
RFC 2039	ASCII, PDF	**Applicability of Standards Track MIBs to Management of World Wide Web Servers**	C. Kalbfleisch	November 1996		Informational
RFC 2068	ASCII, PDF	Hypertext Transfer Protocol -- HTTP/1.1	R. Fielding, J. Gettys, J. Mogul, H. Frystyk, T. Berners-Lee	January 1997	Obsoleted by RFC 2616	Proposed Standard
RFC 2069	ASCII, PDF	An Extension to HTTP : Digest Access Authentication	J. Franks, P. Hallam-Baker, J. Hostetler, P. Leach, A. Luotonen, E. Sink, L. Stewart	January 1997	Errata, Obsoleted by RFC 2617	Proposed Standard
RFC 2109	ASCII, PDF	HTTP State Management Mechanism	D. Kristol, L. Montulli	February 1997	Obsoleted by RFC 2965	Historic (changed from Proposed Standard April

Figure 7-1. *Querying the RFC Editor for HTTP*

Figure 7-2 displays the home page of the project's site.

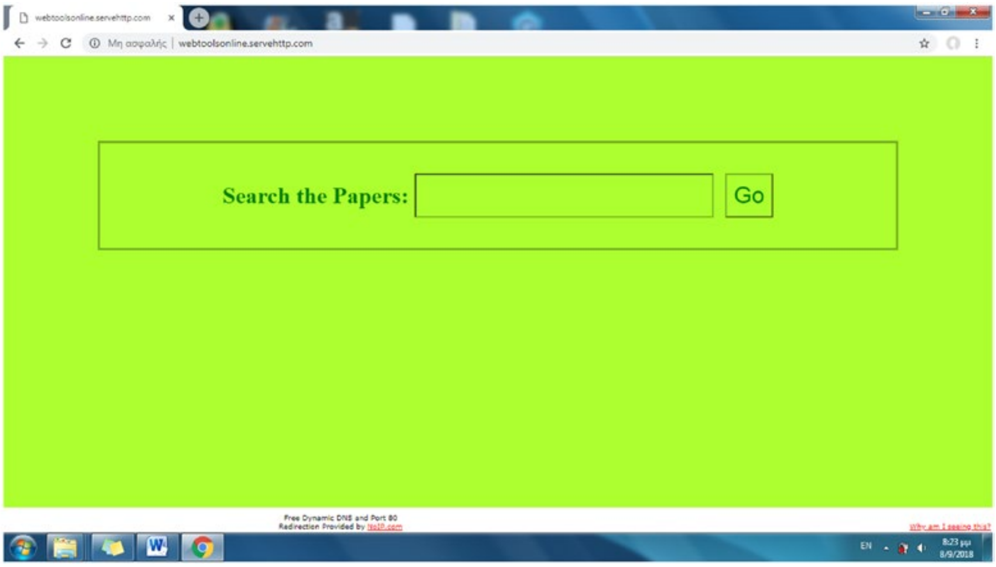
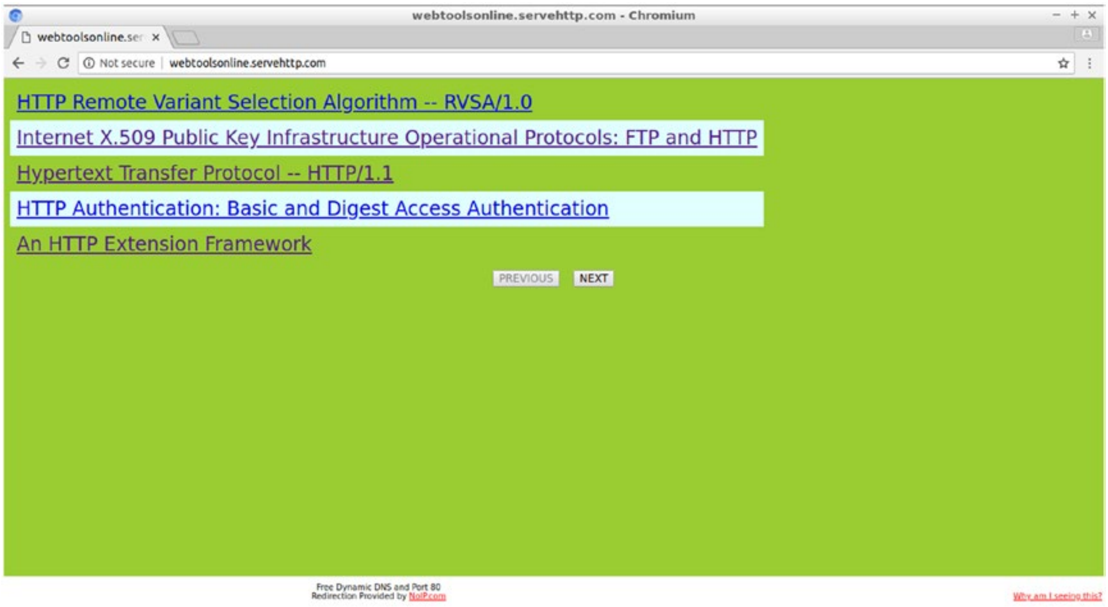

webtoolsonline.servehttp.com
Μη ασφαλής | webtoolsonline.servehttp.com
Search the Papers:
Go
Free Dynamic DNS and Port 80 Redirection Provided by No-IP.com
Why am I seeing this?

Figure 7-2. *The home page of the project's site*

As displayed in Figure 7-3, the results appear as links to RFCs, and pagination is used to show five results per page.


webtoolsonline.servehttp.com - Chromium
webtoolsonline.ser
Not secure
webtoolsonline.servehttp.com
PREVIOUS
NEXT
Free Dynamic DNS and Port 80
Redirection Provided by NoIP.com
Why am I seeing this?

HTTP Remote Variant Selection Algorithm -- RVSA/1.0
Internet X.509 Public Key Infrastructure Operational Protocols: FTP and HTTP
Hypertext Transfer Protocol -- HTTP/1.1
HTTP Authentication: Basic and Digest Access Authentication
An HTTP Extension Framework

Figure 7-3. *The results of querying the project's site for HTTP*

Designing the Project

The site you'll implement requires a number of web pages that will be the content that the site offers; these pages are placed in a separate directory called `info` in this example. A Bash shell script running in regular intervals from `cron` will update a database with all the web page files currently included in the directory `info`. The title included in each "content" web page is what the user will remotely query in the database. The query will be issued from the home page where the user will enter keywords in an HTML form. A PHP program, after receiving the keywords, will connect to and query the database and return the results as links, with the title as the link text and the relative URL of the content web page file as the link's URL.

Creating the First Web Content Samples

You can place this project's content web pages in the new directory in the document root so that they are isolated from the directory index that provides the form and the action PHP program that processes the keywords. In this way, only the content web pages will be automatically inserted into the database. To create a new directory named `info`, enter the following command at the Linux terminal:

```
$ sudo mkdir /var/www/html/info
```

To create the first web page of this site, continue with the following commands:

```
$ cd info
$ sudo gedit page1.html
```

Enter the following HTML source code:

```
<!DOCTYPE html>
<html>
<head>
<title></title>
</head>
<body>
<h1>Hypertext Markup Language - 2.0</h1>
</body>
</html>
```

This is an empty web page that includes a heading (`<h1>`) that is the RFC's title. The heading size here must be the same that the Bash shell will use for locating the title of each content web page. You can borrow the titles from the previous RFC Editor search. You can also enter some content in the body section of your page, which for simplicity is empty here other than the heading. What is required for this project is to create a large number of similar web pages with different titles to display how pagination is implemented. For the moment, just create a second content web page by using the following at the Linux terminal:

```
$ sudo cp page1.html page2.html
$ sudo gedit page2.html
```

In the gedit window, change the title to another one from the RFC Editor and save the file. Use, for instance, the title `Form-based File Upload in HTML` in the `h1` element.

```
<!DOCTYPE html>
<html>
<head>
<title></title>
</head>
<body>
<h1>Form-based File Upload in HTML</h1>
</body>
</html>
```

You can continue this process to create lots of web pages for the site. The aim is to have many pages so that you can have a lot of query results.

Creating and Updating the Project's Database

Next, you will create the database that includes all the titles of the content web pages placed in the `info` directory. As described in the following section, the database update will be an automated process.

To create `info`, the database used in this project, and also `content`, the table included in the `info` database, connect to the MySQL server with `mysql`, the MySQL client, using the following command:

```
$ mysql -u root
```

At the `mysql>` prompt that appears, create the `info` database.

```
mysql> create database info;
```

The MySQL server responds with an OK command.

```
Query OK, 1 row affected (0.00 sec)
```

The database is included with the other databases of the MySQL server. You can view this with the following command:

```
 mysql> show databases;
```

The MySQL server responds with the following table, with the names of all the databases included so far:

```
+--------------------+
| Database           |
+--------------------+
| information_schema |
| apress             |
| info               |
| library            |
| mysql              |
| performance_schema |
| sys                |
+--------------------+
7 rows in set (0.00 sec)
```

You can locate database `info` and database `apress`, used in the previous chapter, as well as all the preexisting MySQL databases. Select `info` as the database that the commands entered from this point on will target.

```
mysql> use info;
```

The MySQL server responds with the following message:

```
Database changed
```

Create a table called `content`. This table will include two columns: `url`, which is a `varchar` up to 255 characters, and `title`, which also is type `varchar`. The `url` column will store the root-relative URL path of a specific web page. For instance, the URL for `page1.html` will be `/info/page1.html`, where the first slash is the document root. The column `url` is a nice candidate for a primary key because it includes unique values; no files are allowed by the operating system to have the same name in the same directory. The `title` column corresponds to the title of the web page, included in the `<h1>` tags. For instance, for `page1.html`, the title is `Hypertext Markup Language - 2.0`. To create the table content, use the `create table` SQL statement.

```
mysql> create table content (url varchar(255), primary key(url), title
varchar(255));
```

The MySQL server responds with an OK message.

```
Query OK, 0 rows affected (0.40 sec)
```

You don't have to manually enter any records because, as explained previously, this will be an automated process. Exit the MySQL client using the following command:

```
mysql> exit
```

MySQL responds with a good-bye message.

```
Bye
```

Writing the Shell Script That Updates the Database

Who will be responsible for updating the database so that each time a new web page is added to the site its title is included in the database? For this, many approaches can be used. For instance, it could be the responsibility of the person who places a new web page in the `info` directory to open MySQL and use an `insert into` command to store the title of the new page in the database. This sounds like it creates a little overhead, and if a person forgets to do this every time they add a page, the system will lose its reliability. Another approach is to create a shell script that hides the overhead from the administrator; however, forgetting to run the script would result in the same problem of unreliability. Another solution would be to automate the process and have the script run at regular intervals to update the database. Because this approach doesn't require anyone to intervene, it is less error prone.

To create `db.sh`, the Bash shell script that updates the database, change the working directory to your home directory, e.g., `/home/christos/`, with the following command:

```
$ cd ~
```

Use a text editor like gedit to create a file called `db.sh`.

```
$ gedit db.sh
```

In the new window that appears, enter the following lines of Bash code and save the file:

```
#!/bin/bash

FILES=/var/www/html/info/*

      db="info";
      table="content";
      sqlstring="truncate table $table;";
      mysql --user="root" --database="$db" -e "$sqlstring";

for file in $FILES
do
      title=`grep -o '<h1>.*</h1>' $file | sed 's/\(<h1>\|<\/h1>\)//g'`;
     filename=$(basename "$file");
      path="/info/";
      url=$path$filename;
      records="url, title";
      my_values="'$url', '$title'";
      sqlstring="insert into $table ($records) values($my_values);";
      mysql --user="root" --database="$db" -e "$sqlstring";
done
```

The first line is a directive stating that the Bash language will be used for this script. Next comes a number of variable definitions. For instance, `FILES` means all (*) files found in `/var/www/html/info`. The variable `db` is assigned to `info`, which is the name of the database in this example. Also, `table`, the variable that holds the name of the database's tables, is assigned to the value `content`. The variable `sqlstring` temporarily holds the value:

```
"truncate table $table;"
```

That evaluates to the following string:

```
"truncate table content;"
```

One approach for the script is to enter only the titles of the HTML files that are not already included in the table. However, if the title of a specific file changes, the database will still include the previous one. The other approach is to delete all the database entries and add all the titles from HTML files located in `info` to the database. This script implements the second approach, and for this, the `truncate table` SQL statement is used to remove all the records from a table.

The `db.sh` script will run either manually, invoked by the user, or automatically in predefined time intervals. Each time the script runs, it truncates the table and then inserts the titles and file paths of the HTML files in the `info` directory.

The following is the command used by the shell script to connect to the MySQL server:

```
mysql --user="root" --database="$db" -e "$sqlstring";
```

It evaluates to the following command:

```
mysql --user="root" --database="info" -e "truncate table content;";
```

Hint! This is a command run from inside a shell program, but you can run this as a single command from the Linux terminal. After all, a shell program is a collection of shell commands.

After all the records in the table are deleted, you can use a `for` loop to insert the title and root-relative path of each HTML file in the `info` directory to the `info` database. The loop is included between the `do...done` commands.

```
for file in $FILES
do
...
done
```

For each file in the directory `info`, the line that includes the `h1` element—whose text is the web page's title—is extracted with `grep`:

```
title=`grep -o '<h1>.*</h1>' $file | sed 's/\(<h1>\|<\/h1>\)//g'`;
```

By using the Unix pipe operator (`|`), the line output by `grep` is passed as input to `sed`. Then `sed` removes the start and end tags of the `h1` element by replacing them with an empty character. The `sed` output, which is the title of the HTML page, is assigned as a value to the variable `title`.

The web page file name is returned to the variable `filename` when the command `basename` runs.

```
    filename=$(basename "$file");
```

The file name is then concatenated to string `/info/` to form `url`, the root-relative path.

```
path="/info/";
url=$path$filename;
```

For instance, for the file name `page1.html`, the path becomes `/info/page1.html`.

The `title` and `url` values (e.g., `info/page1.html` and `Hypertext Markup Language - 2.0`) will be entered in the corresponding table columns (`url`, `title`) with the `sqlstring`, which forms the SQL `insert` command.

```
records="url, title";
my_values="'$url', '$title'";
sqlstring="insert into $table ($records) values($my_values);";
```

The next command uses the `mysql` client to connect to the MySQL server and submit the command included in `sqlstring`, shown here:

```
mysql --user="root" --database="$db" -e "$sqlstring";
```

The following is an example of the command sent to the server after evaluating the variables:

```
mysql --user="root" --database="info" -e "insert into content (url, title)
values('/info/page1.html', 'Hypertext Markup Language - 2.0');";
```

To run the shell script, you need to grant executable (`x`) file permission at least to yourself, that is, to the user (`u`). The other options are to grant this right to your group (`g`) and all others (`o`). Use the `chmod` command from your home directory as follows:

```
$ chmod u+x db.sh
```

Run manually the shell script from your home directory as follows:

```
$ ./db.sh
```

The period before the slash denotes the current directory. This is used because when running executable Linux files, their relevant or absolute path needs to be provided except if the script is stored on one of the directories assigned to the `PATH` environment variable. To view the directories included in the `PATH` list, use the following:

```
$ echo $PATH
```

Next, connect to the info database to view the contents of the table called content. Use the command:

```
$ mysql -u root
```

The MySQL client waits for the next command with the mysql> prompt. Select the database to work with.

```
mysql> use info;
```

Read all the records of the table content.

```
mysql> select * from content;
```

After using this command, the MySQL server responds by outputting the following table (given that so far you have created two web pages in the directory info: page1.html and page2.html):

```
+------------------+----------------------------------+
| url              | title                            |
+------------------+----------------------------------+
| /info/page1.html | Hypertext Markup Language - 2.0 |
| /info/page2.html | Form-based File Upload in HTML  |
+------------------+----------------------------------+
2 rows in set (0.00 sec)
```

Close the database with the exit command.

```
mysql> exit
```

The MySQL server responds with a good-bye message.

```
Bye
```

Automating the Database Updates with cron

To schedule db.sh to execute automatically, use Linux cron to schedule tasks. This daemon process checks a crontab (cron table) file containing instructions for cron to execute. cron as a daemon process runs in the background and executes commands at specific dates and times; for instance, it can be used hourly to take backups from a database.

The crontab command opens the crontab for editing and lets you add, remove, or modify scheduled tasks. Before using crontab, you may want to select the text editor to work with. For instance, to use gedit, enter the following at the Linux terminal:

```
$ export VISUAL=gedit
```

Run the command crontab as follows:

```
$ crontab -e
```

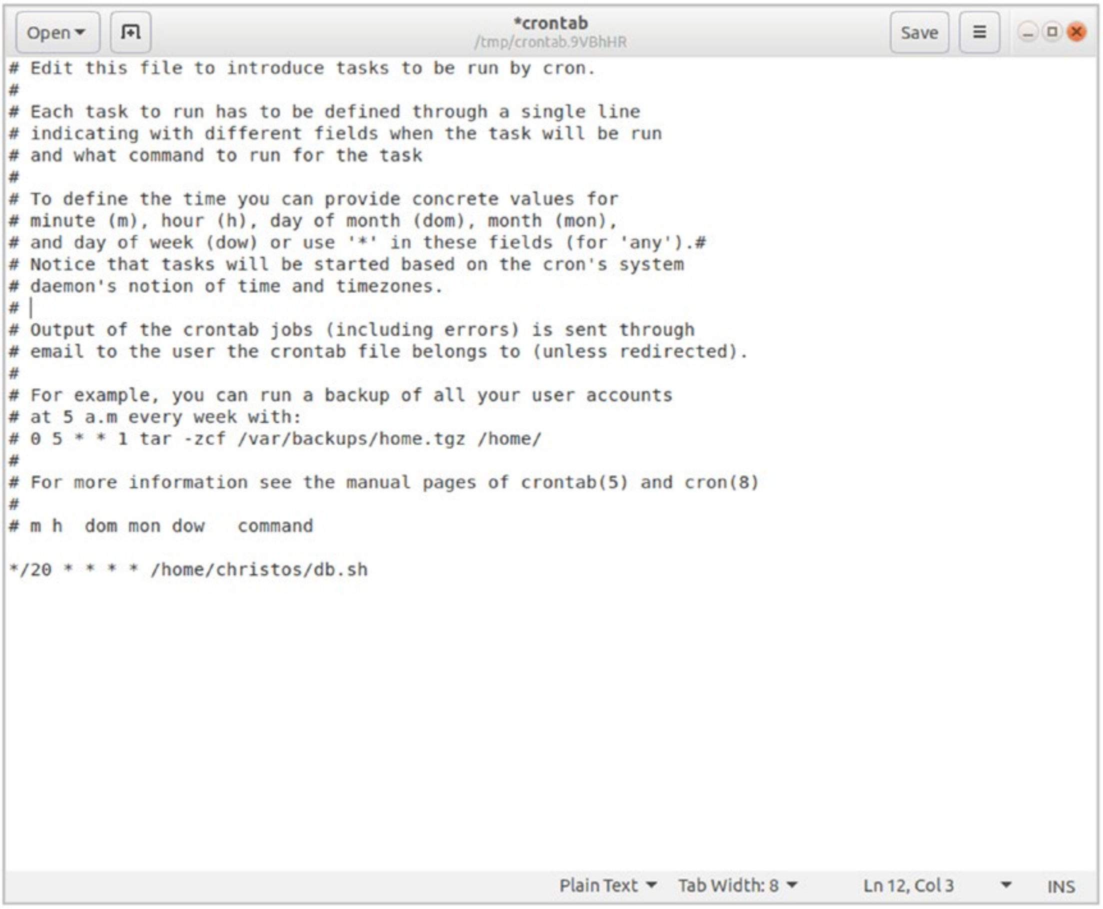
As shown in Figure 7-4, crontab opens in the gedit environment. Enter the following entry:

```
*/20 * * * * /home/christos/db.sh
```

Each crontab entry consists of six fields, specified in the following order:

```
minute(s) hour(s) day(s) month(s) weekday(s) command(s)
```

An asterisk (*) indicates “every,” a forward slash (/) means repeat at a specific interval, and a hyphen (-) indicates a range. Therefore, the previous entry indicates the following: “Execute /home/christos/db.sh every 20 minutes (*/20), every hour, every day, every month, every weekday.”



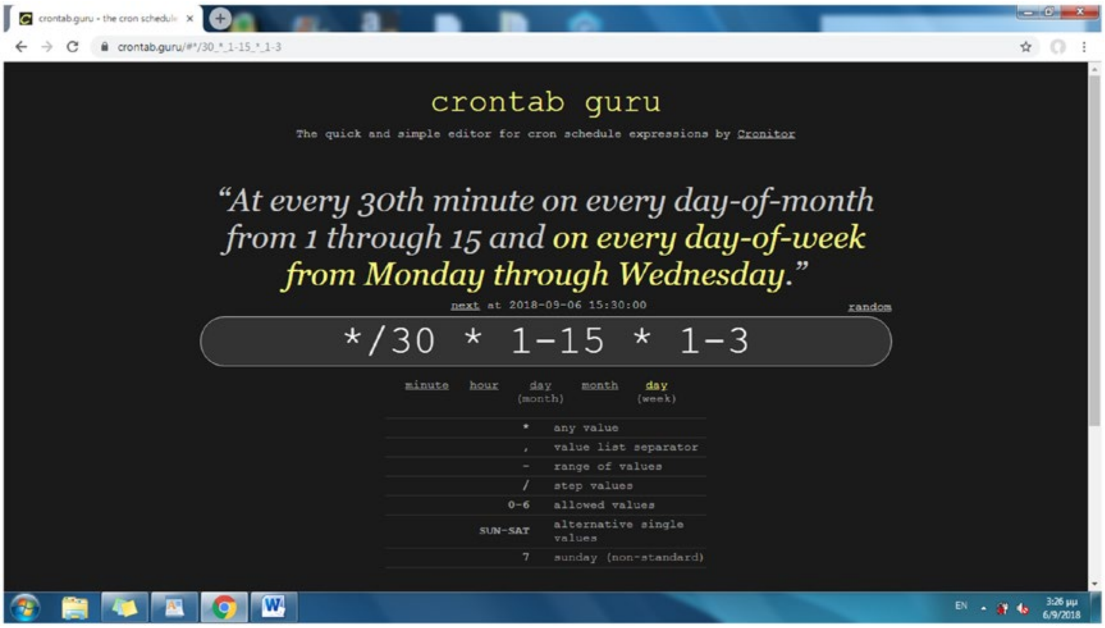
```
# Edit this file to introduce tasks to be run by cron.
#
# Each task to run has to be defined through a single line
# indicating with different fields when the task will be run
# and what command to run for the task
#
# To define the time you can provide concrete values for
# minute (m), hour (h), day of month (dom), month (mon),
# and day of week (dow) or use '*' in these fields (for 'any').#
# Notice that tasks will be started based on the cron's system
# daemon's notion of time and timezones.
#
# Output of the crontab jobs (including errors) is sent through
# email to the user the crontab file belongs to (unless redirected).
#
# For example, you can run a backup of all your user accounts
# at 5 a.m every week with:
# 0 5 * * 1 tar -zcf /var/backups/home.tgz /home/
#
# For more information see the manual pages of crontab(5) and cron(8)
#
# m h  dom mon dow   command

*/20 * * * * /home/christos/db.sh
```

Figure 7-4. *The crontab entry used in the example*

Hint! To experiment with the syntax, use the URL `https://crontab.guru/` in the address bar of your browser.

This site, displayed in Figure 7-5, provides a textbox to insert a `crontab` entry and get a description, based on the entry, about how often a specific job will be run.



crontab guru

The quick and simple editor for cron schedule expressions by Cronitor

"At every 30th minute on every day-of-month from 1 through 15 and on every day-of-week from Monday through Wednesday."

next at 2018-09-06 15:30:00 random

```
*/30 * 1-15 * 1-3
```

minute hour day (month) month day (week)

*	any value
,	value list separator
-	range of values
/	step values
0-6	allowed values
SUN-SAT	alternative single values
7	sunday (non-standard)

crontab.guru - the cron schedule
crontab.guru/#*/30_*_1-15_*_1-3
EN
3:26 μμ
6/9/2018

***Figure 7-5.** The crontab test page from crontab.guru*

Do not click the Save button yet in the gedit window.

To test `crontab`, press Ctrl+Alt+T to open a new terminal, connect with `mysql` to the MySQL server, and use the `info` database. Run the `select` statement, the same used in the previous section.

```
mysql> select * from content;
```

The MySQL server responds with the same output as last time.

```
+------------------+---------------------------------+
| url              | title                           |
+------------------+---------------------------------+
| /info/page1.html | Hypertext Markup Language - 2.0 |
| /info/page2.html | Form-based File Upload in HTML  |
+------------------+---------------------------------+
2 rows in set (0.00 sec)
```

Press Ctrl+Alt+T to open a new terminal window. Make `info` the working directory.

```
$ cd /var/www/html/info
```

Create another web page.

```
$ sudo cp page1.html page3.html
```

Change the title of `page3.html` to be a different one from the one used in `page1.html`.

```
$ sudo gedit page3.html
```

Replace the original title with another. For instance, use the following:

```
<h1>Hypertext Transfer Protocol -- HTTP/1.1</h1>
```

Save the file and close the gedit window.

Move to the gedit window of `crontab` and change the time interval of the `crontab` entry from 20 to 2 minutes so that you won't wait long for the daemon process to run. You can restore it to 20 minutes later. You can now click the Save button in the gedit window of `crontab`. Wait for two minutes, and at the terminal of the `mysql` client press the up arrow on the keyboard to execute the previous command.

```
mysql> select * from content;
```

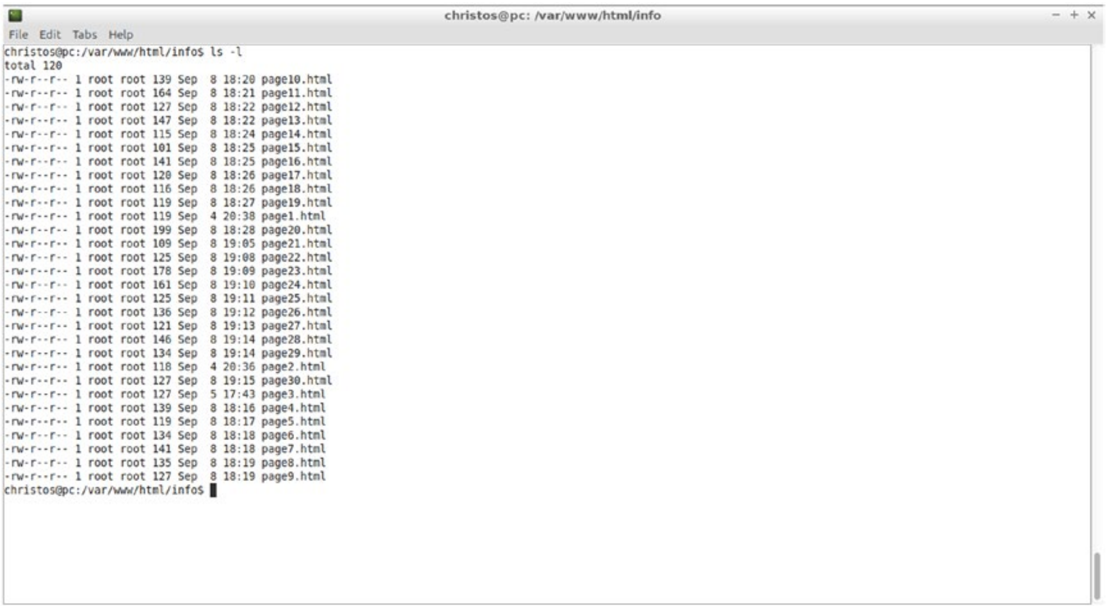
In the output table, a new record is included with the columns corresponding to the `page3.html` filepath and title.

```
+-----------------+-----------------------------------------+
| url             | title                                   |
+-----------------+-----------------------------------------+
| /info/page1.html | Hypertext Markup Language - 2.0        |
| /info/page2.html | Form-based File Upload in HTML         |
| /info/page3.html | Hypertext Transfer Protocol -- HTTP/1.1 |
+-----------------+-----------------------------------------+
3 rows in set (0.00 sec)
```

This entry was added by the `db.sh` shell script that was run by cron. You can restore now the entry interval from 2 to 20 minutes.

At this point, the database used for searching all the web page titles has been created, and the Bash script scheduled by `cron` constantly updates the database to reflect the added or deleted HTML files of the `info` directory.

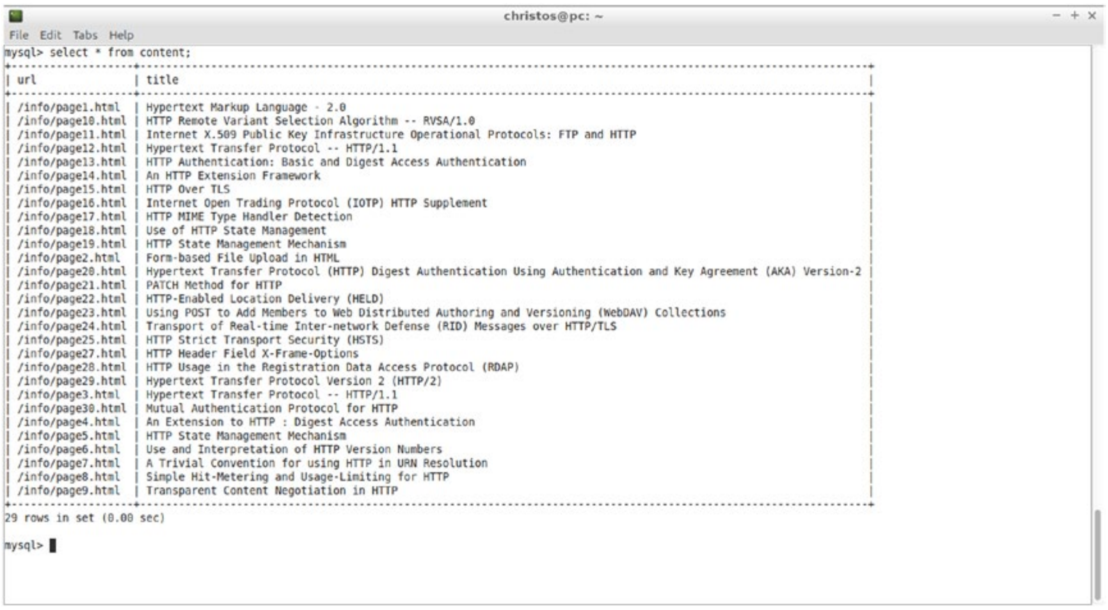
Now is a good opportunity to create more web pages and therefore more entries in the `info` database so you can have a larger number of results, which will be required when we implement pagination. The site will show five results per web page, instead of putting all the results on a single web page. For the example used in this chapter, the HTML files `page1.html` up to `page30.html` were created, as indicated by the `ls -l` output for the `info` directory, displayed in Figure 7-6.



```
christos@pc:/var/www/html/info$ ls -l
total 120
-rw-r--r-- 1 root root 139 Sep  8 18:20 page10.html
-rw-r--r-- 1 root root 164 Sep  8 18:21 page11.html
-rw-r--r-- 1 root root 127 Sep  8 18:22 page12.html
-rw-r--r-- 1 root root 147 Sep  8 18:22 page13.html
-rw-r--r-- 1 root root 115 Sep  8 18:24 page14.html
-rw-r--r-- 1 root root 101 Sep  8 18:25 page15.html
-rw-r--r-- 1 root root 141 Sep  8 18:25 page16.html
-rw-r--r-- 1 root root 120 Sep  8 18:26 page17.html
-rw-r--r-- 1 root root 116 Sep  8 18:26 page18.html
-rw-r--r-- 1 root root 119 Sep  8 18:27 page19.html
-rw-r--r-- 1 root root 119 Sep  4 20:38 page1.html
-rw-r--r-- 1 root root 199 Sep  8 18:28 page20.html
-rw-r--r-- 1 root root 109 Sep  8 19:05 page21.html
-rw-r--r-- 1 root root 125 Sep  8 19:08 page22.html
-rw-r--r-- 1 root root 178 Sep  8 19:09 page23.html
-rw-r--r-- 1 root root 161 Sep  8 19:10 page24.html
-rw-r--r-- 1 root root 125 Sep  8 19:11 page25.html
-rw-r--r-- 1 root root 136 Sep  8 19:12 page26.html
-rw-r--r-- 1 root root 121 Sep  8 19:13 page27.html
-rw-r--r-- 1 root root 146 Sep  8 19:14 page28.html
-rw-r--r-- 1 root root 134 Sep  8 19:14 page29.html
-rw-r--r-- 1 root root 118 Sep  4 20:36 page2.html
-rw-r--r-- 1 root root 127 Sep  8 19:15 page30.html
-rw-r--r-- 1 root root 127 Sep  5 17:43 page3.html
-rw-r--r-- 1 root root 139 Sep  8 18:16 page4.html
-rw-r--r-- 1 root root 119 Sep  8 18:17 page5.html
-rw-r--r-- 1 root root 134 Sep  8 18:18 page6.html
-rw-r--r-- 1 root root 141 Sep  8 18:18 page7.html
-rw-r--r-- 1 root root 135 Sep  8 18:19 page8.html
-rw-r--r-- 1 root root 127 Sep  8 18:19 page9.html
christos@pc:/var/www/html/info$
```

Figure 7-6. *Web pages page1.html up to page30.html are the content web pages used for the example's site*

After the time indicated in the `crontab` file, `db.sh` updates the database with the 30 entries shown in Figure 7-7.



```
mysql> select * from content;
+-------------------+-----------------------------------------------------------------------------------------------------------------+
| url               | title                                                                                                           |
+-------------------+-----------------------------------------------------------------------------------------------------------------+
| /info/page1.html  | Hypertext Markup Language - 2.0                                                                                 |
| /info/page10.html | HTTP Remote Variant Selection Algorithm -- RVSA/1.0                                                             |
| /info/page11.html | Internet X.509 Public Key Infrastructure Operational Protocols: FTP and HTTP                                    |
| /info/page12.html | Hypertext Transfer Protocol -- HTTP/1.1                                                                         |
| /info/page13.html | HTTP Authentication: Basic and Digest Access Authentication                                                     |
| /info/page14.html | An HTTP Extension Framework                                                                                     |
| /info/page15.html | HTTP Over TLS                                                                                                   |
| /info/page16.html | Internet Open Trading Protocol (IOTP) HTTP Supplement                                                           |
| /info/page17.html | HTTP MIME Type Handler Detection                                                                                |
| /info/page18.html | Use of HTTP State Management                                                                                    |
| /info/page19.html | HTTP State Management Mechanism                                                                                 |
| /info/page2.html  | Form-based File Upload in HTML                                                                                  |
| /info/page20.html | Hypertext Transfer Protocol (HTTP) Digest Authentication Using Authentication and Key Agreement (AKA) Version-2 |
| /info/page21.html | PATCH Method for HTTP                                                                                           |
| /info/page22.html | HTTP-Enabled Location Delivery (HELD)                                                                           |
| /info/page23.html | Using POST to Add Members to Web Distributed Authoring and Versioning (WebDAV) Collections                      |
| /info/page24.html | Transport of Real-time Inter-network Defense (RID) Messages over HTTP/TLS                                       |
| /info/page25.html | HTTP Strict Transport Security (HSTS)                                                                           |
| /info/page27.html | HTTP Header Field X-Frame-Options                                                                               |
| /info/page28.html | HTTP Usage in the Registration Data Access Protocol (RDAP)                                                      |
| /info/page29.html | Hypertext Transfer Protocol Version 2 (HTTP/2)                                                                  |
| /info/page3.html  | Hypertext Transfer Protocol -- HTTP/1.1                                                                         |
| /info/page30.html | Mutual Authentication Protocol for HTTP                                                                         |
| /info/page4.html  | An Extension to HTTP : Digest Access Authentication                                                             |
| /info/page5.html  | HTTP State Management Mechanism                                                                                 |
| /info/page6.html  | Use and Interpretation of HTTP Version Numbers                                                                  |
| /info/page7.html  | A Trivial Convention for using HTTP in URN Resolution                                                           |
| /info/page8.html  | Simple Hit-Metering and Usage-Limiting for HTTP                                                                 |
| /info/page9.html  | Transparent Content Negotiation in HTTP                                                                         |
+-------------------+-----------------------------------------------------------------------------------------------------------------+
29 rows in set (0.00 sec)

mysql> █
```

Figure 7-7. *Cron updates the database and creates one record for each web page found in the info directory*

With the content of the site ready, you can proceed to designing `index.php`, the home page of the site that provides the search form, and also `search.php`, the `action` program that receives the form's keywords, connects to the `info` database, and returns the results to the client.

Designing the Home Page of the Site

Like with the previous web-based projects, two basic HTML files are required for this site. One web page provides the HTML form for submitting the keywords to the web server, usually included in the home page of the site. Another web page, indicated in the `action` attribute of the `form` element, is the one that receives the keywords, queries the database, and dispatches the query results to the user. The database is automatically updated at regular intervals with the titles and the filepaths of all the content web pages of the site.

In the previous chapter, you learned how to connect to the MySQL server with the Bash shell scripting language. Here you will connect to the MySQL server from a PHP program. The PHP-MySQL interface routines will be used to issue the query and include the results in an HTML table, in the form of hyperlinks that lead to the corresponding content web pages.

Creating the Directory Index of the Site

For the home page of the site, you will use the `index.php` file. You probably already have a directory index with the name `index.php` in the document root directory from a project of a previous chapter. If the command `ls /var/www/html` returns an `index.php` file, rename it by using the following commands:

```
$ cd /var/www/html
$ sudo cp index.php indexOLD.php
```

Create next a new `index.php` file with gedit.

```
$ sudo gedit index.php
```

Enter the following source code and save the file:

```
<!DOCTYPE html>
<html>
<head>
<style>
body{
background-color:greenyellow;
}
.center {
    margin: auto;
    width: 80%;
    border: 3px solid #74AD23;
    padding: 10px;
}
p{
text-align:center;
font-size:32px;
color:green;
font-weight:bold;
}
input{
border-color:#74AD23;
font-size:32px;
color:green;
padding:10px;
background-color:greenyellow;
}
</style>
</head>
<body>
<br><br><br><br><br><br>
<div class="center">
<form name="form1" method="post" action="search.php">
  <p>Search the Papers:
     <input type="text" name="keywords">&nbsp;
     <input type="submit" value="Go">
 </p>
</form>
</div>
</body>
</html>
```

The previous source code creates a web page with a form. You center the form horizontally by setting the CSS `margin` property to `auto`.

```
margin: auto;
```

The form's method is `POST`, and the form's action is set to `search.php`. The code of `search.php` will therefore receive the keywords the user enters in the textbox and will use the PHP-MySQL interface routines to forward them to the MySQL server to query the `info` database. The query results will be converted to links with text that is the title of the web page. An HTML table with the results will be displayed to the user. As indicated by the value in the `action` attribute file, `search.php` is located in the same directory as `index.php` since no other relevant or absolute path is provided.

Figure 7-8 shows the home page of the site (`index.php`).

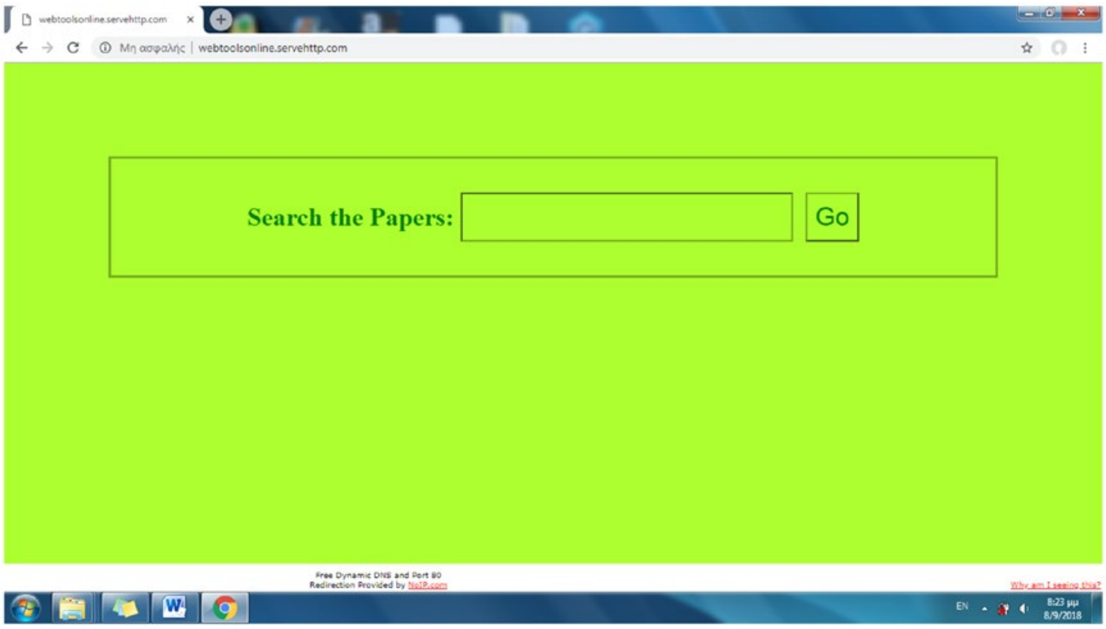

webtoolsonline.servehttp.com
Μη ασφαλής | webtoolsonline.servehttp.com
Search the Papers:
Go
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Figure 7-8. The home page of the site

There are two main methods to connect PHP and MySQL.

- MySQLi extension (MySQL improved)
- PDO (PHP Data Objects)

In this project, you will use the first one. To be able to use the `mysqli` PHP command, you have to install the MySQL extension for PHP. At the command line, enter the following:

```
$ sudo apt-get install php-mysql
```

Creating the Action PHP Program

Create `search.php` in the document root directory. `search.php` is used as the value of the form's `action` attribute, the one that defines the file that processes the user's keywords.

```
$ cd /var/www/html
$ sudo gedit search.php
```

Enter the following lines and click the Save button in the gedit window to save the file:

```
<!DOCTYPE html>

<html>
<head>
<style>
body {
background-color:yellowgreen;
}
a {
font-size:24px;
}
</style>
</head>

<body>

<?php

if(!empty($_POST["keywords"])){
$keywords = $_POST["keywords"];
}

$array = preg_split('/\s+/', trim($keywords));

$cnt=0;
$items="";
foreach ($array as $item) {
    ++$cnt;
    $item = " title like '%{$item}%'";
    if ($cnt != count($array)) {
       $item="{$item} or ";
    }
    $items .= $item;
}
```

```
$servername = "localhost";
$username = "root";
$password = "";
$dbname = "info";

$mysqli = new mysqli($servername, $username, $password, $dbname);

if ($mysqli->connect_error) {
    die("Connection failed: " . $mysqli->connect_error);
}

$sqlquery = "select title, url from content where ".$items." ;";

if ($result = mysqli_query($mysqli, $sqlquery)) {
  echo "<table>";
    while ($row = mysqli_fetch_assoc($result)) {
        echo "<tr><td>";
        echo "<a href=\"".$row['url']."\">".$row['title']."</a>";
        echo "</td></tr>";
    }
  echo "</table>";
  mysqli_free_result($result);
}

$mysqli->close();

?>
</body>
</html>
```

The PHP code starts with the following command, which sets the PHP variable `$keywords` to the value sent with the `POST` HTTP method, from the textbox named `keywords` of the form found in `index.php`:

```
if(!empty($_POST["keywords"])){
$keywords = $_POST["keywords"];
}
```

In the next code line, the PHP function `trim()` removes spaces before and after the `$keyword` value, which is a string.

At a result, the `preg_split()` function applies. PREG stands for PCRE Regular Expression, where PCRE means Perl Compatible Regular Expressions. `preg_split()` splits a string into a regular expression and returns the parts to an array, `$array` in this example. The regular expression used is as follows:

```
/\s+/
```

This indicates one or more (+) spaces (`\s`) from the start to the end of the string (/ /).

```
$array = preg_split('/\s+/', trim($keywords));
```

The next code snippet starts by setting the variable `$cnt` to zero. This variable will increase by one at any `foreach()` iteration, which extracts each item of `$array` and assigns it to the variable `$item`. `$array` at this point is an array of all the keywords inserted into the form's textbox. On each iteration, the current `$item` is used to form the string `title like '%{$item}%'`, which for instance for the keyword *HTML* evaluates to the string `title like '%HTML%'`. This string will be used as part of the SQL query command for the `info` database that will be submitted to the MySQL server.

```
select title, url from content where title like '%HTML%';
```

Hint! The curly braces ({}) provide another way to enter a PHP variable into a string.

As you recall from the previous chapter, the `like` operator is used with the `where` SQL clause to return select columns that include the keyword that `like` applies to. By including the keyword between the `like` wildcard symbol (%), which represents zero or more characters, the keyword may be included in any position of the column's value.

The `$cnt` variable is used therefore to determine the last element of the `$array`. For any item of the array except the last one, an `or` (the OR logical operator) is appended at the end of the item. For a multikeyword search, for instance if both the *HTML* and *HTTP* keywords are used, the values of the variable `$items` will be concatenated with `or` (and for the last keyword an `or` operator should not be used).

```
title like '%HTML%' or title like '%HTTP%'
```

The concatenation of all `$item` values takes place recursively and is accumulated to the `$items` variable. The concatenating assignment operator (`.=`) is used to append the argument on the right side to the argument on the left side.

```
$cnt=0;
$items="";
foreach ($array as $item) {
    ++$cnt;
    $item = " title like '%{$item}%'";
    if ($cnt != count($array)) {
       $item="{$item} or ";
    }
    $items .= $item;
}
```

The following variables are used for the `mysqli()` function in the PHP code to make a connection to the MySQL server:

- `$servername` indicates the hostname of the computer, and it can simply be assigned to the `localhost` value.
- `$username` is assigned to root, the username used for the MySQL server connection. This corresponds to the `-u` argument of the `mysql` command.

  ```
  $ mysql -u root
  ```

- `$password` is the password used for the MySQL connection, provided with the `-p` argument when running `mysql` at the command line. The empty string (no password) is used in this example.
- `$dbname` is assigned to `info`, the name of the database used in the MySQL server.

The previous variables hold therefore the following values for this connection:

```
$servername = "localhost";
$username = "root";
$password = "";
$dbname = "info";
```

Those variables are passed to the `mysqli()` object constructor function to return on connection success `$mysqli`, the newly created `mysqli` object. The following code makes and also tests the connection from the PHP code to the MySQL server:

```
$mysqli = new mysqli($servername, $username, $password, $dbname);

if ($mysqli->connect_error) {
    die("Connection failed: " . $mysqli->connect_error);
}
```

With the arrow (`->`) operator and the name of the object, you can access object properties and methods.

Next, the `$sqlquery` variable is assigned the command of the query to be executed. The following value after evaluation selects the columns `title` and `url` from the table `content` where the title includes one or more of the keywords entered in the form by the user.

```
$sqlquery = "select title, url from content where ".$items." ;";
```

The query is submitted to the server with the `mysqli_query()` function, and the results are retrieved with the `$result` variable. The function `mysqli_fetch_assoc()` returns the next record of the query results in the variable `$row`. The `while` loop iterates until all result rows are read. For each `$row` value, the two table columns `url` and `title` are indicated as `$row['url']` and `$row['title']`, respectively. An HTML link will be formed with the title as the link text and the URL as the value of the `href` attribute. By using the PHP concatenation operator (.) to concatenate strings like `<a href=\"` and string variable values like `$row['url']`, a working HTML link is formed. For example, with the title `Hypertext Markup Language - 2.0` and URL `/info/page1.html`, the HTML link element becomes the following:

```
<a href="/info/page1.html">Hypertext Markup Language - 2.0</a>
```

Notice that the PHP escape (`\`) character is used with a double quote (`\"`) to allow the double quote be used as a normal character so that it does not delimit the start or end of a string.

All links will be included in a table data (`<td>`) element, and this element will be included in a table row (`<tr>`) element of a table. The table is used to align the results. For example, center alignment can also be used for better visual appearance. The table is delimited with the start table tag and the end table tag, both entered in the evaluated PHP code with the PHP `echo` command.

```
if ($result = mysqli_query($mysqli, $sqlquery)) {
  echo "<table>";
    while ($row = mysqli_fetch_assoc($result)) {
        echo "<tr><td>";
        echo "<a href=\"".$row['url']."\">".$row['title']."</a>";
        echo "</td></tr>";
    }
  echo "</table>";
  mysqli_free_result($result);
}

$mysqli->close();
```

The function `mysqli_free_result()` is used to free the memory occupied by `$result` when it is no longer needed. Also, the database connection is closed by invoking the `close` method of `$mysqli` as follows:

```
 $mysqli->close();
```

The result of the previous code snippet is to evaluate the PHP code to an HTML table without borders. Each row includes the title of each result that the MySQL query returns. This title is a link that leads to the web page that discusses the topic included in the title.

Testing the Dynamic Content Site

In the address bar of your browser, use the URL domain name you have registered to display the directory index (`index.php`) of your site. In this example, the following domain name is used:

```
http://webtoolsonline.servehttp.com/
```

Use some keywords and feel free to include unnecessary spaces before and after the words, as displayed in Figure 7-9.

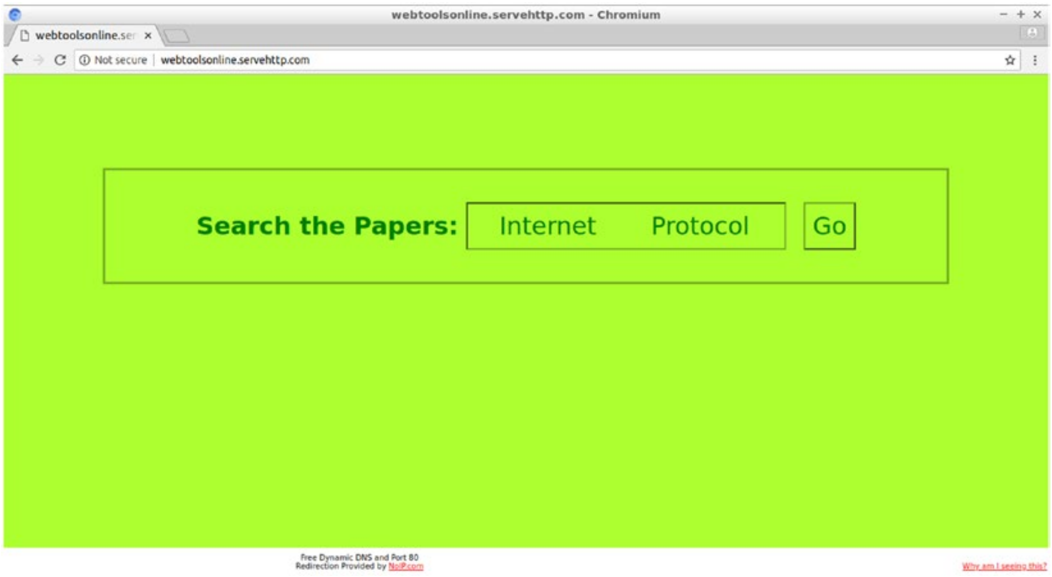
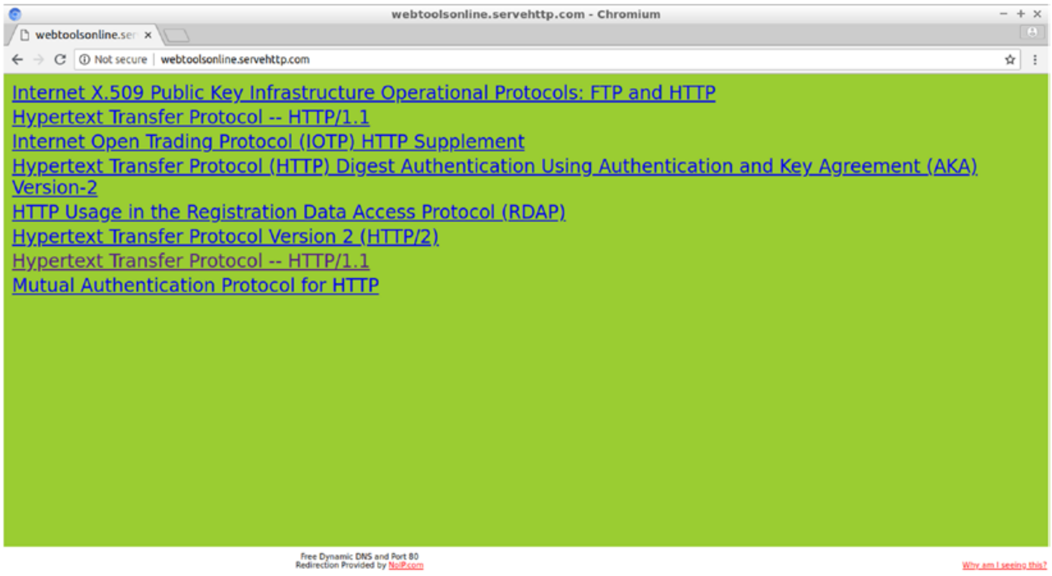

webtoolsonline.servehttp.com - Chromium
webtoolsonline.servehttp.com
Not secure
Search the Papers:
Internet Protocol
Go
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Figure 7-9. *Entering keywords in the home page's form*

Click the Go button. The query results (in the form of links) appear, as shown in Figure 7-10.


webtoolsonline.servehttp.com - Chromium
webtoolsonline.servehttp.com
Not secure

Internet X.509 Public Key Infrastructure Operational Protocols: FTP and HTTP
Hypertext Transfer Protocol -- HTTP/1.1
Internet Open Trading Protocol (IOTP) HTTP Supplement
Hypertext Transfer Protocol (HTTP) Digest Authentication Using Authentication and Key Agreement (AKA) Version-2
HTTP Usage in the Registration Data Access Protocol (RDAP)
Hypertext Transfer Protocol Version 2 (HTTP/2)
Hypertext Transfer Protocol -- HTTP/1.1
Mutual Authentication Protocol for HTTP

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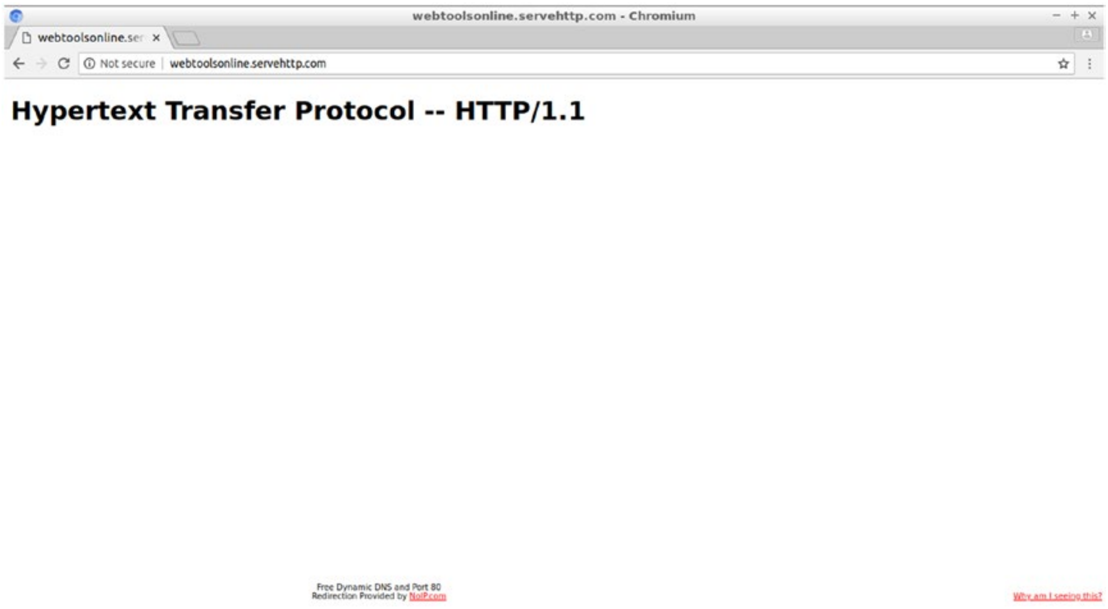
Figure 7-10. *The query results appear as links, each one leading to one of the content web pages*

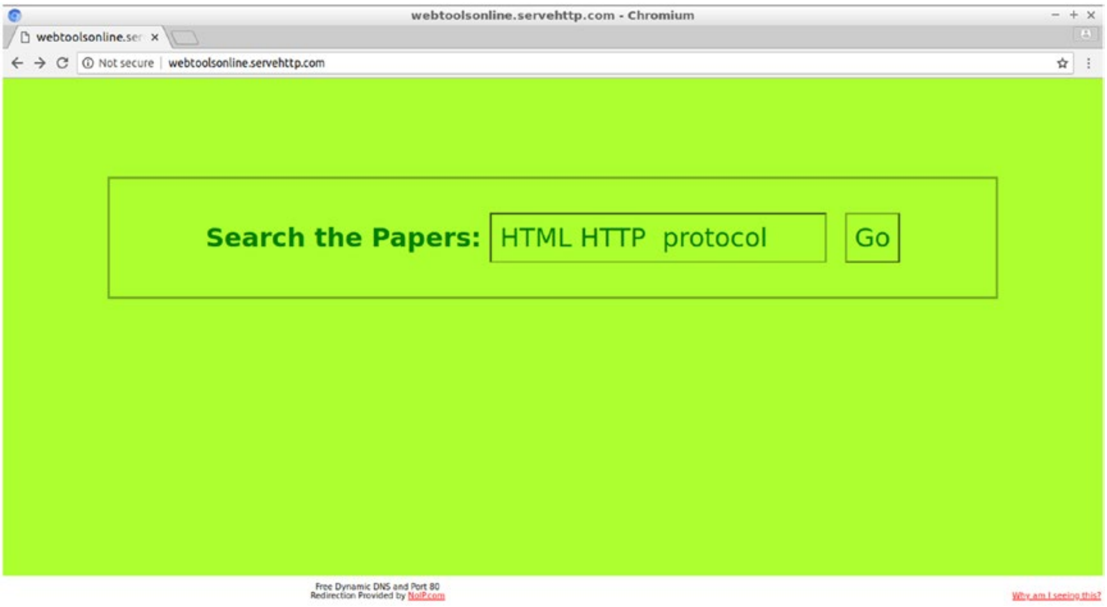
Click any of the links included in the results. The corresponding web page appears in your browser, as shown in Figure 7-11 (for simplicity it is not filled with any usable content yet).


webtoolsonline.servehttp.com - Chromium
webtoolsonline.ser
Not secure
webtoolsonline.servehttp.com
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Hypertext Transfer Protocol -- HTTP/1.1

Figure 7-11. *The web page of one of the query results*

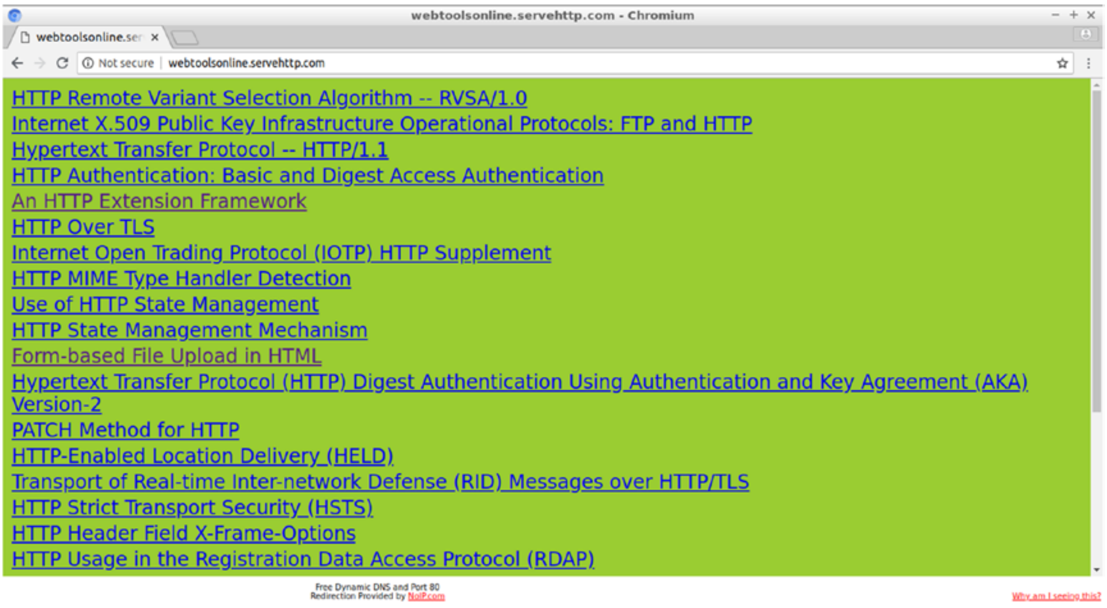
Next, enter a query that will return more results. You can use even more keywords than the ones used here. Figure 7-12 displays, for instance, using *HTML*, *HTTP*, and *protocol* as keywords.


webtoolsonline.servehttp.com - Chromium
Not secure | webtoolsonline.servehttp.com
Go
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Search the Papers: HTML HTTP protocol

Figure 7-12. *Using multiple keywords to view more results than a computer screen accommodates*

Click Go again. The web page shown in Figure 7-13 appears.


webtoolsonline.servehttp.com - Chromium
Not secure | webtoolsonline.servehttp.com
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HTTP Remote Variant Selection Algorithm -- RVSA/1.0
Internet X.509 Public Key Infrastructure Operational Protocols: FTP and HTTP
Hypertext Transfer Protocol -- HTTP/1.1
HTTP Authentication: Basic and Digest Access Authentication
An HTTP Extension Framework
HTTP Over TLS
Internet Open Trading Protocol (IOTP) HTTP Supplement
HTTP MIME Type Handler Detection
Use of HTTP State Management
HTTP State Management Mechanism
Form-based File Upload in HTML
Hypertext Transfer Protocol (HTTP) Digest Authentication Using Authentication and Key Agreement (AKA) Version-2
PATCH Method for HTTP
HTTP-Enabled Location Delivery (HELD)
Transport of Real-time Inter-network Defense (RID) Messages over HTTP/TLS
HTTP Strict Transport Security (HSTS)
HTTP Header Field X-Frame-Options
HTTP Usage in the Registration Data Access Protocol (RDAP)

Figure 7-13. *Viewing multiple results requires scrolling*

To view the query results, scrolling is required. Another approach is to use pagination to group the results onto separate pages. This is what you'll do next.

Making Modifications

To make some modifications and inspect in detail the inner workings of the previous code, create a backup copy of `search.php` called `search2.php`.

```
$ cd /var/www/html

$ sudo cp search.php search2.php
```

You can modify `search.php` and restore it when you finish experimenting. In the following steps, you will change the source code to examine how the exclusion of `trim()` and `preg_split()` can lead to serious problems.

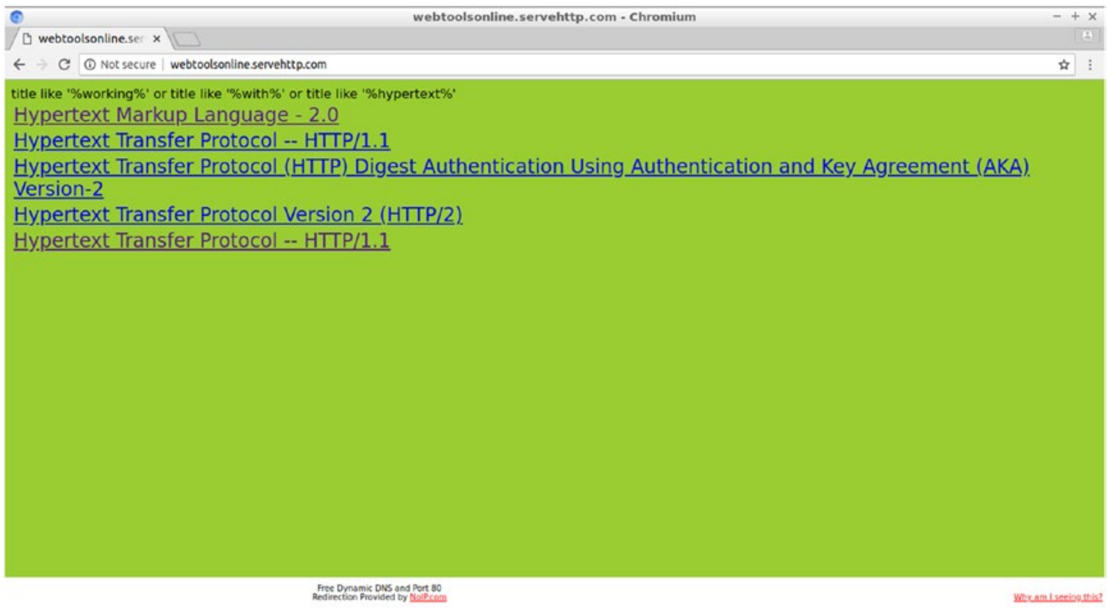
Enter at the end of the following code snippet the `echo $items` command for inspecting the variable's value:

```
<?php
if(!empty($_POST["keywords"])){
$keywords = $_POST["keywords"];
}

// trim() spaces left right, preg_split() between
$array = preg_split('/\s+/', trim($keywords));

$cnt=0;
$items="";
foreach ($array as $item) {
    ++$cnt;
    $item = " title like '%{$item}%'";
    if ($cnt != count($array)) {
       $item="{$item} or ";
    }
    $items .= $item;
}
echo $items;
```

Use your browser to make a query from `index.php` and view the results. Use the following keywords (including some spaces before or after the words):

```
working       with     hypertext
```

Click the Go button. As displayed in Figure 7-14, the `$items` value is displaying in the `search.php` window.


webtoolsonline.servehttp.com - Chromium
webtoolsonline.ser
Not secure
webtoolsonline.servehttp.com

title like '%working%' or title like '%with%' or title like '%hypertext%'
Hypertext Markup Language - 2.0
Hypertext Transfer Protocol -- HTTP/1.1
Hypertext Transfer Protocol (HTTP) Digest Authentication Using Authentication and Key Agreement (AKA) Version-2
Hypertext Transfer Protocol Version 2 (HTTP/2)
Hypertext Transfer Protocol -- HTTP/1.1

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***Figure 7-14.** Printing echo messages for relating the source code to the query results*

The `$items` value is as follows:

```
title like '%working%' or title like '%with%' or title like '%hypertext%'
```

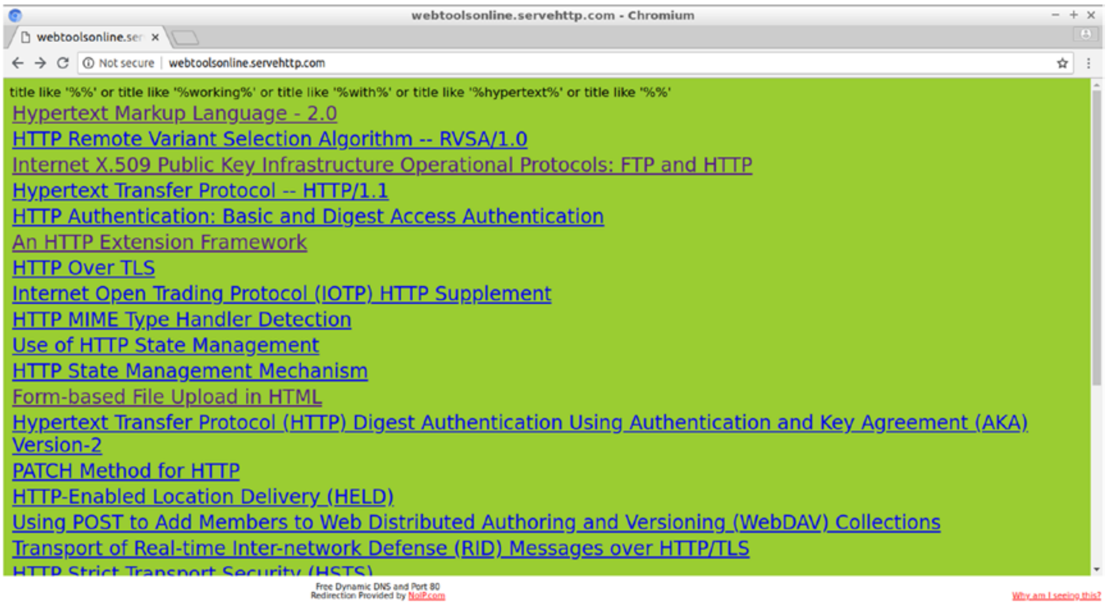
Modify the following line:

```
$array = preg_split('/\s+/', trim($keywords));
Remove the trim() function:
$array = preg_split('/\s+/', $keywords);
```

Run the previous query again. Without `trim()` in the query string, there are now empty keywords (%%) at the start and the end, as the following echo output displays:

```
title like '%%' or title like '%working%' or title like '%with%' or title
like '%hypertext%' or title like '%%'
```

Figure 7-15 shows the evaluated `search.php` web page.


webtoolsonline.servehttp.com - Chromium
webtoolsonline.ser
Not secure
webtoolsonline.servehttp.com

```
title like '%%' or title like '%working%' or title like '%with%' or title like '%hypertext%' or title like '%%'
Hypertext Markup Language - 2.0
HTTP Remote Variant Selection Algorithm -- RVSA/1.0
Internet X.509 Public Key Infrastructure Operational Protocols: FTP and HTTP
Hypertext Transfer Protocol -- HTTP/1.1
HTTP Authentication: Basic and Digest Access Authentication
An HTTP Extension Framework
HTTP Over TLS
Internet Open Trading Protocol (IOTP) HTTP Supplement
HTTP MIME Type Handler Detection
Use of HTTP State Management
HTTP State Management Mechanism
Form-based File Upload in HTML
Hypertext Transfer Protocol (HTTP) Digest Authentication Using Authentication and Key Agreement (AKA)
Version-2
PATCH Method for HTTP
HTTP-Enabled Location Delivery (HELD)
Using POST to Add Members to Web Distributed Authoring and Versioning (WebDAV) Collections
Transport of Real-time Inter-network Defense (RID) Messages over HTTP/TLS
HTTP Strict Transport Security (HSTS)
```

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Figure 7-15. *By excluding trim(), all database records are selected*

As shown in Figure 7-15, including `like '%%'` inserts all the available database records in the query results.

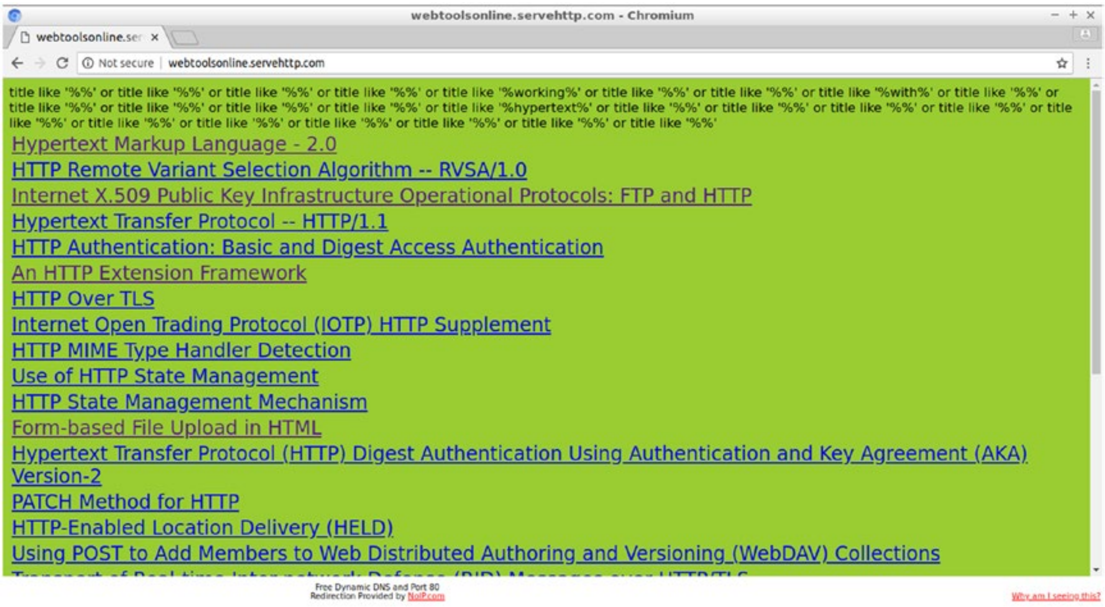
Make a final modification to `search.php` by removing the function `trim()` and the function `preg_split()` from the command line. Insert `$array` using a simple function like `explode()` that uses a single space as a delimiter.

```
$array = explode(" ", $keywords);
```

The $items may look like the following:

```
title like '%%' or title like '%%' or title like '%%' or title like '%%' or
title like '%working%' or title like '%%' or title like '%%' or title like
'%with%' or title like '%%' or title like '%%' or title like '%%' or title
like '%%' or title like '%%' or title like '%hypertext%' or title like '%%'
or title like '%%' or title like '%%' or title like '%%' or title like '%%'
or title like '%%' or title like '%%' or title like '%%' or title like '%%'
or title like '%%' or title like '%%'
```

As shown in Figure 7-16, by excluding preg_split(), all the database query records are included in the query results.


webtoolsonline.servehttp.com - Chromium
webtoolsonline.ser
Not secure
webtoolsonline.servehttp.com

title like '%%' or title like '%%' or title like '%%' or title like '%%' or title like '%working%' or title like '%%' or title like '%%' or title like '%with%' or title like '%%' or title like '%%' or title like '%%' or title like '%%' or title like '%%' or title like '%hypertext%' or title like '%%' or title like '%%' or title like '%%' or title like '%%' or title like '%%' or title like '%%' or title like '%%' or title like '%%' or title like '%%' or title like '%%' or title like '%%'

Hypertext Markup Language - 2.0
HTTP Remote Variant Selection Algorithm -- RVSA/1.0
Internet X.509 Public Key Infrastructure Operational Protocols: FTP and HTTP
Hypertext Transfer Protocol -- HTTP/1.1
HTTP Authentication: Basic and Digest Access Authentication
An HTTP Extension Framework
HTTP Over TLS
Internet Open Trading Protocol (IOTP) HTTP Supplement
HTTP MIME Type Handler Detection
Use of HTTP State Management
HTTP State Management Mechanism
Form-based File Upload in HTML
Hypertext Transfer Protocol (HTTP) Digest Authentication Using Authentication and Key Agreement (AKA) Version-2
PATCH Method for HTTP
HTTP-Enabled Location Delivery (HELD)
Using POST to Add Members to Web Distributed Authoring and Versioning (WebDAV) Collections

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Redirection Provided by NoIP.com
Why am I seeing this?

Figure 7-16. *By excluding preg_split(), all database records are selected*

Finally, restore the original search.php file.

```
$ sudo rm search.php
$ sudo mv search2.php search.php
```

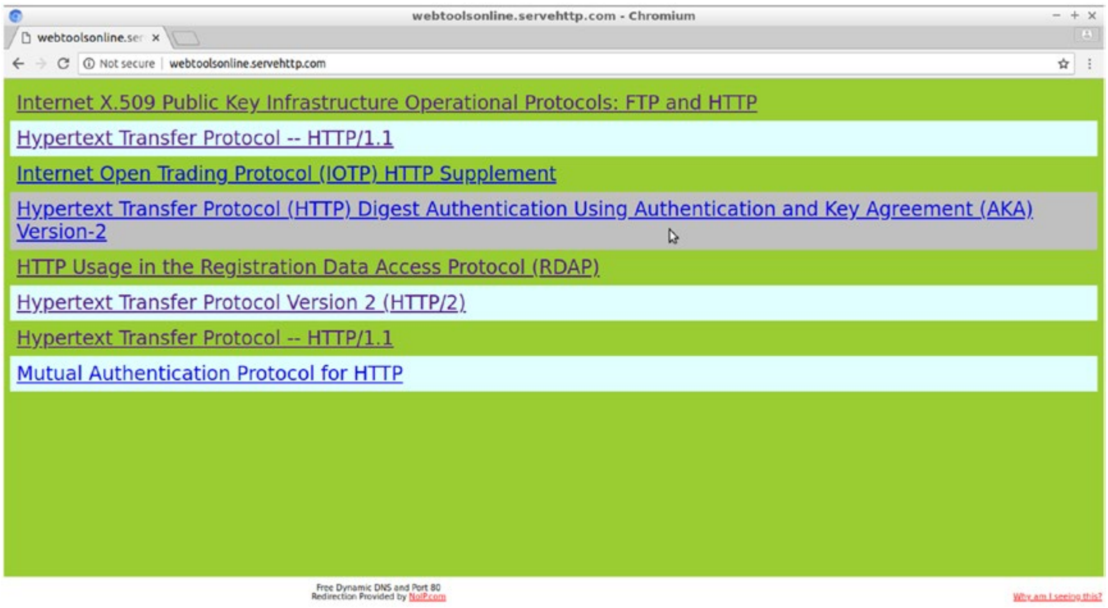
Improving the Query Results Appearance with a Two-Colored Table

Next, you'll use CSS properties to provide a different background color to the even-numbered rows than the odd-numbered rows. Also, with the `:hover` CSS pseudoclass, you can provide a different background color to the row the mouse is resting on. Change the `style` element of `search.php` to look like the following:

```
<style>

body {
background-color:yellowgreen;
}

a {
font-size:24px;
}

table.center {
    margin-left:auto;
    margin-right:auto;
  }

table {
    border-collapse: collapse;
   /* border: 1px solid blue; */
}

 th {
    text-align: center;
    padding: 8px;
    color: goldenrod;
    font-size:24px;
}

 td {
    text-align: left;
    padding: 8px;
    color: green;
    font-size:18px;
}

tr:nth-child(even){
background-color: lightcyan;
}

tr:hover {
background-color:silver;
}

tr.no_hover:hover {
 background-color:floralwhite;
}

</style>
```

Use the form in `index.php` to make a new query, e.g., for the keyword *protocol*.

Figure 7-17 displays the results displayed in a two-colored table and also shows the row highlighted that the mouse pointer is on.


webtoolsonline.servehttp.com - Chromium
webtoolsonline.ser
Not secure
webtoolsonline.servehttp.com

Internet X.509 Public Key Infrastructure Operational Protocols: FTP and HTTP
Hypertext Transfer Protocol -- HTTP/1.1
Internet Open Trading Protocol (IOTP) HTTP Supplement
Hypertext Transfer Protocol (HTTP) Digest Authentication Using Authentication and Key Agreement (AKA) Version-2
HTTP Usage in the Registration Data Access Protocol (RDAP)
Hypertext Transfer Protocol Version 2 (HTTP/2)
Hypertext Transfer Protocol -- HTTP/1.1
Mutual Authentication Protocol for HTTP

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Figure 7-17. *Using a two-colored table*

Implementing Pagination

Instead of having all the results appear on a single page, you can group them into sets of a specific number per page, e.g., 20, and present them using several web pages that are linked with buttons or images. You can use at least two buttons: one for the next available results and one for the previous results (if any exist). This is especially useful when the query returns lots of results like a real-world search engine query usually does.

Each web page will provide part of the total results. The `limit` MySQL clause is the key to return the results starting at a specific offset and to include a count of the number of results to return. To experiment with the `limit` option, run a SQL query from the MySQL client. For example, use the following:

```
$ mysql -u root

mysql> use info;

mysql> select * from content where title like '%http%';
```

MySQL responds with the following results:

```
+-------------------+-----------------------------------------------------+
| url               | title                                               |
+-------------------+-----------------------------------------------------+
| /info/page10.html | HTTP Remote Variant Selection
                      Algorithm -- RVSA/1.0                               |
| /info/page11.html | Internet X.509 Public Key Infrastructure
                      Operational Protocols: FTP and HTTP                 |
| /info/page12.html | Hypertext Transfer Protocol -- HTTP/1.1             |
| /info/page13.html | HTTP Authentication: Basic and Digest Access
                      Authentication                                      |
| /info/page14.html | An HTTP Extension Framework                         |
| /info/page15.html | HTTP Over TLS                                       |
| /info/page16.html | Internet Open Trading Protocol (IOTP)
                      HTTP Supplement                                     |
| /info/page17.html | HTTP MIME Type Handler Detection                    |
| /info/page18.html | Use of HTTP State Management                        |
| /info/page19.html | HTTP State Management Mechanism                      |
| /info/page20.html | Hypertext Transfer Protocol (HTTP)
                      Digest Authentication Using Authentication and
                      Key Agreement (AKA) Version-2                        |
| /info/page21.html | PATCH Method for HTTP                                |
| /info/page22.html | HTTP-Enabled Location Delivery (HELD)                |
| /info/page24.html | Transport of Real-time Inter-network Defense (RID)
                      Messages over HTTP/TLS                               |
| /info/page25.html | HTTP Strict Transport Security (HSTS)                |
| /info/page27.html | HTTP Header Field X-Frame-Options                    |
| /info/page28.html | HTTP Usage in the Registration Data
                      Access Protocol (RDAP)                               |
| /info/page29.html | Hypertext Transfer Protocol Version 2 (HTTP/2)       |
| /info/page3.html  | Hypertext Transfer Protocol -- HTTP/1.1              |
| /info/page30.html | Mutual Authentication Protocol for HTTP              |
| /info/page4.html  | An Extension to HTTP : Digest Access Authentication |
| /info/page5.html  | HTTP State Management Mechanism                      |
| /info/page6.html  | Use and Interpretation of HTTP Version Numbers       |
| /info/page7.html  | A Trivial Convention for using HTTP in
                      URN Resolution                                       |
| /info/page8.html  | Simple Hit-Metering and Usage-Limiting for HTTP      |
| /info/page9.html  | Transparent Content Negotiation in HTTP              |
+-------------------+------------------------------------------------------+
26 rows in set (0.01 sec)
```

Next use the same command with the `limit` clause, where `limit 5, 3` indicates `limit` is 5 and count is 3:

```
mysql> select * from content where title like '%http%' limit 5, 3;
```

The results are restricted therefore to only three records, starting from the record that is indexed as five. Because the first record is indexed as zero, the following table includes the sixth, seventh, and eighth records:

```
+------------------+----------------------------------------------------+
| url              | title                                              |
+------------------+----------------------------------------------------+
| /info/page15.html | HTTP Over TLS                                     |
| /info/page16.html | Internet Open Trading Protocol (IOTP)
                      HTTP Supplement                                   |
| /info/page17.html | HTTP MIME Type Handler Detection                  |
+------------------+----------------------------------------------------+
3 rows in set (0.00 sec)
```

In the new version of the previous site, the number of records per page will be set for simplicity to five. The initial query from `index.php` will set the `limit` and `count` values to 0 and 5, respectively, to display the first five records. Two buttons with the captions Previous and Next will be used on the evaluated `search.php` page for browsing the rest of the records. Initially, the Previous button will be disabled since the first results page does not include previous results. By clicking the Next button, the following five (or fewer if the remaining result number is less than five) records will be fetched. The Previous button will move you to the five records before the first one currently displayed.

Each button is used as a submit-type button in a separate HTML form, requesting a query that moves the offset backward for the Previous button and forward for the Next button to the result list.

Where is the current offset saved, though, when swapping from one page to another? The PHP engine extracts the offset sent along with the form data, updates it (either increasing or decreasing it), and includes it on the reply page so that it can be available for the next form submission. The offset placement is not visible to the user since it is included as the value of the form's input element of type `Hidden`. Other than the offset, the keywords entered by the user need also to be retained at each pagination transition when clicking the buttons. The initial web page used by the client includes a textbox for entering the keywords; however, the Previous and Next buttons can perform a keyword search on the same keywords by carrying them also in a hidden field.

Figure 7-18 displays the HTML form of the new version of `search.php` used to query the database for *HTTP*. This is the same query executed previously from the command line.

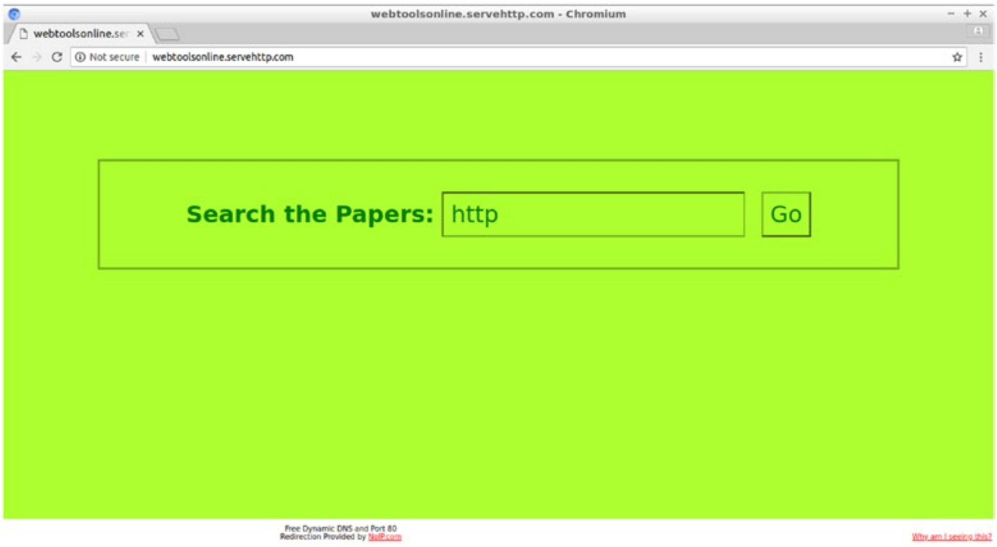
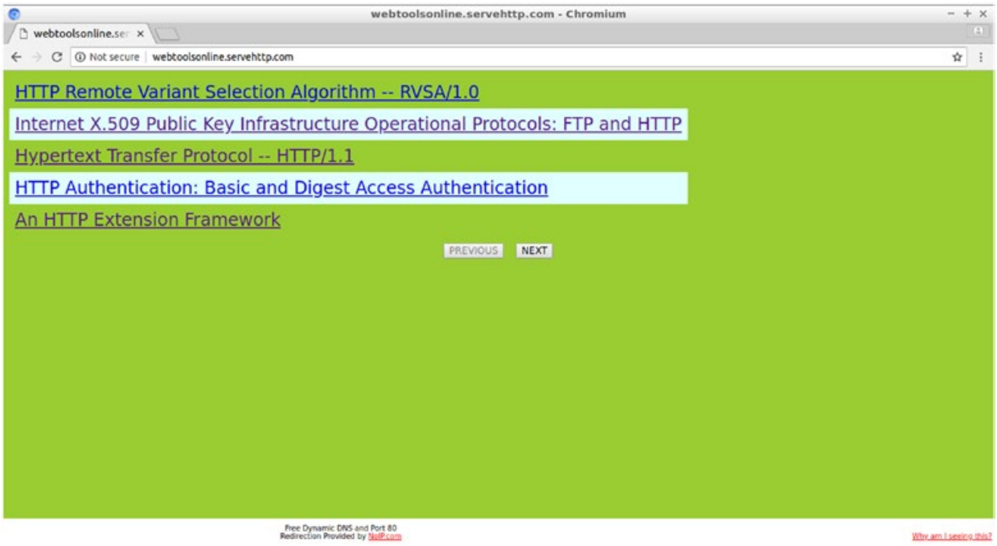

webtoolsonline.servehttp.com - Chromium
webtoolsonline.se
Not secure | webtoolsonline.servehttp.com
Search the Papers:
http
Go
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Figure 7-18. *Using the pagination version of index.php*

By clicking the Go button, the first set of records appear, as shown in Figure 7-19.

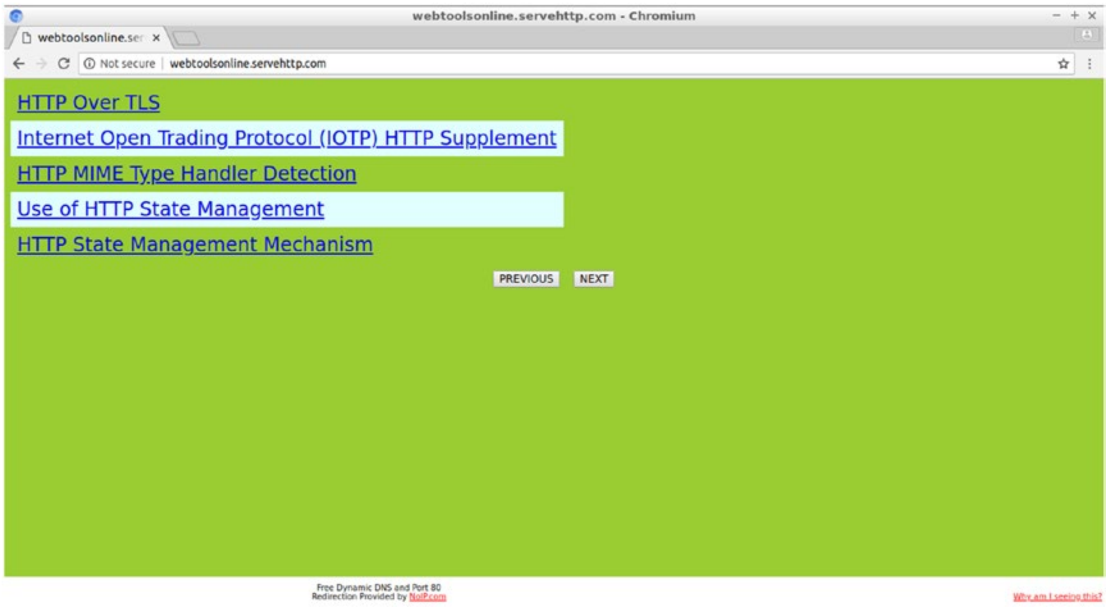

webtoolsonline.servehttp.com - Chromium
webtoolsonline.se
Not secure | webtoolsonline.servehttp.com

HTTP Remote Variant Selection Algorithm -- RVSA/1.0
Internet X.509 Public Key Infrastructure Operational Protocols: FTP and HTTP
Hypertext Transfer Protocol -- HTTP/1.1
HTTP Authentication: Basic and Digest Access Authentication
An HTTP Extension Framework

PREVIOUS
NEXT
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Figure 7-19. *Displaying the query results with the new version of search.php*

So far, no previous results exist, and therefore the Previous button is disabled. Click the Next button. The web page displayed in Figure 7-20 with the next five records appears.


webtoolsonline.servehttp.com - Chromium
webtoolsonline.ser
Not secure
webtoolsonline.servehttp.com
PREVIOUS
NEXT
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

HTTP Over TLS
Internet Open Trading Protocol (IOTP) HTTP Supplement
HTTP MIME Type Handler Detection
Use of HTTP State Management
HTTP State Management Mechanism

Figure 7-20. *By clicking the Next button, the Previous button becomes enabled*

This time, both buttons are enabled, and you can proceed forward or return backward. Click the Next button four times until you reach the final web page, the sixth one, displayed in Figure 7-21.

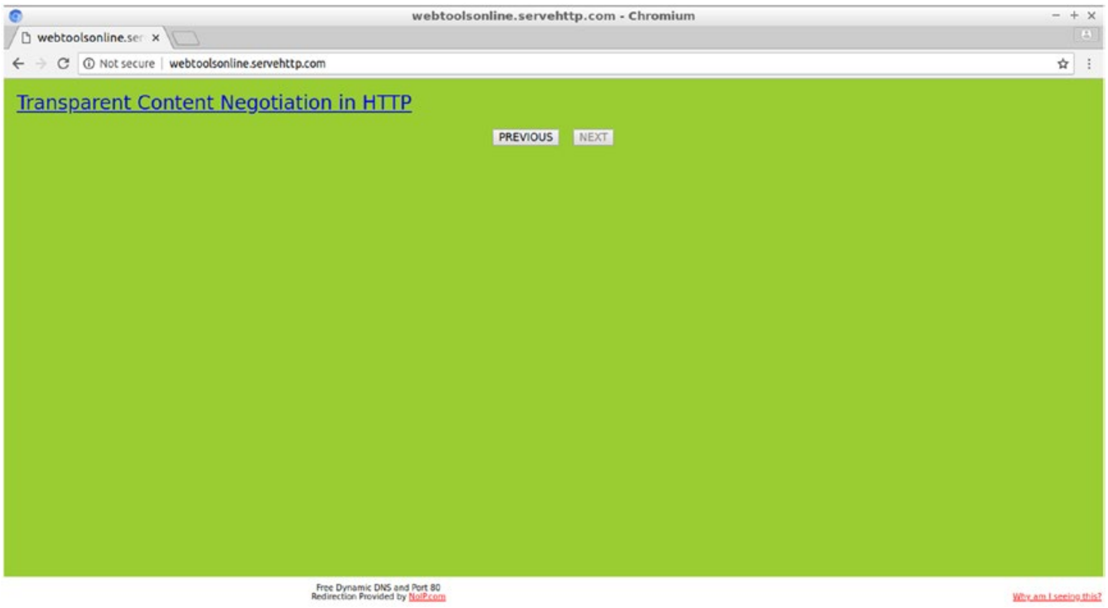

webtoolsonline.servehttp.com - Chromium
webtoolsonline.se
Not secure | webtoolsonline.servehttp.com
Transparent Content Negotiation in HTTP
PREVIOUS
NEXT
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

Figure 7-21. *When you reach the last web page of results, the Next button becomes deactivated*

The Next button as expected is disabled, and you can move only backward. You can also provide on each page a Home link to get to the home page of your site. For now, you can click the Refresh button of your browser to move to the home page.

The Pagination-Enabled Version of index.php

To implement the pagination feature on the site, changes to both the `index.php` and `search.php` source code are required. In these files, the new code added will be included between comment lines of forward slashes. The HTML comments in those files will look therefore like the following:

```
<!-- ///////////// -->
```

CSS comments will look like the following:

```
/*  /////////////  */
```

PHP comments will look like the following:

```
/////////////////////
```

The source code for the new version of `index.php` is as follows:

```
<!DOCTYPE html>
<html>
<head>
<style>
body{
background-color:greenyellow;
}
.center {
    margin: auto;
    width: 80%;
    border: 3px solid #74AD23;
    padding: 10px;
}
p{
text-align:center;
font-size:32px;
color:green;
font-weight:bold;
}
input{
border-color:#74AD23;
font-size:32px;
color:green;
padding:10px;
background-color:greenyellow;
}
</style>
</head>
<body>
<br><br><br><br><br><br>
<div class="center">
```

```
<form name="form1" method="post" action="search.php">
  <p>Search the Papers:
     <input type="text" name="keywords">&nbsp;
     <input type="submit" value="Go">
 </p>

<!-- /////////////////////////////////////// -->
<input type="hidden" name="offset" value="0">
<!-- /////////////////////////////////////// -->

</form>
</div>
</body>
</html>
```

The only line added is the `hidden` input type element required to provide zero as the initial offset value for the first set of result records. The original `index.php` version did not use a `limit` clause for the `select` statement, and therefore no offset variable was used.

The Pagination-Enabled Version of search.php

The following is the source code of the new version of `search.php`:

```
<!DOCTYPE html>

<html>
<head>
<style>
body {
background-color:yellowgreen;
}
a {
font-size:24px;
}

table.center {
    margin-left:auto;
    margin-right:auto;
  }
```

```
table {
    border-collapse: collapse;
   /* border: 1px solid blue; */
}

 th {
    text-align: center;
    padding: 8px;
    color: goldenrod;
    font-size:24px;
}

 td {
    text-align: left;
    padding: 8px;
    color: green;
    font-size:18px;
}

tr:nth-child(even){
background-color: lightcyan;
}

tr:hover {
background-color:silver;
}
tr.no_hover:hover {
 background-color:floralwhite;
}

/* //////////////////////////////////////////////////  */
/*  class center is used just for the second table  */
.center {
    margin-left:auto;
    margin-right:auto;
  }
/* //////////////////////////////////////////////////  */
```

```
</style>
</head>

<body>
<?php

//if(!empty($_POST["keywords"])){
$keywords = $_POST["keywords"];
//}

// trim() spaces left right, preg_split() between
$array = preg_split('/\s+/', trim($keywords));

$cnt=0;
$items="";
foreach ($array as $item) {
    ++$cnt;
    $item = " title like '%{$item}%'";
    if ($cnt != count($array)) {
       $item="{$item} or ";
    }
    $items .= $item;
}

$servername = "localhost";
$username = "root";
$password = "";
$dbname = "info";

$mysqli = new mysqli($servername, $username, $password, $dbname);


if ($mysqli->connect_error) {
    die("Connection failed: " . $mysqli->connect_error);
}

///////////////////////////////////////////
// count: number results per page
$count = 5;
$offset = isset($_POST["offset"])?$_POST["offset"]:"";
```

```
$sqlquery = "select title, url from content where ".$items." limit $offset, $count ;";
///////////////////////////////////////////

if ($result = mysqli_query($mysqli, $sqlquery)) {
  echo "<table>";
    while ($row = mysqli_fetch_assoc($result)) {
        echo "<tr><td>";
        echo "<a href=\"".$row['url']."\">".$row['title']."</a>";
        echo "</td></tr>";
    }
  echo "</table>";
  mysqli_free_result($result);
}

///////////////////////////////////////////////////
$sqlquery2 = "select count(title) as c from content where ".$items." ;";

if ($result2 = mysqli_query($mysqli, $sqlquery2)) {
$row = mysqli_fetch_assoc($result2);
$c = $row['c'];
//echo $c;
//echo ceil($c/$count);
}
///////////////////////////////////////////////////

$mysqli->close();
?>

<!-- ///////////////////////////////////////////////////////// -->
<table class="center">
<tr><td>
<form method="POST" action="<?php echo htmlspecialchars($_SERVER['PHP_SELF']); ?>">
<?php $sub=$offset-$count; echo $sub>=0? '<input type="submit" value=
"PREVIOUS">'.'<input type="hidden" name="keywords" value="'.$keywords.'">'.'
<input type="hidden" name="offset" value="'.$sub.'">':'<input type="submit"
value="PREVIOUS" disabled>'; ?>
</form>
</td><td>
```

```
<form method="POST" action="<?php echo htmlspecialchars($_SERVER['PHP_
SELF']); ?>">
<?php $sum=$offset+$count; echo $sum<$c? '<input type="submit"
value="NEXT">'.'<input type="hidden" name="keywords"
value="'.$keywords.'">'.'<input type="hidden" name="offset"
value="'.$sum.'">':'<input type="submit" value="NEXT"  disabled>'; ?>
</form>
</td></tr>
</table>
<!-- ///////////////////////////////////////////////////////////// -->

</body>
</html>
```

In the CSS section, the class center was used for the second HTML table, which includes only the Previous and Next buttons. A distinct class is required that does not implement multicoloring, as the plain table selector does for the first table, used for the query results.

The following PHP code sets $offset and $count, the two arguments of limit. The variable $count is set to five. $offset is set by $_POST["offset"], and for the query issued from the form's textbox, the value sent is always zero. The form of index.php is not, however, the only form included in the new version of this client-server application. As shown in the last part of the new version of search.php, each one of the two buttons (Previous and Next) is used in their own form, which updates the offset value.

With the $count set to a constant value and $offset set either by the index.php form or by the forms used with the buttons, the query can be executed in the new version with the limit option.

```
///////////////////////////////////////////
// count: number results per page
$count = 5;
$offset = isset($_POST["offset"])?$_POST["offset"]:"";
$sqlquery = "select title, url from content where ".$items." limit $offset,
$count ;";
//////////////////////////////////////////
```

With the following code, the variable $c holds the number of the results of the previous query (the limit option is not used for this query to return the result number). The variable $c will be used later to disable the Previous and Next buttons when at the start or at the end of the query results, respectively. Notice that the echo ceil($c/$count); command is commented out but can be also used for debugging purposes to return the total number of result pages. The PHP function ceil() returns the next highest integer value by rounding up if necessary.

```
//////////////////////////////////////////////////
$sqlquery2 = "select count(title) as c from content where ".$items." ;";
if ($result2 = mysqli_query($mysqli, $sqlquery2)) {
$row = mysqli_fetch_assoc($result2);
$c = $row['c'];
//echo $c;
//echo ceil($c/$count);
}
//////////////////////////////////////////////////
```

The last added source code creates the second HTML table for this web page with the two buttons Previous and Next that are used as the submit buttons of their forms. The value of the action attribute in each form is filled by PHP code, specifically by the echo command. It is set to $_SERVER['PHP_SELF'], the variable that returns the current PHP script executed.

```
<!-- ///////////////////////////////////////////////////////// -->
<table class="center">
<tr><td>
<form method="POST" action="<?php echo htmlspecialchars($_SERVER['PHP_
SELF']); ?>">
<?php $sub=$offset-$count; echo $sub>=0? '<input type="submit"
value="PREVIOUS">'.'<input type="hidden" name="keywords"
value="'.$keywords.'">'.'<input type="hidden" name="offset"
value="'.$sub.'">':'<input type="submit" value="PREVIOUS" disabled>'; ?>
</form>
</td><td>
<form method="POST" action="<?php echo htmlspecialchars($_SERVER['PHP_
SELF']); ?>">
```

```
<?php $sum=$offset+$count; echo $sum<$c? '<input type="submit"
value="NEXT">'.'<input type="hidden" name="keywords"
value="'.$keywords.'">'.'<input type="hidden" name="offset"
value="'.$sum.'">':'<input type="submit" value="NEXT"  disabled>'; ?>
</form>
</td></tr>
</table>
<!-- ///////////////////////////////////////////////////////////
```

The PHP code for the Previous button updates the offset, used hence as $sub, by decreasing it by five as follows:

```
$sub=$offset-$count;
```

Then a conditional echo runs, with the condition $sub>=0. If this is true, which means there are more previous pages, the following HTML tags are printed with the conditional echo command to the evaluated web page received by the client.

```
'<input type="submit" value="PREVIOUS">'.'<input type="hidden"
name="keywords" value="'.$keywords.'">'.'<input type="hidden" name="offset"
value="'.$sub.'">'
```

This prints to the evaluated web page the tags that create three form elements: a submit button with the Previous caption and also two hidden objects, one for sending the keywords used by the client and the other for sending the updated offset ($sub).

If the echo condition is false, just one form element is formed: a submit button. It is disabled, though.

```
'<input type="submit" value="PREVIOUS" disabled>';
```

Similar is the code for the Next button, with the difference being that the update to the offset is done by adding the following count:

```
$sum=$offset+$count;
```

Also, the choice to provide an enabled or disable Next button is determined by the following condition:

```
$sum<$c
```

Here, $c is the total number of query results.

By using each one of the Previous and Next buttons as the submit buttons of two forms, whose `action` attribute indicates the same PHP code, and using `hidden` input type fields for updating the offset value and carrying the keywords, with a button click the query `slide` moves one position backward or forward.

Using Images Instead of Submit Buttons

For a stylish appearance, you can replace the submit buttons with images by providing the appropriate CSS properties to switch them from enabled to disabled. In the following example, two images were borrowed from Wikimedia Commons.

```
https://commons.wikimedia.org/wiki/File:Minimal-next-icon.png
https://commons.wikimedia.org/wiki/File:Minimal-prev-icon.png
```

Download the files, rename them to simpler names such as `next.png` and `prev.png`, and copy them to the document root directory.

Change the source code for the second table of `search.php` to the following:

```
<!-- ////////////////////////////////////////////////////////// -->
<table class="center">
<tr><td>
<form method="POST" action="<?php echo htmlspecialchars($_SERVER['PHP_SELF']); ?>">
<?php $sub=$offset-$count; echo $sub>=0? '<input type="image" src="prev.png"
border=0>'.'<input type="hidden" name="keywords" value="'.$keywords.'">'.'<input
type="hidden" name="offset" value="'.$sub.'">':'<input type="image" src="prev.
png" border=0 disabled>'; ?>
</form>
</td><td>
<form method="POST" action="<?php echo htmlspecialchars($_SERVER['PHP_SELF']); ?>">
<?php $sum=$offset+$count; echo $sum<$c? '<input type="image" src="next.png"
border=0>'.'<input type="hidden" name="keywords" value="'.$keywords.'">'.'
<input type="hidden" name="offset" value="'.$sum.'">':'<input type="image"
src="next.png" border=0  disabled>'; ?>
</form>
</td></tr>
</table>
<!-- ////////////////////////////////////////////////////////// -->
```

The previous code replaces the buttons created from the input elements of type `submit` with image buttons using a `submit` property. The following tag is used for the `prev.png` image file:

```
<input type="image" src="prev.png" border=0>
```

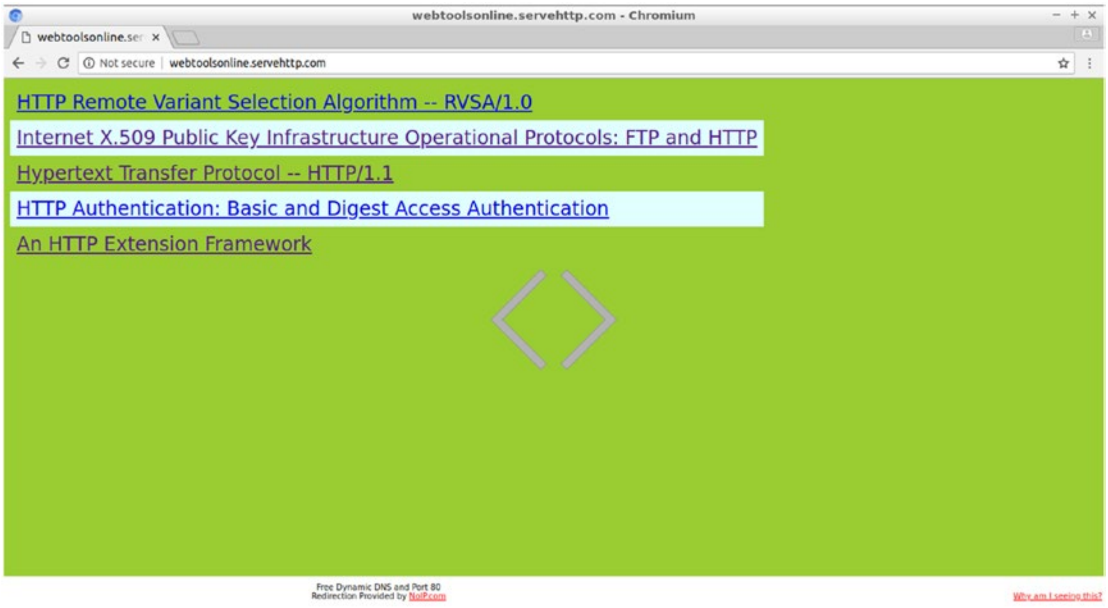
The following tag is used for the `next.png` image file:

```
<input type="image" src="next.png" border=0>
```

The `disabled` attribute can also be used in the previous code with the images.

```
<input type="image" src="prev.png" border=0 disabled>
```

Test the new site using the same query as previously. The two images appear in Figure 7-22.


webtoolsonline.servehttp.com - Chromium
webtoolsonline.ser
Not secure
webtoolsonline.servehttp.com

HTTP Remote Variant Selection Algorithm -- RVSA/1.0
Internet X.509 Public Key Infrastructure Operational Protocols: FTP and HTTP
Hypertext Transfer Protocol -- HTTP/1.1
HTTP Authentication: Basic and Digest Access Authentication
An HTTP Extension Framework

Free Dynamic DNS and Port 80
Redirection Provided by NoIP.com
Why am I seeing this?

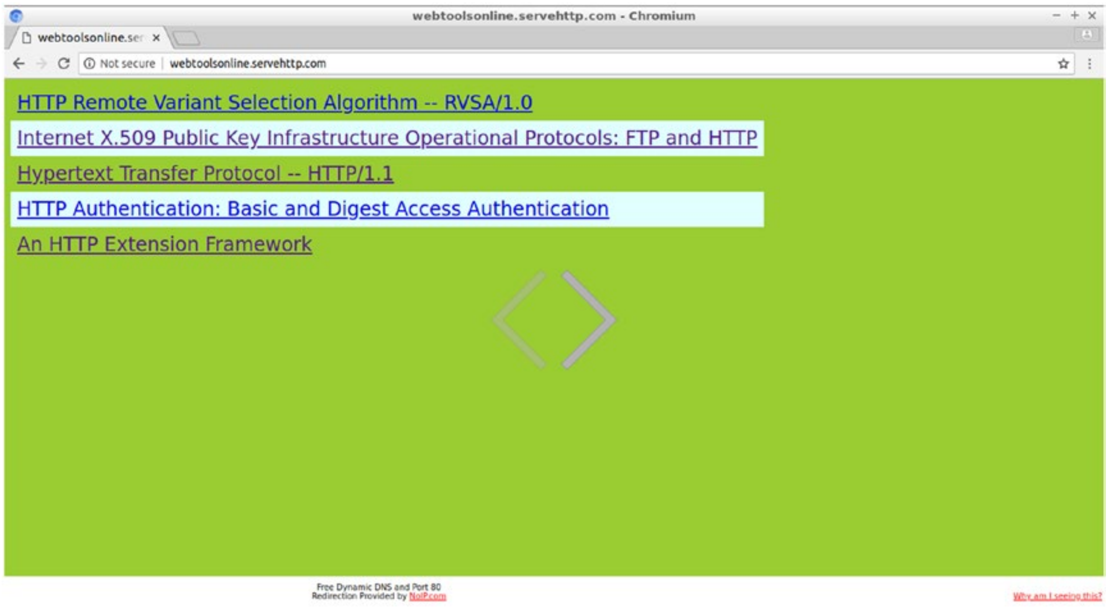
Figure 7-22. *Using images instead of buttons in search.php*

Notice that there is no characteristic to visually indicate that the left image is disabled, although it still behaves as disabled when you click it. You can change that by utilizing CSS properties. In the CSS section of `search.php`, enter the following CSS `disabled` selector that applies to the input elements of type `image`:

```
input[type=image]:disabled
{
    opacity:0.5;
}
```

When the image is disabled, its `opacity` property level becomes 0.5, with 1 being not transparent and 0 being completely transparent.

Run the previous query again. The transparency of the left image is set to 50 percent, as shown in Figure 7-23. This indicates that the image is not active.


webtoolsonline.servehttp.com - Chromium
webtoolsonline.ser
Not secure
webtoolsonline.servehttp.com
Free Dynamic DNS and Port 80 Redirection Provided by NoIP.com
Why am I seeing this?

HTTP Remote Variant Selection Algorithm -- RVSA/1.0
Internet X.509 Public Key Infrastructure Operational Protocols: FTP and HTTP
Hypertext Transfer Protocol -- HTTP/1.1
HTTP Authentication: Basic and Digest Access Authentication
An HTTP Extension Framework

Figure 7-23. *Changing the opacity CSS property for the disabled images*

Implementing the Site with the GET Method

Next, you'll change the request method for this site from POST to GET.

The method POST stores the form data in the body of the request message of the HTTP request, while GET attaches the data to the URL as the query string (name-value pairs) in the request line of the message. By using pagination and the GET method, the URL changes in each page to reflect the offset, count, and keywords carried in the query string.

Change all POST references to GET for both files used in this client-server application. In index.php, change the value of the form method attribute to get.

```
<form name="form1" method="get" action="search.php">
```

In search.php, replace all the $_POST variables with $_GET. Use, therefore, $_GET["keywords"] instead of $_POST["keywords"] and $_GET["offset"] instead of $_POST["offset"].

Replace also POST with GET in the form elements, created for the buttons, so that you finally have the following:

```
<form method="GET" action="<?php echo htmlspecialchars($_SERVER['PHP_SELF']); ?>">
```

To test the GET method, do not use a domain name like http://webtoolsonline.servehttp.com/, which was used previously with POST because of the masking DDNS feature, discussed in Chapter 4, which alters the visible URL in the user's browser. Use, for instance, the address from the masking service, which in the examples of Chapter 4 was as follows:

```
http://christos.ddns.net:8080/index.php
```

Or, as shown in Figure 7-24, simply use the following:

```
localhost/index.php
```

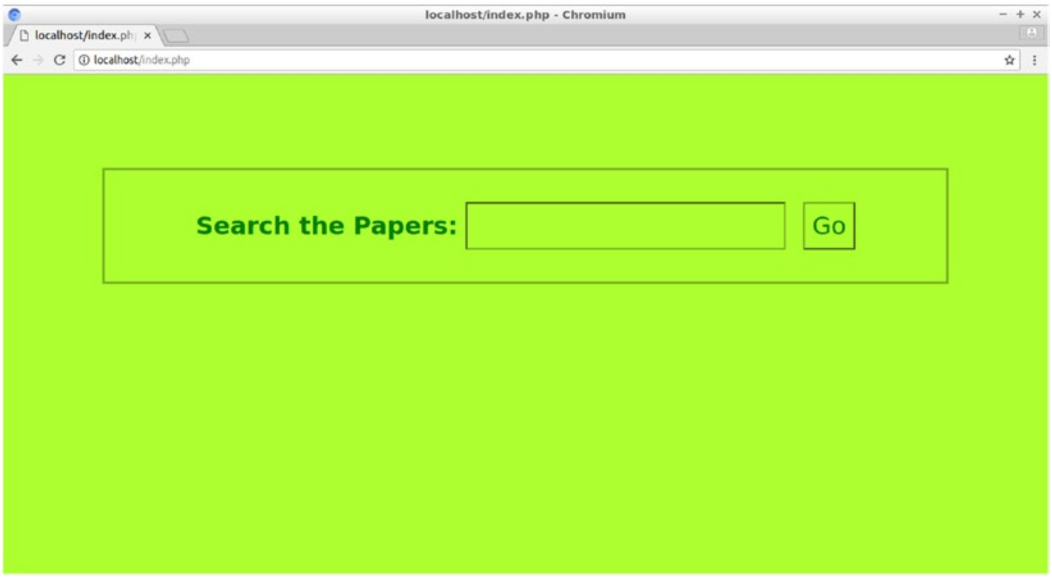
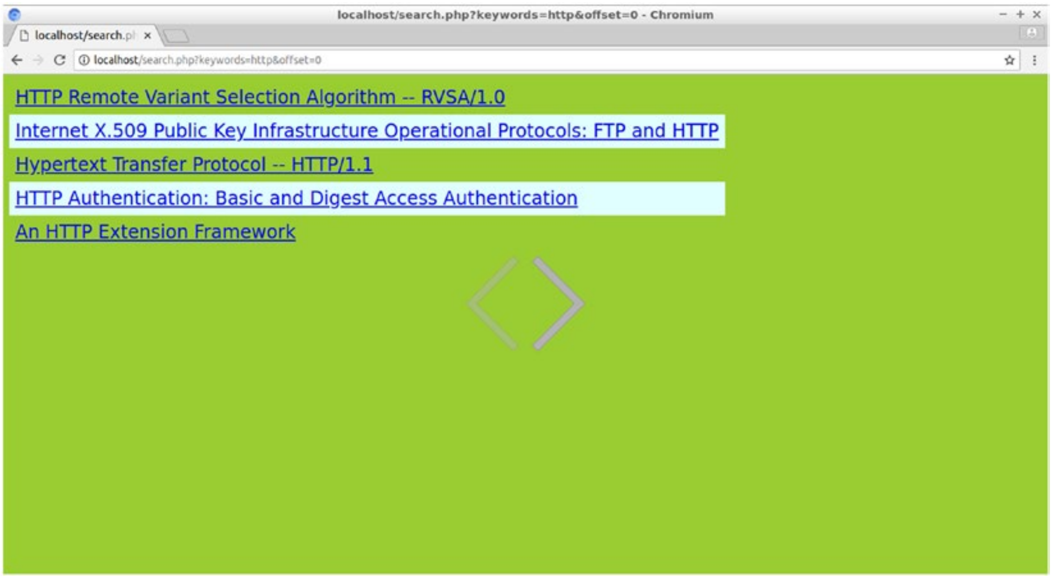


Figure 7-24. *Viewing the GET version of the site locally*

Run the previous query for the keyword *HTTP*. The query string is now visible in the address bar of your browser. In this example, as shown in Figure 7-25, it is as follows:

```
keywords=http&offset=0
```


localhost/search.php?keywords=http&offset=0 - Chromium
localhost/search.php?keywords=http&offset=0

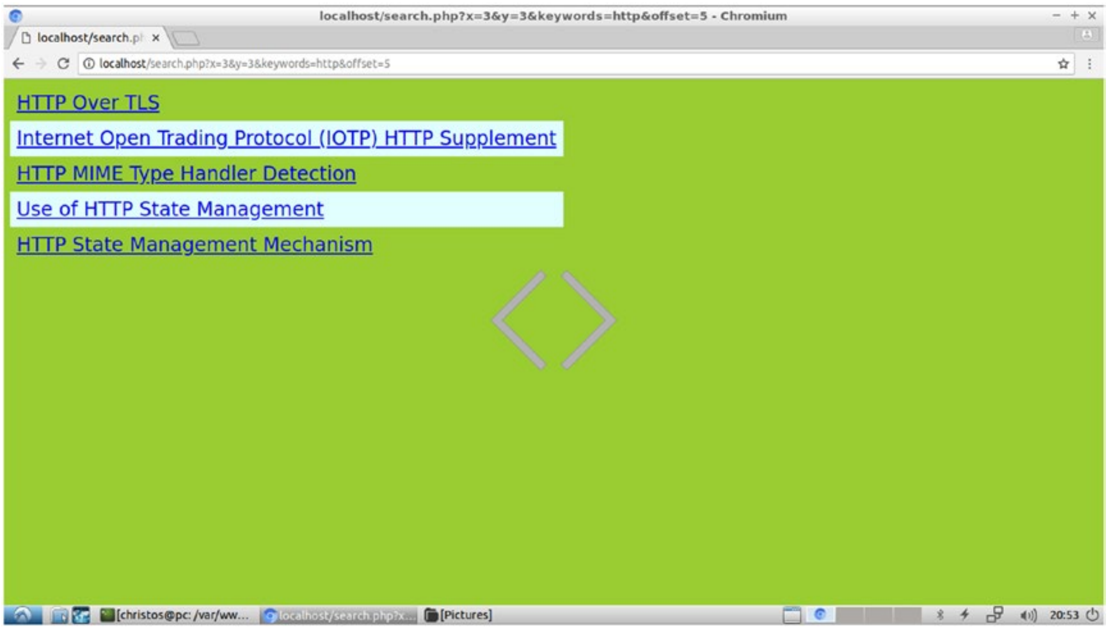
HTTP Remote Variant Selection Algorithm -- RVSA/1.0
Internet X.509 Public Key Infrastructure Operational Protocols: FTP and HTTP
Hypertext Transfer Protocol -- HTTP/1.1
HTTP Authentication: Basic and Digest Access Authentication
An HTTP Extension Framework

Figure 7-25. *With GET, the query string appears in the URL of the site*

Click the right-facing arrow image. The query string, as shown in Figure 7-26, becomes as follows:

```
x=3&y=3&keywords=http&offset=5
```

As expected, the keywords value remains the same, but the other values change. The offset is updated to 5, and you can also see x with a value of 3 and y with a value of 3. The explanation for those two mysterious names comes is that because an image was used as a submit button, it attaches to the query string the x and y coordinates of the mouse pointer when the mouse clicks the image. The value pair (3, 3) means that the mouse pointer was placed near to the origin (0, 0) of the coordinates, which is the upper-left corner of the image.


localhost/search.php?x=3&y=3&keywords=http&offset=5 - Chromium
localhost/search.p
localhost/search.php?x=3&y=3&keywords=http&offset=5
[christos@pc: /var/ww...
localhost/search.php?x...
[Pictures]
20:53

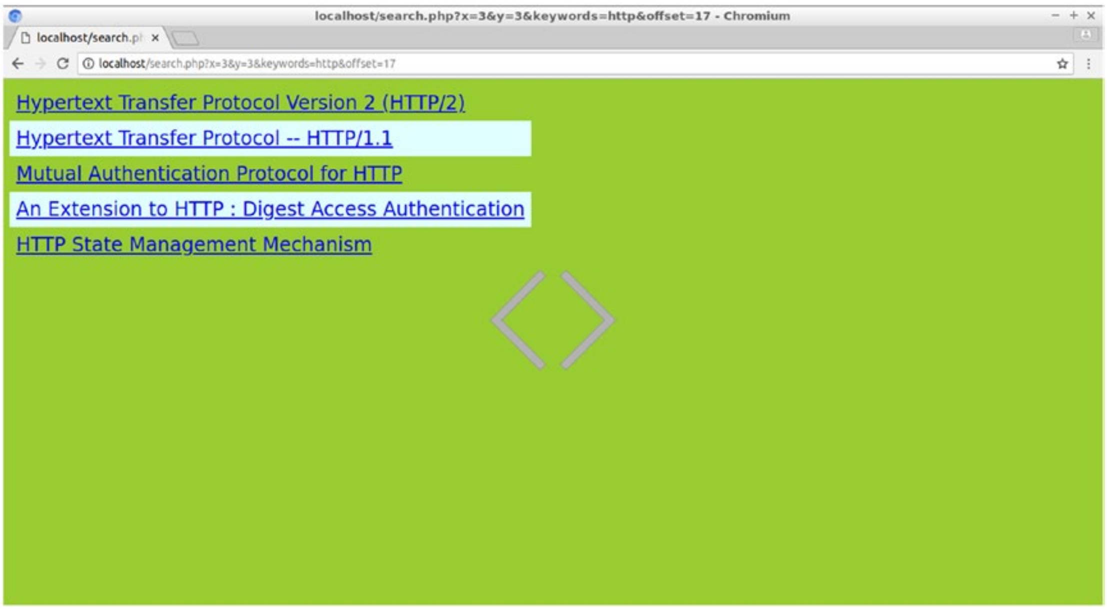
HTTP Over TLS
Internet Open Trading Protocol (IOTP) HTTP Supplement
HTTP MIME Type Handler Detection
Use of HTTP State Management
HTTP State Management Mechanism

Figure 7-26. *Viewing the mouse coordinates in the query string*

In the browser's address bar, change the offset value manually, for instance to 17:

```
localhost/search.php?x=3&y=3&keywords=http&offset=17
```

Press the Enter key. As shown in Figure 7-27, the page content gets updated with the five next records, starting at offset 17.

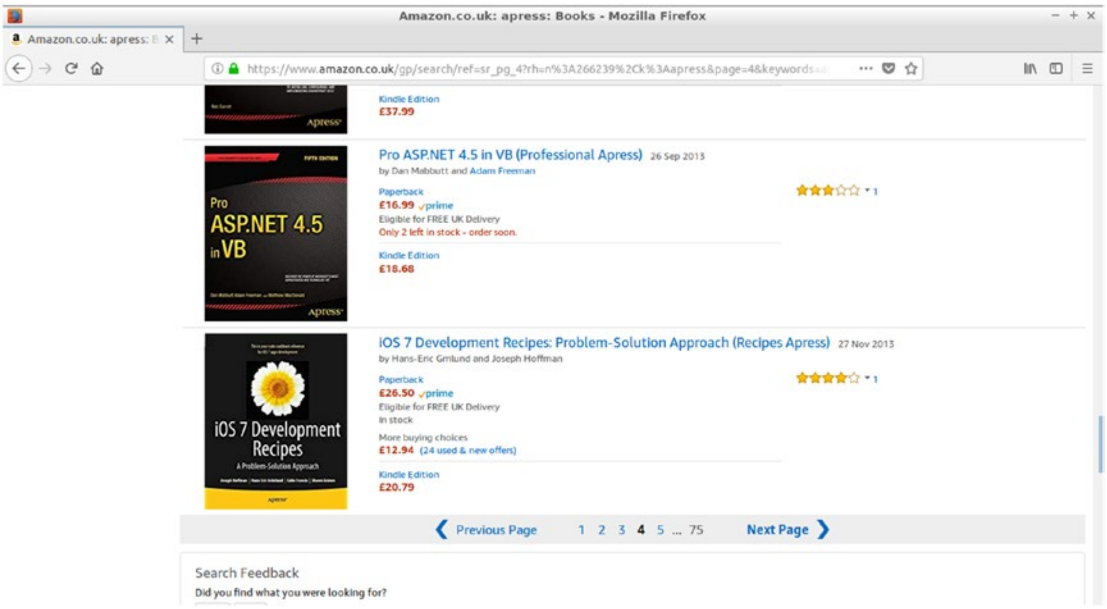

localhost/search.php?x=3&y=3&keywords=http&offset=17 - Chromium
localhost/search.p
localhost/search.php?x=3&y=3&keywords=http&offset=17

Hypertext Transfer Protocol Version 2 (HTTP/2)
Hypertext Transfer Protocol -- HTTP/1.1
Mutual Authentication Protocol for HTTP
An Extension to HTTP : Digest Access Authentication
HTTP State Management Mechanism

Figure 7-27. *Manually changing a value in the query string*

You can use this shortcut in many commercial sites when you want to move to the results at a position that is not included by the web page buttons. For instance, at the `amazon.co.uk` site, displayed in Figure 7-28, the current web page is page 4 of the query results as indicated with the page number at the bottom of the page and also in the web page's URL.

```
https://www.amazon.co.uk/gp/search/ref=sr_pg_4?rh=n%3A266239%2Ck%3Aapress&
page=4&keywords=apress&ie=UTF8&qid=1536775199
```



Amazon.co.uk: apress: Books - Mozilla Firefox

https://www.amazon.co.uk/gp/search/ref=sr_pg_4?rh=n%3A266239%2Ck%3Aapress&page=4&keywords=

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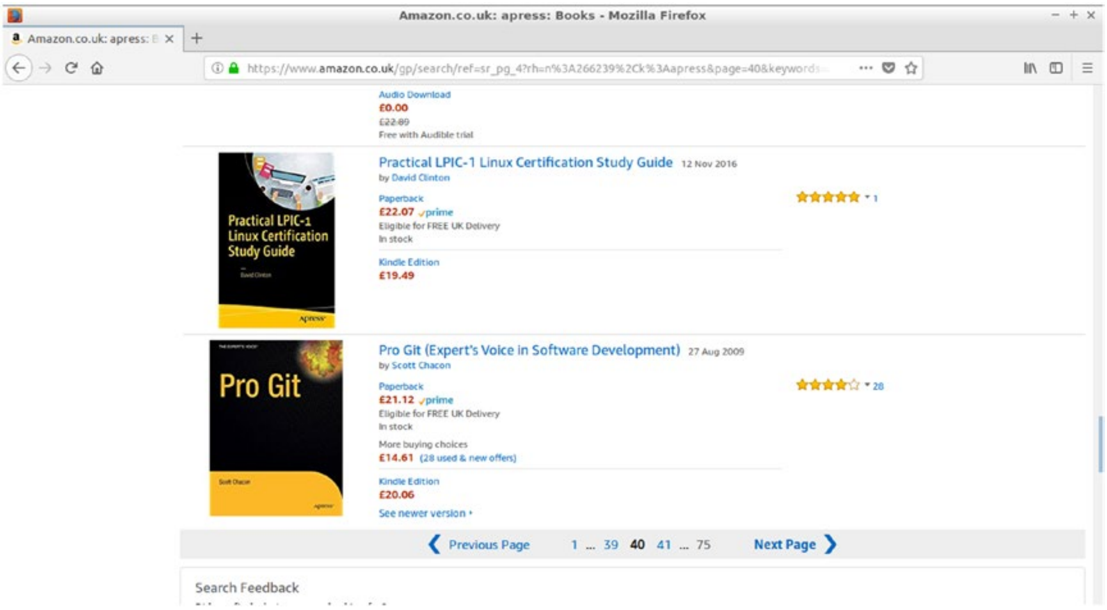
Kindle Edition
£20.79

❮ Previous Page 1 2 3 4 5 ... 75 Next Page ❯

Search Feedback
Did you find what you were looking for?

Figure 7-28. *Amazon.co.uk showing page 4*

Change the value 4 in page=4 to 40 and press the Enter key to instantly move to page 40 of the results (Figure 7-29).



Amazon.co.uk: apress: Books - Mozilla Firefox

https://www.amazon.co.uk/gp/search/ref=sr_pg_4?rh=n%3A266239%2Ck%3Aapress&page=40&keywords=

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❮ Previous Page 1 ... 39 40 41 ... 75 Next Page ❯

Search Feedback

Figure 7-29. *Amazon.co.uk showing page 40*

Summary

In this chapter, you created a project that includes a multiword search feature that is found in a large number of web sites. The query searches the contents of the site and specifically the title of each web page entered in a database. The query results are returned as links to web pages that include the keyword.

You also automated the process of updating the database with new web pages entered into the site by using `cron` to schedule the updates with a Bash shell script.

In the following chapter, you'll implement Secure Sockets Layer (SSL) for your site so that cryptography is enabled and a secure communication between the web server and the clients is ensured.

CHAPTER 8

Implementing Secure Sockets Layer on Your Site

In this chapter, you'll move from using the HTTP protocol to using HTTPS, and you'll apply the SSL/TLS protocols to implement cryptography for a secure communication between the clients and the web server of your site. The messages exchanged after this between the client and the web server will be encrypted, and it will be extremely difficult for "any man in the middle" to decrypt them. The HTTPS protocol implementation will be indicated in the protocol part of the URLs as `https://` instead of `http://`, which was used in the previous chapters for simple HTTP connections. For this to work, the public key infrastructure (PKI) of the web server (Apache or Lighttpd) has to be configured correctly.

You'll create two more projects in this chapter. The first one uses HTTP cookies to allow the otherwise stateless HTTP protocol to retain some user-specific data for each visitor, such as the user's name, which is stored on the client side. The second project utilizes HTTP cookies to implement PHP sessions and allow users to switch from one page to another in your site while maintaining the user-defined customization settings, which are stored on the server side.

Implementing SSL/TLS

PKI is considered one of the previous century's most important inventions. The ability to transfer sensitive data, such as account numbers in bank transactions or credit card details when online shopping, is essential for the reliable operation of all web services.

C. Karayiannis, *Web-Based Projects that Rock the Class*, https://doi.org/10.1007/978-1-4842-4463-0_8

Web security relies on the protocols of public key cryptography, also referred as *asymmetric cryptography*. The adjective *asymmetric* means two different cryptographic keys are used for the encryption and the decryption of a message—the private key and the public key. A *key* in cryptography is a string of bits of a specific length, and it used by a cryptographic algorithm to transform plain text into cipher text, or vice versa. A message encrypted with the public key, which is usually publicly available for the clients, can be decrypted only by its corresponding private key, which is kept secret on the server side. While a PKI session between a client and a server initiates with the public/private key pair, at the end of the session a symmetric key is established to be used for the client-server communication.

Secure HTTP (HTTPS) is implemented by including Secure Sockets Layer (SSL)—or its successor the Transport Layer Security (TLS) protocol—in the TCP/IP protocol stack just below the application protocol, which is HTTP for the World Wide Web.

SSL Certificates

To establish a secure communication with SSL/TLS, the client and the server exchange the information required to create a common symmetric key. The server sends to the client its public key in the form of a digital certificate. A digital certificate, commonly called an *SSL certificate*, is a data file that binds the public key of the web server with other attributes that identify the specific server. A valid certificate adds authentication to the communication by ensuring that an imposter, or the *man in the middle* of the communication path, will not assume the identity of the other communication's end.

Hint! While the TLS protocol tends to replace SSL, the name SSL is used broadly when referring to the cryptographic protocol used, even when the underlying mechanism is actually TLS. Because of this, certificates are generally called SSL certificates even though the right term is SSL/TLS certificates.

Digital certificates are granted by root certificate authorities (CAs), which are trusted third parties that issue SSL certificates after verifying the identity of their clients. The certificates of root CAs, called *root certificates*, are self-signed. That is, in a way, they guarantee for themselves and also are pre-installed in the browsers so that they can readily be used to verify the applicant's domain certificate. To enhance the security of the root certificate, other intermediate certificates may be utilized, with one signing another and thus creating a "chain of trust" with the domain certificate of the web server at the one end and the root CA certificate at the other.

The public key of a certain site is retrieved by the browser through the site's domain SSL certificate. To create a digital certificate for a domain, the applicant has to create a certificate-signing request (CSR) file and submit it to a CA or otherwise can self-sign it. A self-signed certificate enables a site with HTTPS; however, it will not be trusted by certain browsers, and users will be warned by some browsers against visiting the potentially insecure site. The CSR is a digital document including the public key and other identifying information and is usually created along with the matching private key. The CA may request identifying information. For instance, the applicant may be asked to prove ownership of a domain, e.g., by responding to an e-mail sent to the address of the specific domain. Next, the CA generates the certificate, signs it using its private key, and issues it to the applicant, who then imports the CA signed certificate to their own web server.

Hint! What does digital signing mean?

The CA signs a certificate by implementing a hash algorithm on the certificate to generate a message digest, which is a fixed-length string that is typically shorter than the algorithm's input and—theoretically—a unique output string. A hash algorithm is a one-way algorithm. You cannot derive the algorithm's input from its output. The digest is then encrypted with the CA's private key. The signed certificate, which is the certificate attached to the digest, is sent then to the recipient.

The recipient can verify that the certificate is received unaltered by decrypting its digest with the CA's public key. Also, it generates another digest from the received certificate using the same hashing algorithm as the sender. The two digests are compared, and if found to be identical, the certificate is considered a valid one.

After receiving a copy of the certificate, the client side (e.g., the browser) checks which CA has signed the certificate. When the validation process succeeds, the public key of the server is used on the client side, and the private key of the server is used on the server side to encrypt the messages of the SSL handshake process. This process involves exchanging a number of messages between the client and the server that result in creating a symmetric key used for the client-server communication.

Creating Self-Signed Certificates with OpenSSL

As mentioned in the previous section, an inexpensive option for your site, especially when you are just experimenting with cryptography and do not have to run an absolutely trustworthy commercial site, is to self-sign an SSL certificate instead of using a CA. Obtaining a certificate from a CA costs money and usually requires purchasing a non-DDNS domain name. On the other hand, this cost is not prohibitive, and you certainly avoid the browser warning messages viewed by your visitors about entering an insecure site.

Hint! In this chapter, you will create and use a self-signed certificate and configure the web server to use it. In the following chapters, you will learn how to obtain and use one from a certificate authority. However, you don't have to obtain a CA certificate to run the projects in the next chapters.

To generate a self-signed certificate and also your private key, use the `openssl req` (request) command in your home directory as follows:

```
$ cd ~
$ sudo openssl req -x509 -nodes -days 365 -newkey rsa:2048 -keyout server.
key -out server.crt
```

The `openssl req` command creates a certificate request in the PKCS#10 format, which is the common format used with CAs. It can additionally create self-signed certificates, which is how it will be used here.

The command's arguments are as follows:

- `-nodes` (no DES) creates a certificate that does not require a Data Encryption Standard (DES) passphrase.
- `-newkey rsa:2048` creates a 2048-bit RSA (Rivest-Shamir-Adleman) key for use with the certificate.

- `-x509` creates a self-signed certificate instead of a certificate request.
- `-keyout` specifies `server.key` as the private key file that will be created.
- `-out` specifies `server.crt` as the certificate file.
- `-days` determines the length of time in days that the certificate will be issued for.

You will be asked to enter the following information; you can press Enter for the default values or insert a period for a blank value:

```
Country Name (2 letter code) [AU]:
State or Province Name (full name) [Some-State]:
Locality Name (eg, city) []:
Organization Name (eg, company) [Internet Widgits Pty Ltd]:
Organizational Unit Name (eg, section) []:
Common Name (e.g. server FQDN or YOUR name) []:
Email Address []:
```

As the common name, you can specify your name or the fully qualified domain name (FQDN), e.g., `secureserver.ddns.net`.

Two files, `server.key` and `server.crt`, are created in your home directory. Restrict the file's access rights to be read-only by the root. Use the following:

```
$ sudo chmod 400 server.key server.crt
```

Hint! To read the file contents of `server.key` or `server.crt`, use `cat` as follows:

```
$ sudo cat server.key
```

The command's output will look like the following:

```
-----BEGIN PRIVATE KEY-----
MIIEvAIBADANBgkqhkiG9w0BAQEFAASCBKYwggSiAgEAAoIBAQCwgxSlj6d+eCtw
xWFNhBMlMN4fhhk7vmMd43JjHBOoJyJzQOk+5ziBHF9MRT9KHbDlVlCfIL3OivQm
I6AvV17vEK6zDXJ87WxhIzSdY4H9YhT7dkZ2a8YhwBLiQDDOmIf/QE2bV9Ghgdek
xj+qqcpxASh2Q4NcOgSax6rxFv3o+rxk1S7IxsjSyTnWTWQQFzEtRCV1C/sGV3PM
```

```
Ws2waf9B9tEn7HOUbqOteFXSl4P1v/iMSWddGjl2kBb8tzQ1ZIps/cPefY+Tx7MO
U7vLSv+RBRfO6Mr6iNeZnCEQOMxIxEgxpewGtEzNou8q+bRcDf9XyAL5KMVcOsE9
FIILA6AFAgMBAAECggEAFrO1Oxn/O99GzwlD24FqKPVhDDLmGe4Bt31iX+bjjd8e
qi4mEaYReWGZzCh33GN3NfflBKJkbAhXIHSijJQzLJI7teG74N9OegXaJYf/1wP/
aNwscdyorfyTMTBKVrf9fdHaaWlhF+GoR5QL6jpORDx+5L8ILRt1LicSEFIBtC4c
rgqAiJzD1qHhQzbpT9E+OcR+Ue/JK4h3YOmPF7I9wcfqOGyMoOTh1c+NIRgAgybs
1k6Kpe4pN9tujmWuHolnjOaOpX/ZtbEX9GoOgWOLUwPjw7PbzKou1UyUt3r2ufQe
ZbWGGqmktd1+tSDfserfQepZwpW8Orv8bBh8yGZYoQKBgQDkD1b16sNb7WVy5AcE
+bTB74X4s/xgt3BXcMpz1s5WWfzLTlpiU2UomO8OFtDldX1TgXrDWjzpGD8DIZjr
oSplFZ7MyWtHPLsxGxccT7oBzcx5PADDmuk3ZSez8/fvbde1xzt+eIGUD6R6XhmW
RXeduZVigtcb7Xu1lh4zJLKxGQKBgQDGIwpt3JtzWmOByblPmzY5kxtxSghPdqt+
mPI81nB1PmxmuWJULDuEcAxs6zY+6vEJiK9URago2tHHWxDIb42SwoxSxYtOVkup
DZBb8rJJLDOe/wouakjPNIDBqiTvx24vpOB9pYfuqozR1tHRaC2QhIu/BIhtUD81
Mpy/L5knzQKBgH7nWkh1XkglDbKk2JMYMFFKa448+U8IRGcjyEQ1X5QFdvnam8jj
BwNUNpHseEl22OpAXoOeDw7WAxpG88UKZYDiSv9BhYSacr+ch3ulkae3UPSVQweV
h/jfPPyR4YFF6iaoup5hiBlPqwK8ohhQh4Mo5ctvayuLNq+Q3TUwUo7hAoGAcLtv
K6LhL3i2NRo5PXnqGEgCzSp6H/w9BwKukL7RrWOe+bNwpsOj+W5nI3GQo6u5CNuk
JiabzuLxiKPfoKsXufDHNjD/WcrvsXfuMuKbXda1z/T8Lfx7AKm2uHm+Gk81+hcH
MnYEKV8QUDQRnTvQ8PD5Me26Ubfevr3VQVIrqeECgYAdKGP29sE4JxV9yCk5pECN
T4OHtHbZTTmENzNm8UaMGnFiQNtBWOa/JEuejeV8OanKHCgxoWn792Pync+hfE6D
3lzgc94vfsdthgVztpV1JHtJ5lwVqO+k8RqTHMPOc+Eg21ESghFOjagoAVFSsV1F
MLWnqVLzTBD8QPHgYfHhIA==
-----END PRIVATE KEY-----
```

Unlike with your public key, you should never display your private key (the previous key has been exposed and therefore was replaced by another one). From the private key created previously, you can extract the public key. To include the public key in another file, e.g., file `public.key`, use the following in your home directory:

```
$ sudo openssl rsa -in server.key -pubout -out public.key
```

The server responds with the following output:

```
writing RSA key
```

Use `cat` to read `public.key`.

```
$ sudo cat public.key
```

The `public.key` contents are displayed next.

```
-----BEGIN PUBLIC KEY-----
MIIBIjANBgkqhkiG9w0BAQEFAAOCAQ8AMIIBCgKCAQEAsIMUpY+nfngrcMVhTYQT
JTDeH4YZO75jHeNyYxwTtCcic0DpPuc4gRxfTEU/Sh2w5VZQnyC99Ir0JiOgL1de
7xCusw1yfO1sYSM0nWOB/WIU+3ZGdmvGIcAS4kAwzpiH/0BNm1fRoYHXpMY/qqnK
cQEodkODXDoEmseq8Rb96Pq8ZNUuyMbI0sk51k1kEBcxLUQldQv7BldzzFrNsGn/
QfbRJ+x9FG6tLXhV0peD9b/4jElnXRo5dpAW/Lc0NWSKbP3D3n2Pk8ezDlO7y0r/
kQUXzujK+ojXmZwhENDMSMRIMaXsBrRMzaLvKvm0XA3/V8gC+SjFXDrBPRSCCwOg
BQIDAQAB
-----END PUBLIC KEY----
```

Concatenate the two files created, `server.key` and `server.crt`, as a `.pem` file. PEM stands for Privacy Enhanced Mail and is the de facto file format for storing and sending cryptographic keys and certificates.

```
$ sudo cat server.key server.crt > server.pem
```

Change the access right of `server.pem`.

```
$ sudo chmod 400 server.pem
```

Set root as the owner of `server.pem`.

```
$ sudo chown root:root server.pem
```

You need to import the `server.pem` file into the configuration of both the Lighttpd and Apache web servers to enable the HTTPS protocol. In the following two sections, you will first configure SSL for Lighttpd and then do the same for Apache.

Configuring SSL for Lighttpd

To use the PEM file created in the previous section to configure SSL with Lighttpd, use the steps in this section.

Copy the file `server.pem` in `/etc/lighttpd`.

```
$ sudo cp server.pem /etc/lighttpd
```

Edit `lighttpd.conf`, the Lighttpd configuration file. Use any text editor like gedit.

```
$ sudo gedit /etc/lighttpd/lighttpd.conf
```

Replace the `server.port` value currently used (port 80 or 8080) with port number 443, which is the one used by HTTPS.

```
server.port                = 443
```

Also, set the value of the `ssl.engine` directive to `enable`, and set the `ssl.pemfile` directive to the filepath of your `.pem` file.

```
ssl.engine    = "enable"
ssl.pemfile   = "/etc/lighttpd/server.pem"
```

After saving `lighttpd.conf`, it should look like the following:

```
server.modules = (
      "mod_access",
      "mod_alias",
        "mod_accesslog",
      "mod_compress",
      "mod_redirect",
)
```

```
server.document-root        = "/var/www/html"
server.upload-dirs          = ( "/var/cache/lighttpd/uploads" )
server.errorlog             = "/var/log/lighttpd/error.log"
server.pid-file             = "/var/run/lighttpd.pid"
server.username             = "www-data"
server.groupname            = "www-data"
#######################################################
server.port                 = 443
#######################################################
#server.port                = 8080
#server.bind                = "webtoolsonline.servehttp.com"
server.errorfile-prefix     = "/srv/www/errors/status-"

dir-listing.activate        = "disable"

accesslog.filename          = "/var/log/lighttpd/access.log"
#accesslog.format           = "%V %h %l %u %t \"%r\" %>s %b \"%{Referer}i\"
                              \"%{User-Agent}i\""

index-file.names            = ( "index.php", "index.html", "index.lighttpd.
                              html" )
url.access-deny             = ( "~", ".inc" )
static-file.exclude-extensions = ( ".php", ".pl", ".fcgi" )

compress.cache-dir          = "/var/cache/lighttpd/compress/"
compress.filetype           = ( "application/javascript", "text/css",
                              "text/html", "text/plain" )

##########################################################
ssl.engine    = "enable"
ssl.pemfile   = "/etc/lighttpd/server.pem"
##########################################################

# default listening port for IPv6 falls back to the IPv4 port
## Use ipv6 if available
#include_shell "/usr/share/lighttpd/use-ipv6.pl " + server.port
include_shell "/usr/share/lighttpd/create-mime.assign.pl"
include_shell "/usr/share/lighttpd/include-conf-enabled.pl"
```

```
#include "vhost.conf"
At this point it is assumed that the Lighttpd server runs. If Apache is
currently used stop this server and start lighttpd:
$ sudo service apache2 stop
$ sudo service lighttpd start
```

To enable the changes in the configuration file, enter the following at the Linux terminal:

```
$ sudo service lighttpd force-reload
```

Configuring SSL for Apache

The same PEM file as used previously for the Lighttpd server can be used for Apache. To test Apache, stop the Lighttpd process. At the Linux terminal, enter the following:

```
$ sudo service lighttpd stop
$ sudo service apache2 start
```

You can start the Lighttpd server using this:

```
$ sudo service lighttpd start
```

Copy the PEM file used for Lighttpd to the `/etc/apache2` directory.

```
$ sudo cp /etc/lighttpd/server.pem /etc/apache2
```

You can find the `default-ssl.conf` configuration file in the `/etc/apache2/sites-available` directory. Make a backup of this file to use it as the configuration file for the Apache HTTPS server.

```
$ sudo cp /etc/apache2/sites-available/default-ssl.conf /etc/apache2/sites-
available/default-ssl.conf.bak
```

Edit the `default-ssl.conf` with a text editor.

```
$ sudo gedit /etc/apache2/sites-available/default-ssl.conf
```

You just need to add the following directive:

```
SSLCertificateFile /etc/apache2/server.pem
```

The `default-ssl.conf` file (with most comments omitted) will look like the following:

```
<IfModule mod_ssl.c>
      <VirtualHost _default_:443>
            ServerAdmin webmaster@localhost

            DocumentRoot /var/www/html


            ErrorLog ${APACHE_LOG_DIR}/error.log
            CustomLog ${APACHE_LOG_DIR}/access.log combined

            # SSL Engine Switch:
            # Enable/Disable SSL for this virtual host.
            SSLEngine on

            SSLCertificateFile    /etc/apache2/server.pem


            <FilesMatch "\.(cgi|shtml|phtml|php)$">
                        SSLOptions +StdEnvVars
            </FilesMatch>
            <Directory /usr/lib/cgi-bin>
                        SSLOptions +StdEnvVars
            </Directory>

      </VirtualHost>
</IfModule>
```

Next, you need to enable the `ssl` module. Use the following:

```
$ sudo a2enmod ssl
```

The command's output is as follows:

```
Considering dependency setenvif for ssl:
Module setenvif already enabled
Considering dependency mime for ssl:
Module mime already enabled
Considering dependency socache_shmcb for ssl:
Enabling module socache_shmcb.
Enabling module ssl.
See /usr/share/doc/apache2/README.Debian.gz on how to configure SSL and
create self-signed certificates.
To activate the new configuration, you need to run:
$ systemctl restart apache2
```

To enable the site with the configuration defined in `default-ssl.conf`, use the following:

```
$ sudo a2ensite default-ssl
```

The command's output is as follows:

```
Enabling site default-ssl.
```

The last action is to reload Apache with the new configuration. Use the command suggested by the `a2enmod` output.

```
$ sudo systemctl restart apache2
```

Or use the following:

```
$ sudo service apache2 force-reload
```

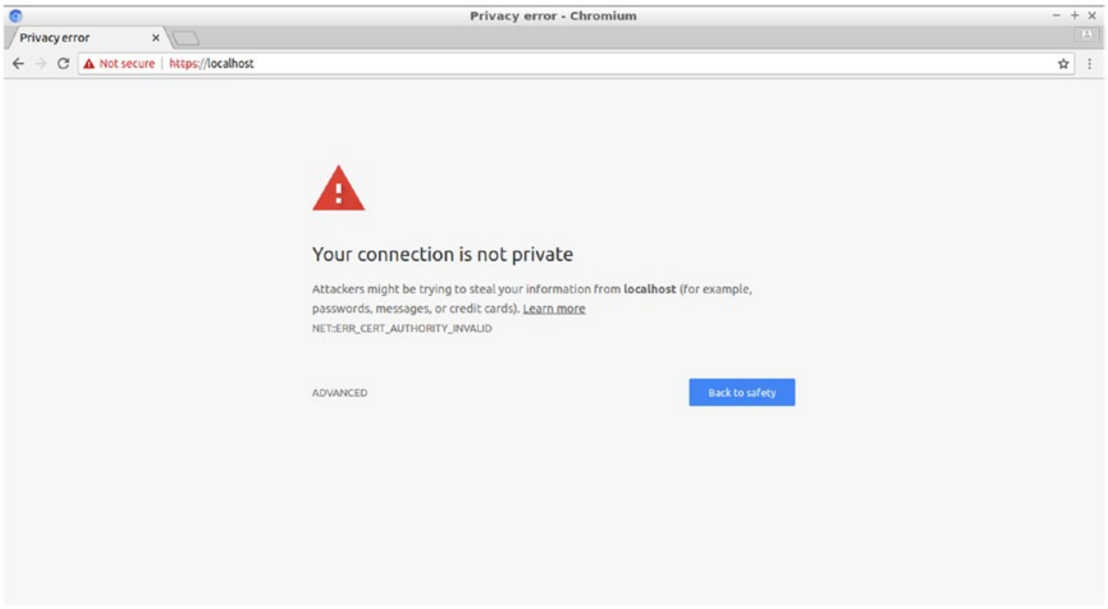
Test your site using either Apache or Lighttpd with the steps included in the following section.

Testing the Self-Signed Certificate

Test your site locally first using the following URL:

```
https://localhost
```

Because the HTTPS connection to this site is not verified by a certificate authority, the user will see a warning message, like the one shown in Figure 8-1, to urge the user to skip visiting an untrusted site.



Your connection is not private

Attackers might be trying to steal your information from **localhost** (for example, passwords, messages, or credit cards). Learn more

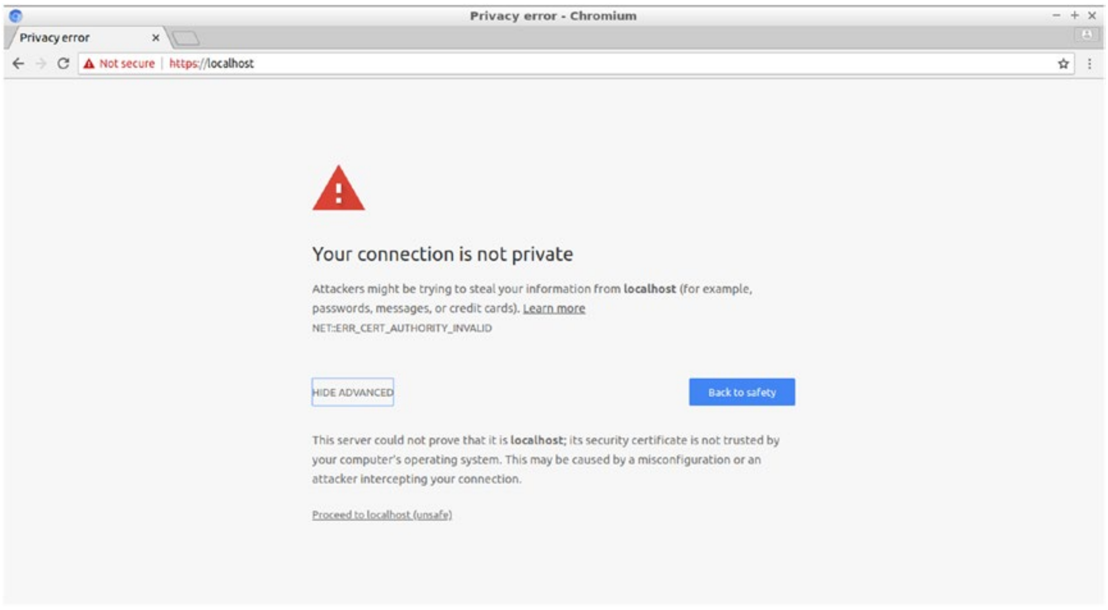
NET::ERR_CERT_AUTHORITY_INVALID

Figure 8-1. *Chromium warning against visiting an untrusted site*

Since you know that it is your own site, proceed by clicking the Advanced link. The following message appears (for the Chromium browser), displayed in Figure 8-2:

> *"This server could not prove that it is localhost; its security certificate is not trusted by your computer's operating system. This may be caused by a misconfiguration or an attacker intercepting your connection."*

Click the "Proceed to localhost (unsafe)" link.



Your connection is not private

Attackers might be trying to steal your information from **localhost** (for example, passwords, messages, or credit cards). Learn more

NET::ERR_CERT_AUTHORITY_INVALID

This server could not prove that it is **localhost**; its security certificate is not trusted by your computer's operating system. This may be caused by a misconfiguration or an attacker intercepting your connection.

Proceed to localhost (unsafe)

Figure 8-2. *By clicking the Advanced link, you have the option to proceed to a potentially "untrusted" site*

The directory index of the site appears, as displayed in Figure 8-3.

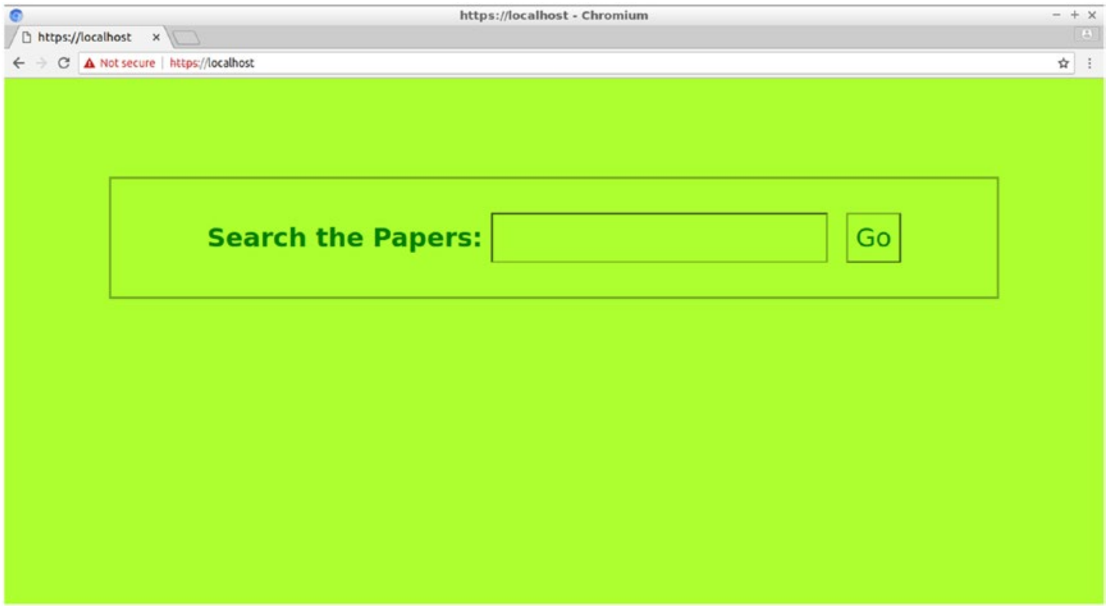
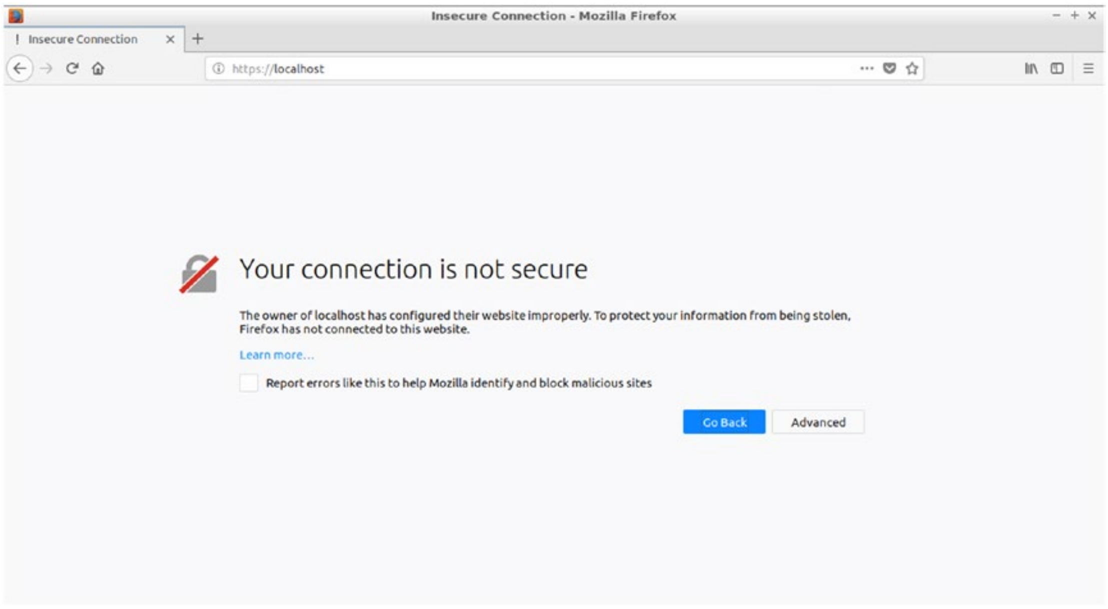


Figure 8-3. *The directory index of your site, as viewed with Chromium, when a self-signed certificate is implemented*

As you'll notice, the Chromium browser strikes out the protocol part of the URL in the address bar with a red line. Firefox, on the other hand, is more tactful. Using the same URL in Firefox, you get the message displayed in Figure 8-4.



Your connection is not secure

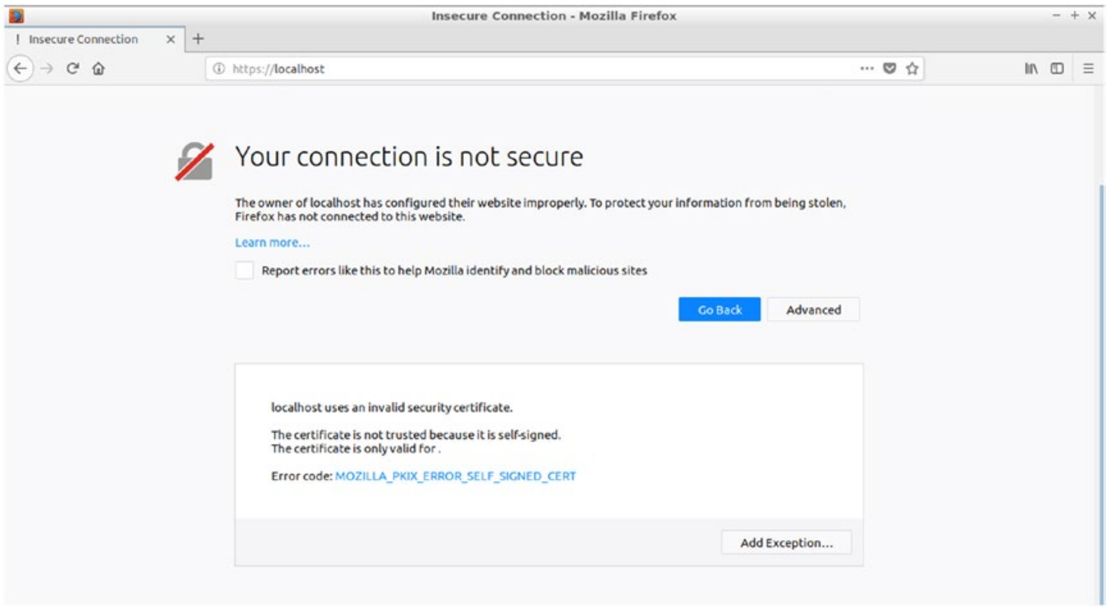
The owner of localhost has configured their website improperly. To protect your information from being stolen, Firefox has not connected to this website.

Learn more...

Report errors like this to help Mozilla identify and block malicious sites

Figure 8-4. *A warning message from Firefox about an insecure connection*

Click the Advanced button. A frame that includes the Add Exception button appears, as shown in Figure 8-5.



Your connection is not secure

The owner of localhost has configured their website improperly. To protect your information from being stolen, Firefox has not connected to this website.

Learn more...

Report errors like this to help Mozilla identify and block malicious sites

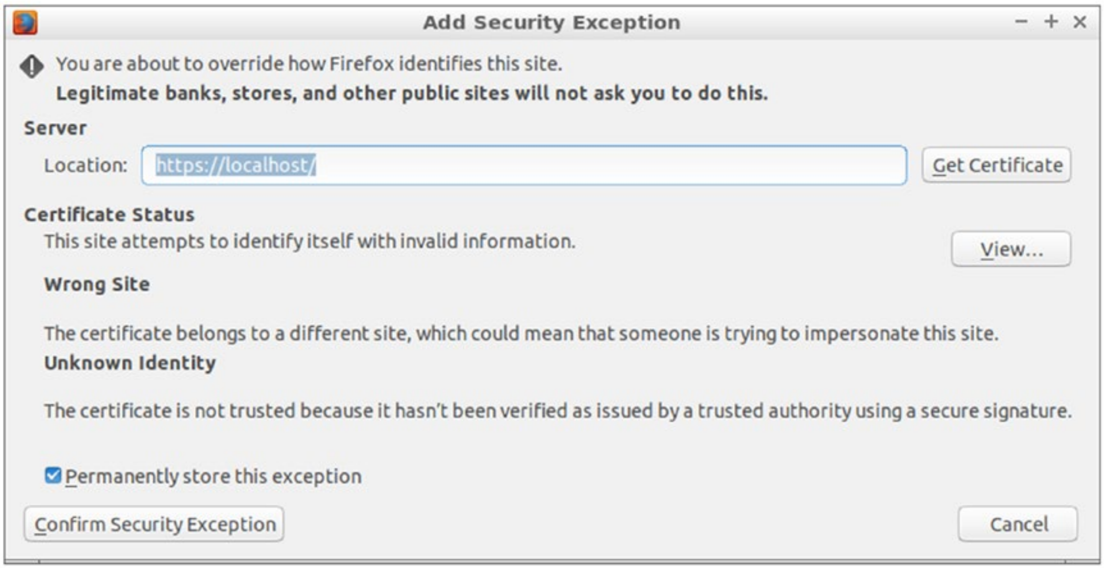
localhost uses an invalid security certificate.

The certificate is not trusted because it is self-signed.
The certificate is only valid for .

Error code: MOZILLA_PKIX_ERROR_SELF_SIGNED_CERT

Figure 8-5. *The Add Exception button in Firefox enables the user to visit the untrusted site*

Click the Add Exception button. A new dialog, displayed in Figure 8-6, requests that you add a security exception for `https://localhost/`. Click the Confirm Security Exception button.



You are about to override how Firefox identifies this site.
Legitimate banks, stores, and other public sites will not ask you to do this.

Server

Location: https://localhost/

Certificate Status

This site attempts to identify itself with invalid information.

Wrong Site

The certificate belongs to a different site, which could mean that someone is trying to impersonate this site.

Unknown Identity

The certificate is not trusted because it hasn't been verified as issued by a trusted authority using a secure signature.

☑ Permanently store this exception

Figure 8-6. *The dialog requesting a confirmation for the security exception*

The directory index of the site appears, as shown in Figure 8-7.

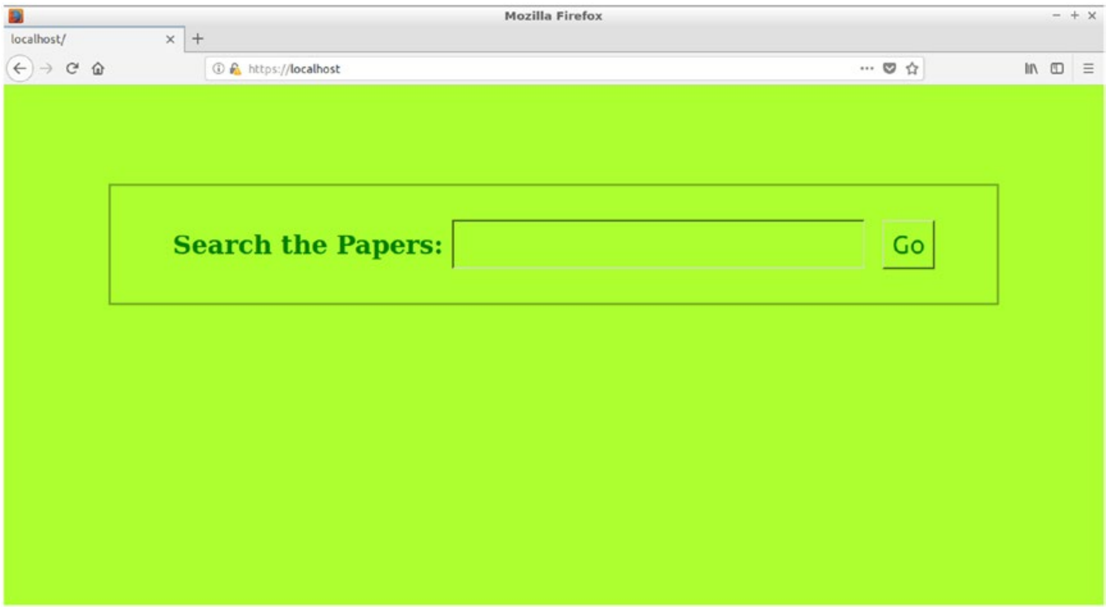
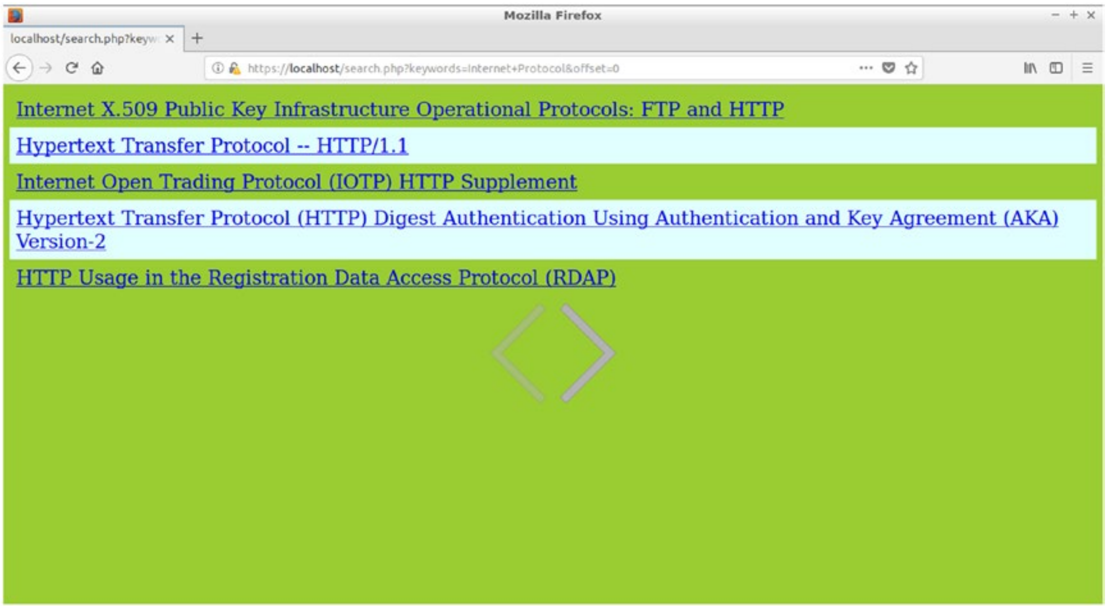


Figure 8-7. *The directory index of your site, as viewed in Firefox, when a self-signed certificate is implemented*

Test the site as usual. In the search textbox, enter, for instance, the *Internet protocol* keywords and click the Go button. The results appear in the user's browser, as shown in Figure 8-8. Click any link in the results. As expected, the corresponding web page is served with the HTTPS protocol.


Mozilla Firefox
localhost/search.php?keyw
https://localhost/search.php?keywords=Internet+Protocol&offset=0

Internet X.509 Public Key Infrastructure Operational Protocols: FTP and HTTP

Hypertext Transfer Protocol -- HTTP/1.1

Internet Open Trading Protocol (IOTP) HTTP Supplement

Hypertext Transfer Protocol (HTTP) Digest Authentication Using Authentication and Key Agreement (AKA) Version-2

HTTP Usage in the Registration Data Access Protocol (RDAP)

Figure 8-8. *The online search for the web site is carried out with HTTPS*

You can alternatively test your site using the private IP address of your server, as displayed in Figure 8-9.

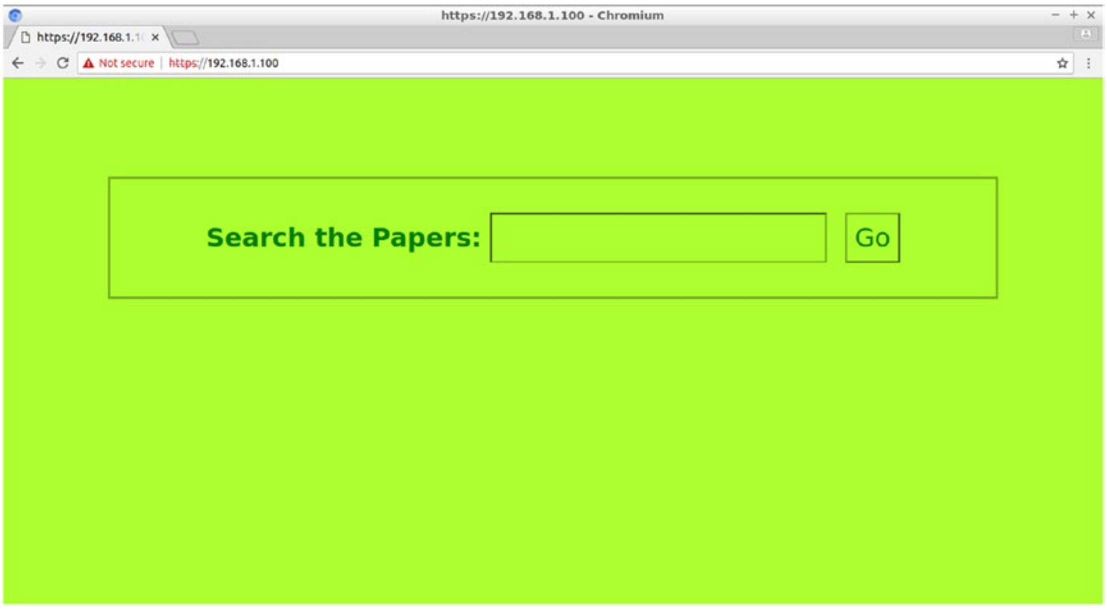


Figure 8-9. *Testing the site with the private IP address of your server*

Enabling Your Site to Be Viewed Outside of Your LAN

As with port 80 for the HTTP protocol in the previous chapters (or port 8080 if your ISP bans inbound port 80 connections), you have to enable port forwarding for port 443, the default HTTPS port number. Connect using the web interface of your router by entering its private IP address in the address bar of your browser. As displayed in Figure 8-10, the router's private IP address is 192.168.1.1 in this example.

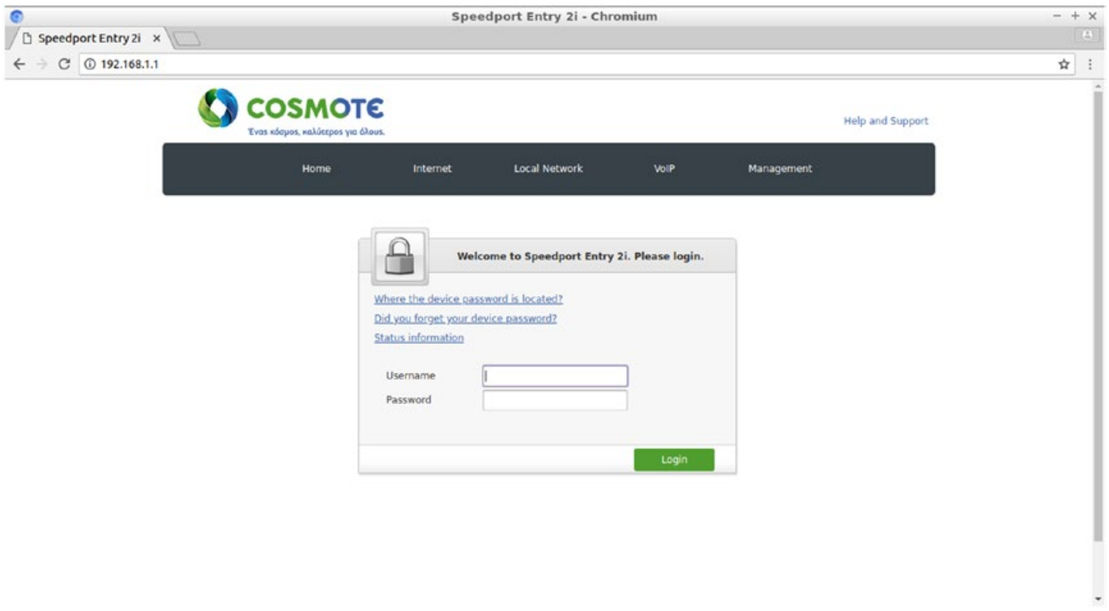
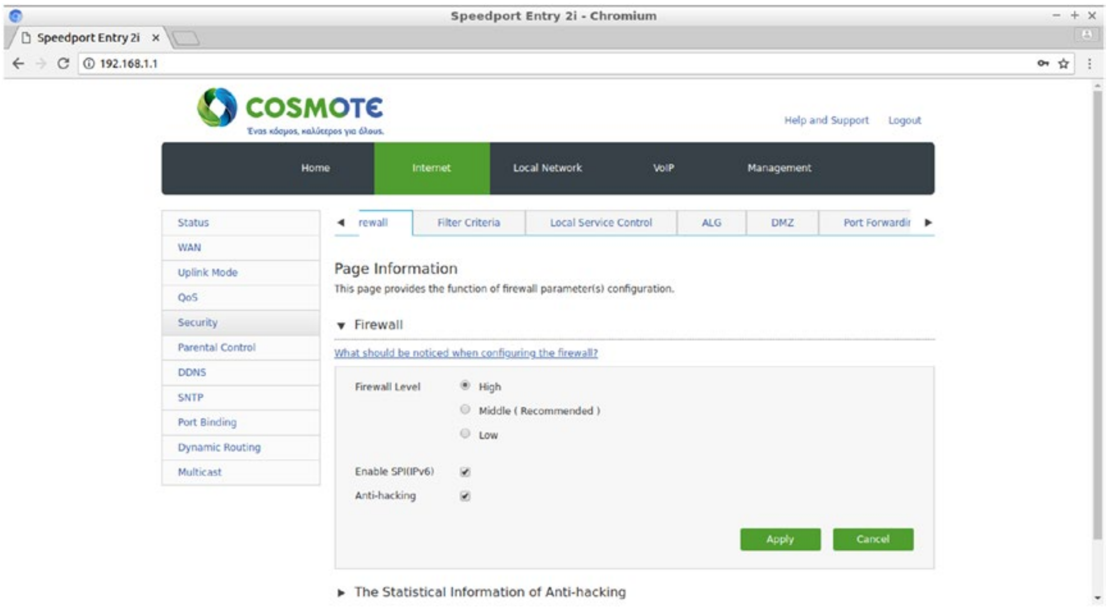

Speedport Entry 2i - Chromium
Speedport Entry 2i
192.168.1.1
COSMOTE
Ένας κόσμος, καλύτερος για όλους.
Help and Support
Home
Internet
Local Network
VoIP
Management
Welcome to Speedport Entry 2i. Please login.
Where the device password is located?
Did you forget your device password?
Status information
Username
Password
Login

Figure 8-10. *Connecting to a router's web interface*

Locate the Port Forwarding (or similar name) tab, as shown in Figure 8-11.


Speedport Entry 2i - Chromium

Speedport Entry 2i

192.168.1.1

COSMOTE

Ένας κόσμος, καλύτερος για όλους.

Help and Support Logout

Home | Internet | Local Network | VoIP | Management

Status, WAN, Uplink Mode, QoS, Security, Parental Control, DDNS, SNTP, Port Binding, Dynamic Routing, Multicast

rewall | Filter Criteria | Local Service Control | ALG | DMZ | Port Forwardi

Page Information

This page provides the function of firewall parameter(s) configuration.

▼ Firewall

What should be noticed when configuring the firewall?

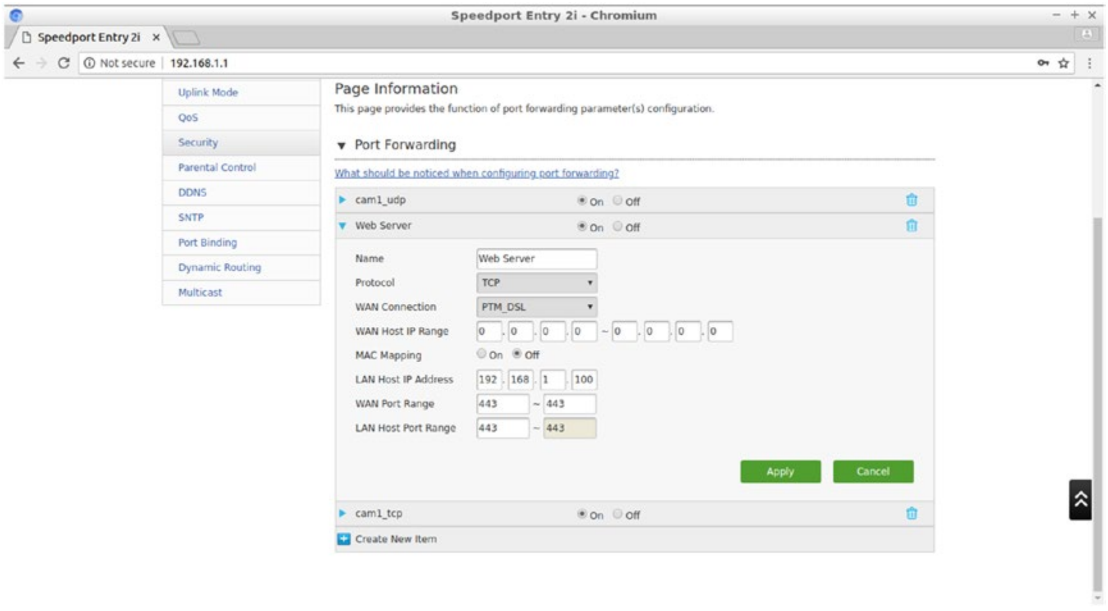
Firewall Level	[✓ High] Middle (Recommended) Low
Enable SPI(IPv6)	✓
Anti-hacking	✓

Apply Cancel

▶ The Statistical Information of Anti-hacking

Figure 8-11. *Locating the port forwarding service in the router's web interface*

Create a new entry for port 443, as displayed in Figure 8-12, and save the new configuration.


Speedport Entry 2i - Chromium

Speedport Entry 2i

Not secure | 192.168.1.1

Uplink Mode, QoS, Security, Parental Control, DDNS, SNTP, Port Binding, Dynamic Routing, Multicast

Page Information

This page provides the function of port forwarding parameter(s) configuration.

▼ Port Forwarding

What should be noticed when configuring port forwarding?

▶ cam1_udp [✓ On] Off

▼ Web Server [✓ On] Off

Name	Web Server
Protocol	TCP
WAN Connection	PTM_DSL
WAN Host IP Range	0 . 0 . 0 . 0 ~ 0 . 0 . 0 . 0
MAC Mapping	On [✓ Off]
LAN Host IP Address	192 . 168 . 1 . 100
WAN Port Range	443 ~ 443
LAN Host Port Range	443 ~ 443

Apply Cancel

▶ cam1_tcp [✓ On] Off

Create New Item

Figure 8-12. *Creating a new entry in the router's Port Forwarding section for port 443*

Your site is now available from outside your LAN. You can access it with the public IP address of your router or with the domain name of your web server. Test this using the router's public IP address in the address bar of your browser. To find the public IP address of your router, use a "find my IP" online service or enter the following in the Linux terminal:

```
$ curl ifconfig.me
```

The command's output consists just of the public IP address of your router. Here's an example:

```
94.69.57.219
```

Enter the following URL in your browser's address bar:

```
https://94.69.57.219
```

The web browser displays the "not secure" warnings discussed in the previous section, and if you proceed to download the web page, the directory index of your site is displayed, as shown in Figure 8-13.

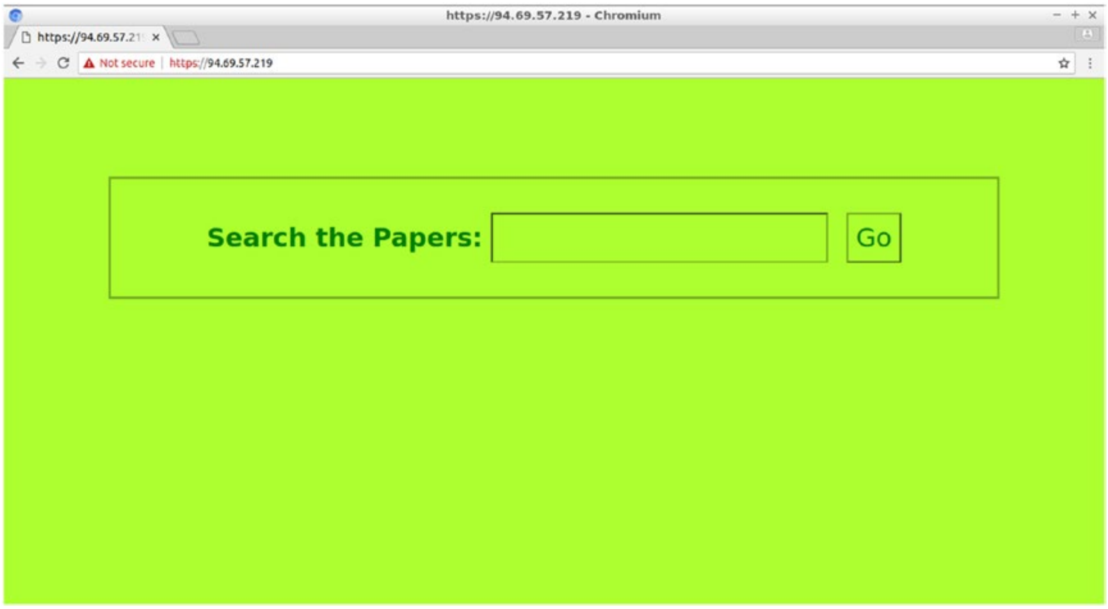


Figure 8-13. *Testing the HTTPS connection to your site using the router's public IP address*

You can also use the one of the FQDN DNS names you registered in Chapter 4. For instance, you can use the following:

```
https://christos.ddns.net
```

Or, you can use the one registered last with a more appropriate name.

```
https://secureserver.ddns.net
```

The directory index of the site also appears, as displayed in Figure 8-14.

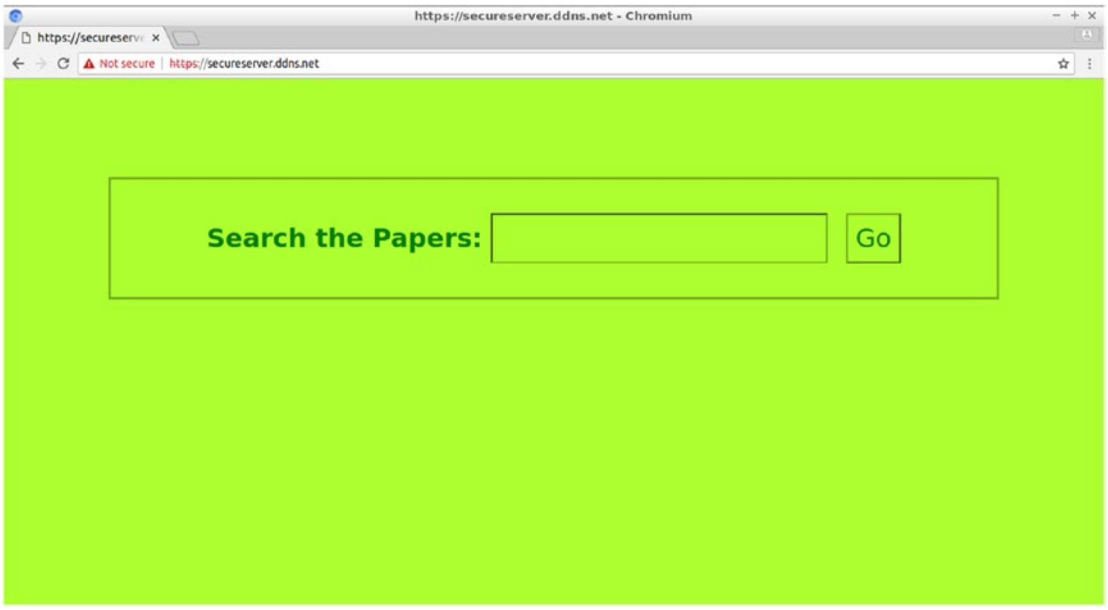

https://secureserver.ddns.net - Chromium
https://secureserv
Not secure
https://secureserver.ddns.net
Search the Papers:
Go

Figure 8-14. *Testing the HTTPS connections to your site using an FQDN*

At this point, you might expect that everything works fine. It doesn't, at least until you check the connection from outside your LAN. Using a online network tool, like `webpagetest.org` or `geoscreenshot.com`, you may discover that the web page test fails. At this point, you have to check the following:

- Your router (port forwarding)
- Your firewall
- Your ISP's inbound port 443 policy

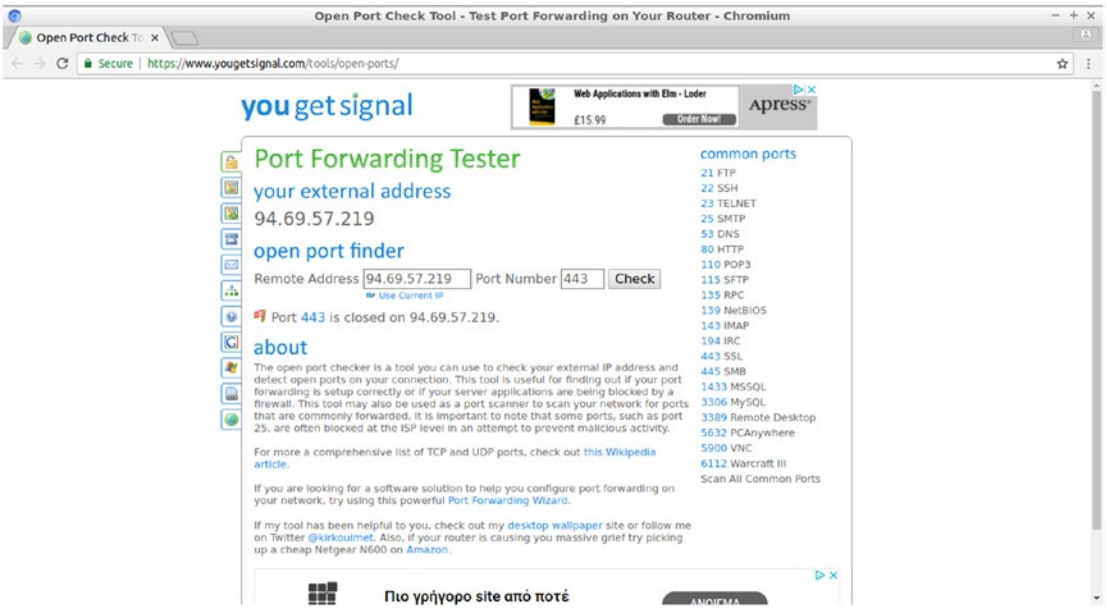
Having set up the port forwarding feature on the router as described previously, the next immediate step is to check your firewall. You can use the ufw as follows:

```
$ sudo ufw enable
$ sudo ufw allow 443
$ sudo ufw status verbose
```

The previous command's output for this example, shown next, indicates that the ports used in the previous chapters are all opened:

```
Status: active
Logging: on (low)
Default: deny (incoming), allow (outgoing), disabled (routed)
New profiles: skip

To                          Action      From
--                          ------      ----
10000/tcp                   ALLOW IN    Anywhere
80,443/tcp (Apache Full)    ALLOW IN    Anywhere
443                         ALLOW IN    Anywhere
8080                        ALLOW IN    Anywhere
8181                        ALLOW IN    Anywhere
10000/tcp (v6)              ALLOW IN    Anywhere (v6)
80,443/tcp (Apache Full (v6)) ALLOW IN    Anywhere (v6)
443 (v6)                    ALLOW IN    Anywhere (v6)
8080 (v6)                   ALLOW IN    Anywhere (v6)
8181 (v6)                   ALLOW IN    Anywhere (v6)
```

If this still doesn't work, you have to contact your ISP and request unblocking the ports if they were indeed blocked. The ISP used for the examples of the book was blocking all inbound ports from 0 up to 1023 (the primary ports). While a connection to the site was achieved internally with the FQDN, the external test with the online service `webpagetest.org` failed. After a request to the ISP, the primary ports were opened. Online services like `www.canyouseeme.org` and `www.yougetsignal.com` can verify whether a specific port number of the computer whose IP address is entered in the corresponding textbox is open. Figure 8-15 displays the test run by `yougetsignal.com`, which shows that port 443 used for the connection to the server's address was closed.


Open Port Check Tool - Test Port Forwarding on Your Router - Chromium

Secure | https://www.yougetsignal.com/tools/open-ports/

Port Forwarding Tester

your external address

94.69.57.219

open port finder

Remote Address 94.69.57.219 Port Number 443 Check

Use Current IP

Port 443 is closed on 94.69.57.219.

about

The open port checker is a tool you can use to check your external IP address and detect open ports on your connection. This tool is useful for finding out if your port forwarding is setup correctly or if your server applications are being blocked by a firewall. This tool may also be used as a port scanner to scan your network for ports that are commonly forwarded. It is important to note that some ports, such as port 25, are often blocked at the ISP level in an attempt to prevent malicious activity.

For more a comprehensive list of TCP and UDP ports, check out this Wikipedia article.

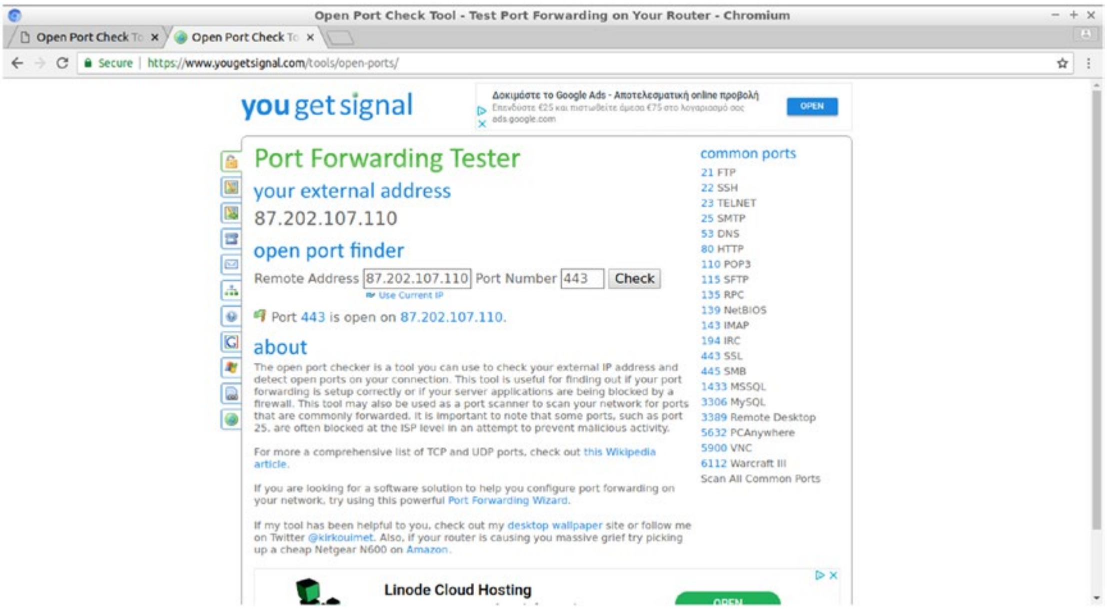
If you are looking for a software solution to help you configure port forwarding on your network, try using this powerful Port Forwarding Wizard.

If my tool has been helpful to you, check out my desktop wallpaper site or follow me on Twitter @kirkouimet. Also, if your router is causing you massive grief try picking up a cheap Netgear N600 on Amazon.

common ports
21 FTP
22 SSH
23 TELNET
25 SMTP
53 DNS
80 HTTP
110 POP3
115 SFTP
135 RPC
139 NetBIOS
143 IMAP
194 IRC
443 SSL
445 SMB
1433 MSSQL
3306 MySQL
3389 Remote Desktop
5632 PCAnywhere
5900 VNC
6112 Warcraft III
Scan All Common Ports

***Figure 8-15.** The online service yougetsignal.com verifies that port 443 is closed*

After the primary ports were opened by the ISP, the same online service ascertains that port 443 is open, as shown in Figure 8-16.


Open Port Check Tool - Test Port Forwarding on Your Router - Chromium

Secure | https://www.yougetsignal.com/tools/open-ports/

Port Forwarding Tester

your external address

87.202.107.110

open port finder

Remote Address 87.202.107.110 Port Number 443 Check

Use Current IP

Port 443 is open on 87.202.107.110.

about

The open port checker is a tool you can use to check your external IP address and detect open ports on your connection. This tool is useful for finding out if your port forwarding is setup correctly or if your server applications are being blocked by a firewall. This tool may also be used as a port scanner to scan your network for ports that are commonly forwarded. It is important to note that some ports, such as port 25, are often blocked at the ISP level in an attempt to prevent malicious activity.

For more a comprehensive list of TCP and UDP ports, check out this Wikipedia article.

If you are looking for a software solution to help you configure port forwarding on your network, try using this powerful Port Forwarding Wizard.

If my tool has been helpful to you, check out my desktop wallpaper site or follow me on Twitter @kirkouimet. Also, if your router is causing you massive grief try picking up a cheap Netgear N600 on Amazon.

common ports
21 FTP
22 SSH
23 TELNET
25 SMTP
53 DNS
80 HTTP
110 POP3
115 SFTP
135 RPC
139 NetBIOS
143 IMAP
194 IRC
443 SSL
445 SMB
1433 MSSQL
3306 MySQL
3389 Remote Desktop
5632 PCAnywhere
5900 VNC
6112 Warcraft III
Scan All Common Ports

***Figure 8-16.** The online service yougetsignal.com verifies that port 443 is open*

Hint! In Chapter 5, you created an online web service like webpagetest.org. In Chapter 10, you'll acually implement a service similar to https://www.yougetsignal.com/tools/open-ports/.

With port 443 released, you can make the final test for the connections to your site issued externally to your LAN. Use an online service like webpagetest or geoscreenshot.com, as displayed in Figure 8-17, that displays your site from various locations in the world, or you can simply test the site using the mobile Internet connection from your cell phone.

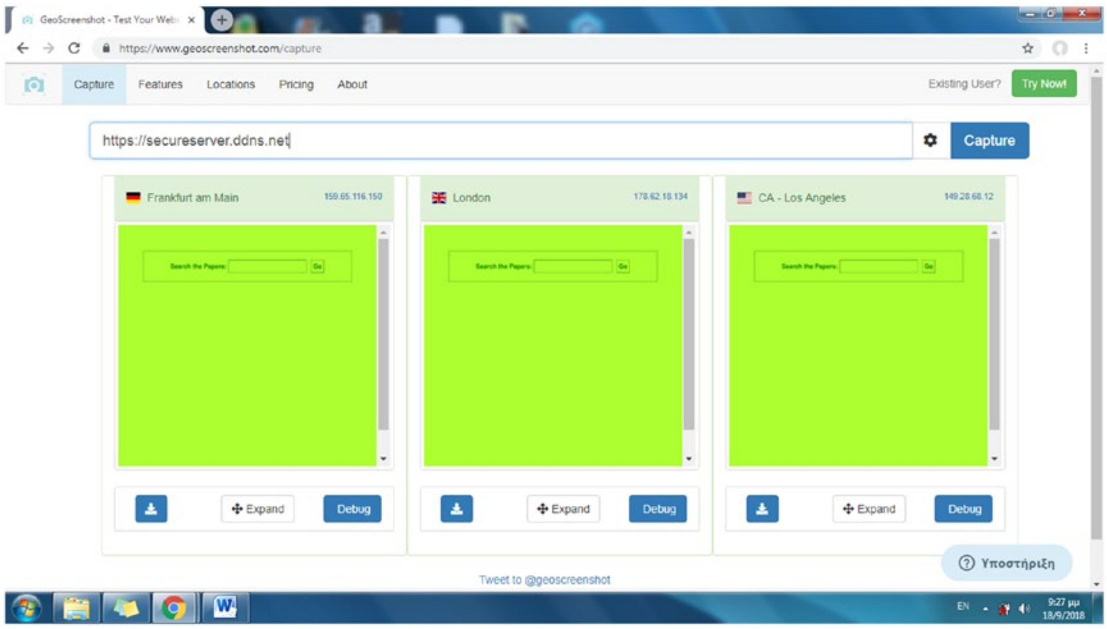


Figure 8-17. *Checking the HTTPS connection to your site from an online service*

HTTP Cookies and PHP Sessions

The HTTP protocol is *stateless*, which means there is no recording of any previous client request activity by default. Therefore, when a client logs in to an e-commerce site and adds an item to the shopping basket, a second login would be required to make a second purchase. To overcome this situation, commercial sites implement mainly two methods to maintain user-specific data: HTTP cookies and PHP sessions. A third method, using input elements of type `hidden`, was examined in the previous chapter. However, its use is temporary. When a user exits the browser, the information contained in a hidden field is lost forever.

In the project for this chapter, PHP sessions will be used. A PHP session is a technique that is based on HTTP cookies, which are small pieces of data that are sent by the web server to the browser and are stored in text files as name-value pairs on the client's file system. With any further requests to the web server, the information stored in the specific client's cookies is attached to the HTTP request message headers. Therefore, cookies are carried back and forth between the client and the server with their values updated by the web server programs.

While with cookies the data is stored on the client side, with PHP sessions, all the data is stored on the server side, except the session ID, which is stored on the client side, usually in the form of a cookie. With PHP sessions, users or spyware programs do not have access to the stored information, and for this reason, PHP sessions are considered a more secure method than cookies.

Because PHP sessions are based on the cookies in the current chapter, you'll first create a cookies-based project and then a PHP sessions project. Also, in the following chapter, when you implement SSL certificates issued from a certificate authority, you'll create a project that utilizes PHP sessions to allow a client to log in to the site and while connected view the user-specific data.

Setting a Cookie with PHP

There are three basic reasons to use cookies for your site.

- Session maintenance, for allowing the user to log in to the site and stay connected, e.g., to add new items to a shopping card
- Customization, for recalling user preferences set by the user in previous visits to the site, e.g., maintaining a specific background color when the user e-mails are displayed in a webmail service
- User tracking, for recording and analyzing user behavior, e.g., e-commerce sites providing advertisements with products relevant to the ones included in web pages visited in the past by the user

The setcookie() PHP function defines a cookie to be sent along with the rest of the HTTP headers. This function has the following syntax:

```
setcookie(name, value, expire, path, domain, secure, httponly);
```

Except name, the parameters are optional. The parameters of setcookie() are described next:

- name: Specifies the name of the cookie.
- value: Specifies the value of the cookie.
- expires: Specifies the time, set in Unix timestamp format, after which the cookie will become invalid.
- path: Specifies the URL path on the server for which the cookie will be available. If path is set to / (root), the cookie will be available within the entire domain.
- domain: Specifies the domain for which the cookie is available, e.g., webtoolsonline.servehttp.com.
- secure: Indicates that the cookie should be sent only in secure HTTPS connections.
- httponly: Indicates that the cookie will be available only through the HTTP protocol, without being accessible from scripting languages, e.g., JavaScript.

The following PHP code creates a cookie named username, assigns the value tyler to it, and specifies that the cookie expires in 30 days (30 days * 24 hours * 60 minutes * 60 seconds) from now. The function time() returns an integer containing the current time as a Unix timestamp.

```
<?php
setcookie("username", "tyler", time()+30*24*60*60);
?>
```

This function setcookie() calls should be placed before sending any output because cookies are sent in the headers of HTTP requests, and the headers of http requests come before the content of a web document.

Retrieving a Cookie Value from PHP

The PHP $_COOKIE superglobal variable is used to retrieve a cookie previously set. The following PHP code snippet types the value of the username cookie:

```
<?php
echo $_COOKIE["username"];
?>
```

Removing Cookies with PHP

To remove a cookie, you just call setcookie() for the cookie you want to delete with an expiration data that refers to the past. For instance to delete the username cookie, you could call the following:

```
<?php
setcookie("username", "", time()-3600);
?>
```

Creating a Site That Uses Cookies

You can create a PHP site that asks the visitor's first name and recalls it every time the user returns to the site until the cookie is expired.

In the document root of your web server (/var/www/html for both Apache and Lighttpd), create cookies, a new directory for this project, at the Linux terminal.

```
$ sudo mkdir /var/www/html/cookies
```

Create index.php, the directory index for this directory.

```
$ sudo gedit /var/www/html/cookies/index.php
```

Enter the following HTML and PHP source code:

```
<?php
if(isset($_POST)){
if (!(isset($_COOKIE["username"])) && (isset($_POST['t1']))){
setcookie("username", $_POST['t1'], time()+3600); //1 hour
}
}
?>
```

```
<!DOCTYPE html>
<html>
<head>
<title>Testing Cookies</title>
<style>
.p1{
color:blue;
font-size:32px;
text-align:center;
}
input{
color:blue;
font-size:32px;
}
.smiley{
color:orange;
font-size:160px;
text-align:center;
}
.center{
margin:auto;
}
</style>
</head>

<body>

<p class="p1">
<?php
if(isset($_COOKIE["username"])){
    echo "Hi " . htmlspecialchars($_COOKIE["username"]) . " I can see it is
    you!";
    echo '<p class="smiley">&#x1f603;</p>';
} else{
    echo "Welcome to the site!";
    echo '<p class="smiley">&#x1f604;</p>';
}
?>
<p>

<div class="center">
<form method="post" action="<?php echo htmlspecialchars($_SERVER['PHP_
SELF']); ?>">
<p class="p1">Please enter your first name: <input type="text" name="t1">
</p>
</form>
</div>

</body>
</html>
```

Since no data is submitted with a POST method to index.php, the first time the PHP code evaluates, the following block of code does not run:

```
<?php
if(isset($_POST)){
if (!(isset($_COOKIE["username"])) && (isset($_POST['t1']))){
setcookie("username", $_POST['t1'], time()+3600); //1 hour
}
}
?>
```

The first time the PHP code evaluates, the PHP global variable $_
COOKIE["username"] is not set yet. Therefore, on the first visit of the user at the site, the second block of PHP code runs the else part, which prints a general welcome message and also a smiley Unicode character in a large size, displayed in Figure 8-18.

The smiley chosen is a smiling face with open mouth and smiling eyes. This is Unicode character &#x1f604;.

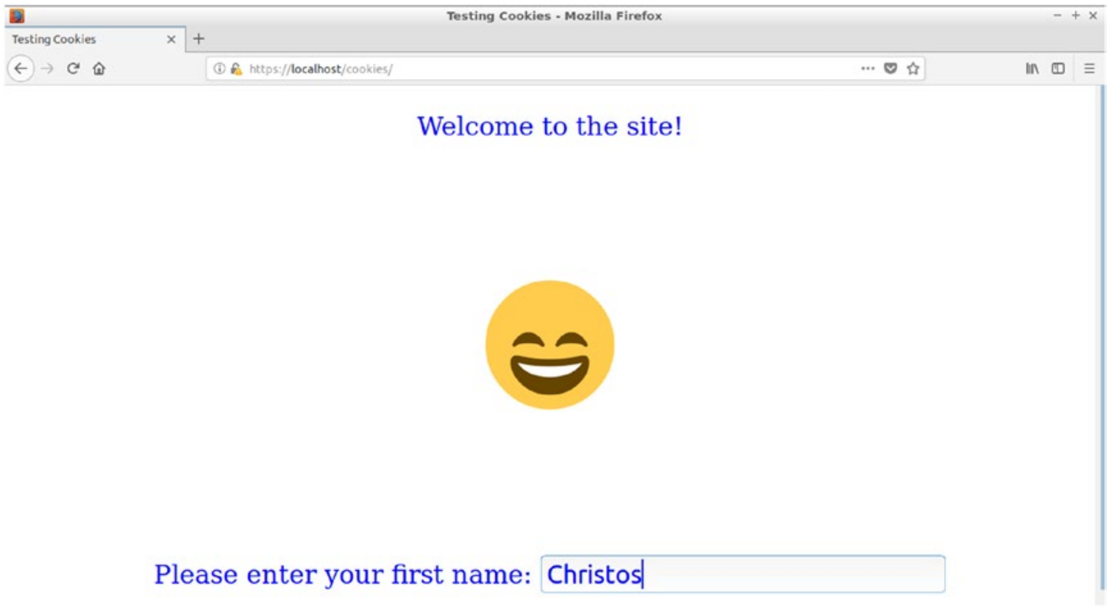

Testing Cookies - Mozilla Firefox
Testing Cookies
https://localhost/cookies/
Welcome to the site!
Please enter your first name:
Christos

Figure 8-18. *The smiley with the closed eyes appears before the user submits the first name*

```
<p class="p1">
<?php
if(isset($_COOKIE["username"])){
    echo "Hi " . htmlspecialchars( $_COOKIE["username"]) . " I can see it
    is you!";
    echo '<p class="smiley">&#x1f603;</p>';
} else{
    echo "Welcome to the site!";
    echo '<p class="smiley">&#x1f604;</p>';
}
?>
<p>
```

Any time the visitor returns to the site, the user will remain anonymous until deciding to enter their first name. In that case, the name, e.g., Christos, is entered in the textbox, as shown in Figure 8-18, and submitted by pressing the Enter key. The `action` attribute of the form, as evaluated in the following PHP block, specifies the same file, `index.php`, as the one that will receive the form's data:

```
<?php echo htmlspecialchars($_SERVER['PHP_SELF']); ?>
```

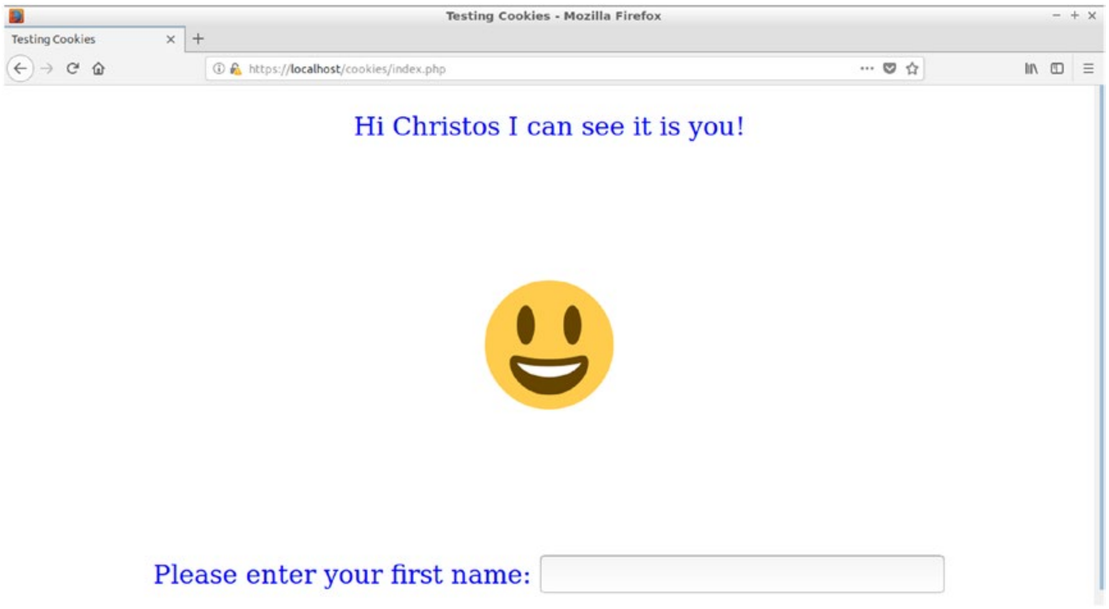
When the form's data is received by `index.php`, the first block of PHP code runs.

```
<?php
if(isset($_POST)){
if (!(isset($_COOKIE["username"])) && (isset($_POST['t1']))){
setcookie("username", $_POST['t1'], time()+3600); //1 hour
}
}
?>
```

In this code block, because the `username` cookie has not been set yet and also because a value (the user's name) was sent via the `POST` method by the `t1` textbox, the `username` cookie is assigned the value sent by textbox `t1`.

For the next hour (3,600 seconds), when someone connects to the site, using the same browser at the same computer, the `if` part of the second PHP block runs and they receive a personalized welcoming with the specific name previously sent. Also, the smiley changes from the one with the smiling eyes to the one with the open eyes (Unicode character `&#x1f603;`). See Figure 8-19.

Hint! Each browser maintains its own cookies. To display this, visit with Chromium and with Firefox and provide different names in the textbox. Then visit the site another time using both Chromium and Firefox. Each browser recalls you with the specific name you submitted in the form of each browser.


Testing Cookies - Mozilla Firefox
Testing Cookies
https://localhost/cookies/index.php

Hi Christos I can see it is you!

Please enter your first name:

Figure 8-19. *The smiley with the opened eyes along with a personalized welcome message appears when the user submits their first name*

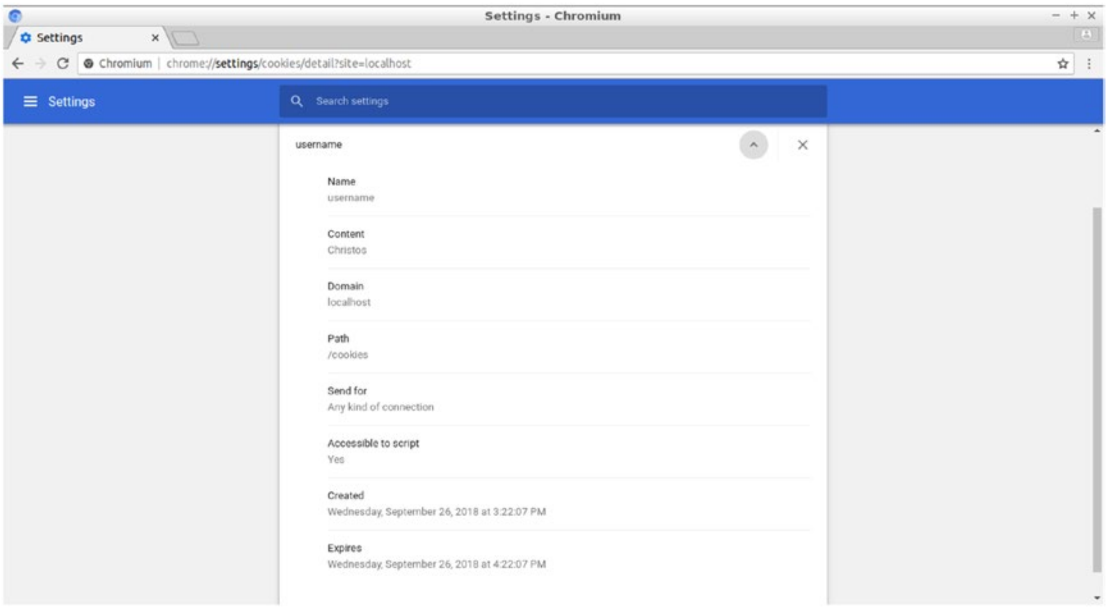
Hint! To run the previous project, cookies must be enabled on your browser. For instance, for Google Chromium, use the following steps:

1. Click the Customize and Control Chromium button (the control button with the three dots in the upper-right corner of the browser window) and select Settings.
2. On the new tab with the settings, click the Advanced link at the bottom to expand the page contents.
3. Under "Privacy and security," click "Content settings."
4. Click Cookies and ensure that the "Allow sites to save and read cookie data (recommended)" option is on.

Viewing the Cookie Details in Your Browser

For the next hour for which the `username` cookie is valid, you can view the cookie's details in your browser. For instance, for Google Chromium, use the following steps.

Click the Customize and Control Chromium button and select Settings. On the new tab with the settings, click the Advanced link at the bottom to expand the page contents. Under "Privacy and security," click "Content settings." Click Cookies and then "See all cookies and site data." In the list that appears, locate the URL used for the site, e.g., `localhost`. Click the URL and locate the cookie's name, e.g., `username`. Click the arrow at the right to view details about the cookie, as displayed in Figure 8-20.



username

Name
username

Content
Christos

Domain
localhost

Path
/cookies

Send for
Any kind of connection

Accessible to script
Yes

Created
Wednesday, September 26, 2018 at 3:22:07 PM

Expires
Wednesday, September 26, 2018 at 4:22:07 PM

Figure 8-20. *Displaying cookies details in the browser*

Using Wireshark to View the HTTP Cookie Header

The cookies are transferred between the client (the browser) and the web server in the Cookie field in the HTTP protocol headers. You can use the Wireshark packet analyzer to view a cookie's fields. To install Wireshark, use the following command:

```
$ sudo apt-get install wireshark
```

To invoke Wireshark, use the following at the terminal:

```
$ sudo wireshark
```

The Wireshark program loads in a new window. As indicated in Figure 8-21, you can choose the interface from the interface list, for instance the wired Ethernet interface denoted as `eno1` or with a similar name. If you are not sure about the interface name, you can run `ifconfig` at the terminal. Click the “Edit/apply display filter” button (the second one that depicts a funnel icon) to display only the packets that carry HTTP protocol messages. In the filter string textbox of the dialog that appears, enter **http**. Click the Apply and OK buttons. The text *http* appears in the Filter toolbar.

For this chapter, it is assumed that the ISP has released ports 80 and 443. In the previous chapters, the web servers were listening either to port 80 or to port 8080, and in a few examples to port 8181. Because the emphasis in those examples was to cover the case where the ISP bans inbound connections to port 80, examples using port 8080 were mostly used. Because HTTPS encrypts the HTTP headers, it is more straightforward with Wireshark to examine unencrypted headers. Therefore, an HTTP connection will be used next. If you have not used port 80 so far with Lighttpd, follow the next steps.

Change the Lighttpd configuration file for the server to accept also HTTP (except HTTPS) by using the following:

```
$ sudo gedit /etc/lighttpd/lighttpd.conf
```

In the configuration file, add the following conditional directive for the web server to utilize port 80 (except port 443):

```
$SERVER["socket"] == ":80" {
server.document-root        = "/var/www/html"
server.upload-dirs          = ( "/var/cache/lighttpd/uploads" )
server.errorlog             = "/var/log/lighttpd/error.log"
server.pid-file             = "/var/run/lighttpd.pid"
server.username             = "www-data"
server.groupname            = "www-data"
}
```

Save the file and reload the server to enable the new configuration by using the following:

```
$ sudo service lighttpd force-reload
```

For Apache to use HTTP port 80, the default configuration file `000-default.conf` should contain at a minimum the following directives:

```
<VirtualHost 192.168.1.100:80>
    DocumentRoot "/var/www/html"
</VirtualHost>
```

If you have altered the file `000-default.conf`, enable the new configuration by using the following:

```
$ sudo service apache2 force-reload
```

Next, open Wireshark by entering the following at the Linux terminal:

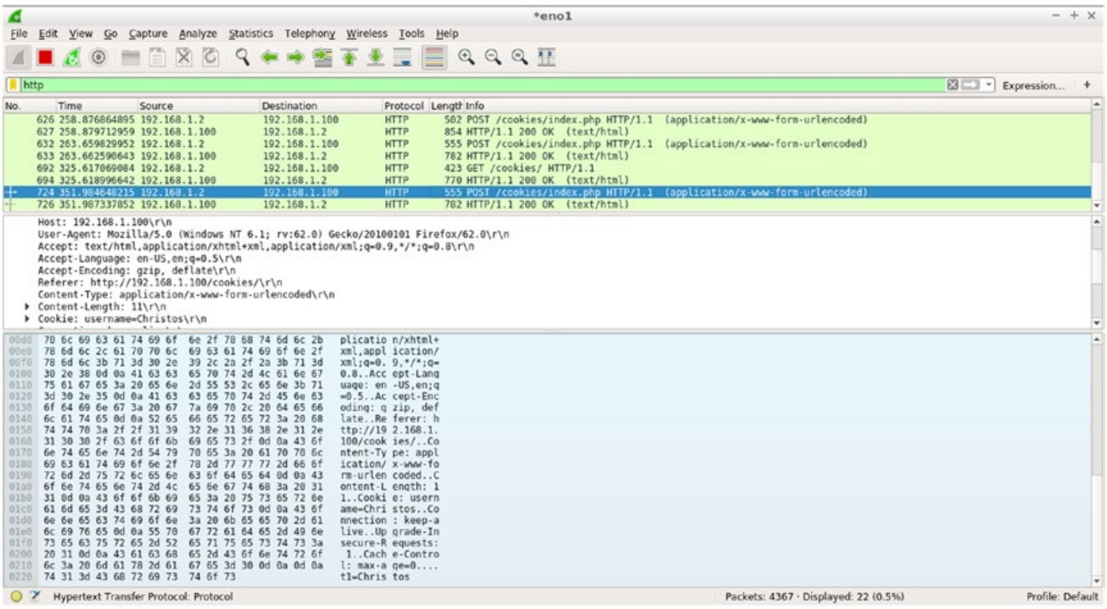
```
$ sudo wireshark
```

In the Wireshark main toolbar, click the “Start capturing packets” button, which is the blue fin button, and from another computer connect to the web server via port 80, using the following URL:

```
http://192.168.1.100/cookies
```

In the textbox of the directory index enter a name (**Christos** was used in this example) and press Enter to set the `username` cookie. The requests from this browser for the specific URL will carry the cookie in the HTTP headers of the packets sent to the web server.

On the web server, terminate the packet capturing process using the “Stop capturing packets” button, which is the red square button. You can also enter **http** in the “Apply a display filter” textbox to list only HTTP packets. In Figure 8-21, an HTTP packet is selected destined for the web server (IP address 192.168.1.100).


*eno1
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
http
Expression...

```
No.   Time           Source         Destination    Protocol Length Info
  626 258.876864895 192.168.1.2    192.168.1.100  HTTP      502 POST /cookies/index.php HTTP/1.1  (application/x-www-form-urlencoded)
  627 258.879712959 192.168.1.100  192.168.1.2    HTTP      854 HTTP/1.1 200 OK  (text/html)
  632 263.659829952 192.168.1.2    192.168.1.100  HTTP      555 POST /cookies/index.php HTTP/1.1  (application/x-www-form-urlencoded)
  633 263.662590643 192.168.1.100  192.168.1.2    HTTP      782 HTTP/1.1 200 OK  (text/html)
  692 325.617069084 192.168.1.2    192.168.1.100  HTTP      423 GET /cookies/ HTTP/1.1
  694 325.618996642 192.168.1.100  192.168.1.2    HTTP      770 HTTP/1.1 200 OK  (text/html)
  724 351.984648215 192.168.1.2    192.168.1.100  HTTP      555 POST /cookies/index.php HTTP/1.1  (application/x-www-form-urlencoded)
  726 351.987337852 192.168.1.100  192.168.1.2    HTTP      782 HTTP/1.1 200 OK  (text/html)

    Host: 192.168.1.100\r\n
    User-Agent: Mozilla/5.0 (Windows NT 6.1; rv:62.0) Gecko/20100101 Firefox/62.0\r\n
    Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8\r\n
    Accept-Language: en-US,en;q=0.5\r\n
    Accept-Encoding: gzip, deflate\r\n
    Referer: http://192.168.1.100/cookies/\r\n
    Content-Type: application/x-www-form-urlencoded\r\n
  ▸ Content-Length: 11\r\n
  ▸ Cookie: username=Christos\r\n

00d0  70 6c 69 63 61 74 69 6f  6e 2f 78 68 74 6d 6c 2b   plicatio n/xhtml+
00e0  78 6d 6c 2c 61 70 70 6c  69 63 61 74 69 6f 6e 2f   xml,appl ication/
00f0  78 6d 6c 3b 71 3d 30 2e  39 2c 2a 2f 2a 3b 71 3d   xml;q=0. 9,*/*;q=
0100  30 2e 38 0d 0a 41 63 63  65 70 74 2d 4c 61 6e 67   0.8..Acc ept-Lang
0110  75 61 67 65 3a 20 65 6e  2d 55 53 2c 65 6e 3b 71   uage: en -US,en;q
0120  3d 30 2e 35 0d 0a 41 63  63 65 70 74 2d 45 6e 63   =0.5..Ac cept-Enc
0130  6f 64 69 6e 67 3a 20 67  7a 69 70 2c 20 64 65 66   oding: g zip, def
0140  6c 61 74 65 0d 0a 52 65  66 65 72 65 72 3a 20 68   late..Re ferer: h
0150  74 74 70 3a 2f 2f 31 39  32 2e 31 36 38 2e 31 2e   ttp://19 2.168.1.
0160  31 30 30 2f 63 6f 6f 6b  69 65 73 2f 0d 0a 43 6f   100/cook ies/..Co
0170  6e 74 65 6e 74 2d 54 79  70 65 3a 20 61 70 70 6c   ntent-Ty pe: appl
0180  69 63 61 74 69 6f 6e 2f  78 2d 77 77 77 2d 66 6f   ication/ x-www-fo
0190  72 6d 2d 75 72 6c 65 6e  63 6f 64 65 64 0d 0a 43   rm-urlen coded..C
01a0  6f 6e 74 65 6e 74 2d 4c  65 6e 67 74 68 3a 20 31   ontent-L ength: 1
01b0  31 0d 0a 43 6f 6f 6b 69  65 3a 20 75 73 65 72 6e   1..Cooki e: usern
01c0  61 6d 65 3d 43 68 72 69  73 74 6f 73 0d 0a 43 6f   ame=Chri stos..Co
01d0  6e 6e 65 63 74 69 6f 6e  3a 20 6b 65 65 70 2d 61   nnection : keep-a
01e0  6c 69 76 65 0d 0a 55 70  67 72 61 64 65 2d 49 6e   live..Up grade-In
01f0  73 65 63 75 72 65 2d 52  65 71 75 65 73 74 73 3a   secure-R equests:
0200  20 31 0d 0a 43 61 63 68  65 2d 43 6f 6e 74 72 6f    1..Cach e-Contro
0210  6c 3a 20 6d 61 78 2d 61  67 65 3d 30 0d 0a 0d 0a   l: max-a ge=0....
0220  74 31 3d 43 68 72 69 73  74 6f 73                  t1=Chris tos

Hypertext Transfer Protocol: Protocol        Packets: 4367 · Displayed: 22 (0.5%)        Profile: Default
```

Figure 8-21. *The Wireshark window displays the client request, carrying the cookie*

The following are the HTTP headers for the specific packet:

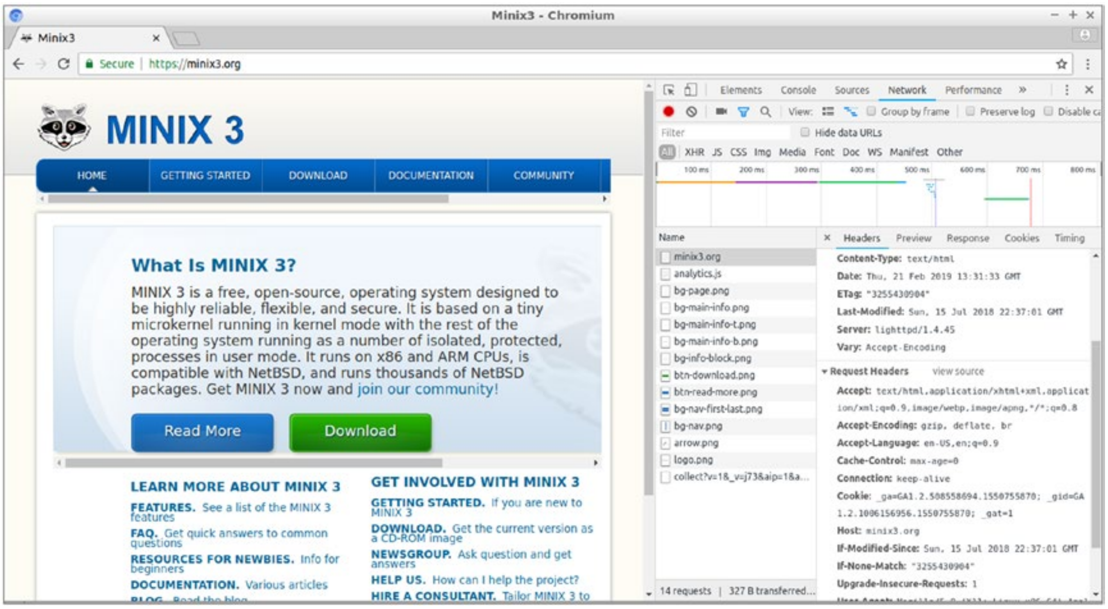
```
POST /cookies/index.php HTTP/1.1\r\n
Host: 192.168.1.100\r\n
User-Agent: Mozilla/5.0 (Windows NT 6.1; rv:62.0) Gecko/20100101
Firefox/62.0\r\n
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;
q=0.8\r\n
Accept-Language: en-US,en;q=0.5\r\n
Accept-Encoding: gzip, deflate\r\n
Referer: http://192.168.1.100/cookies/\r\n
Content-Type: application/x-www-form-urlencoded\r\n
Content-Length: 11\r\n
Cookie: username=Christos\r\n
Connection: keep-alive\r\n
Upgrade-Insecure-Requests: 1\r\n
Cache-Control: max-age=0\r\n
\r\n
```

The cookie with the name `username` and the value `Christos` is included in the cookie header in this and any other packet sent to the web server from the specific browser.

Using Browser Tools to View the HTTP Cookie Header

Many web browsers like Chromium and Firefox enable the user to view many details about the web page content and the connections, and this feature can be used to display the cookie header. In this section, you'll use Chromium to display the cookies set from another site, e.g., from `minix3.org`, using an HTTPS connection.

Visit the site and respond positively to the message about accepting cookies to the site (if such a message is used). Click the Customize and Control Chromium button (the three dots in the upper right of the window) and select "More tools" and then "Developer tools." A new pane appears on the right of the window with the Network tab selected by default. Reload the page to view the client request messages and the web server replies. Click the web page request called, e.g., `minix3.org`. The HTTP header fields appear, as displayed in Figure 8-22. Scroll down to locate the cookie header.



What Is MINIX 3?

MINIX 3 is a free, open-source, operating system designed to be highly reliable, flexible, and secure. It is based on a tiny microkernel running in kernel mode with the rest of the operating system running as a number of isolated, protected, processes in user mode. It runs on x86 and ARM CPUs, is compatible with NetBSD, and runs thousands of NetBSD packages. Get MINIX 3 now and join our community!

LEARN MORE ABOUT MINIX 3

FEATURES. See a list of the MINIX 3 features

FAQ. Get quick answers to common questions

RESOURCES FOR NEWBIES. Info for beginners

DOCUMENTATION. Various articles

GET INVOLVED WITH MINIX 3

GETTING STARTED. If you are new to MINIX 3

DOWNLOAD. Get the current version as a CD-ROM image

NEWSGROUP. Ask question and get answers

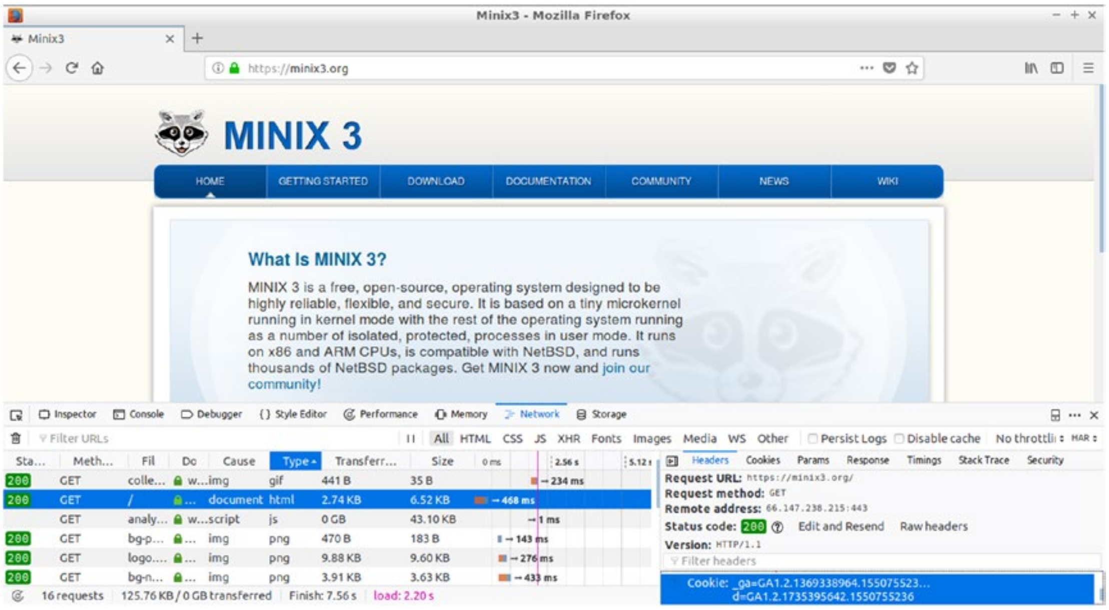
HELP US. How can I help the project?

HIRE A CONSULTANT. Tailor MINIX 3 to

```
Content-Type: text/html
Date: Thu, 21 Feb 2019 13:31:33 GMT
ETag: "3255430904"
Last-Modified: Sun, 15 Jul 2018 22:37:01 GMT
Server: lighttpd/1.4.45
Vary: Accept-Encoding
▾ Request Headers     view source
Accept: text/html,application/xhtml+xml,applicat
ion/xml;q=0.9,image/webp,image/apng,*/*;q=0.8
Accept-Encoding: gzip, deflate, br
Accept-Language: en-US,en;q=0.9
Cache-Control: max-age=0
Connection: keep-alive
Cookie: _ga=GA1.2.508558694.1550755870; _gid=GA
1.2.1006156956.1550755870; _gat=1
Host: minix3.org
If-Modified-Since: Sun, 15 Jul 2018 22:37:01 GMT
If-None-Match: "3255430904"
Upgrade-Insecure-Requests: 1
```

Figure 8-22. *Viewing the HTTP headers from the Chromium browser*

Similarly, you can view the cookie header from Firefox by clicking the Open menu button (the three stripes on the upper right of the window) and then selecting Web Developer and then Network. Reload the web page to view the request messages and the web server replies. Click the `GET` request of type `html`. The HTTP protocol headers, among them the cookie header, appear, as shown in Figure 8-23 after scrolling.



What Is MINIX 3?

MINIX 3 is a free, open-source, operating system designed to be highly reliable, flexible, and secure. It is based on a tiny microkernel running in kernel mode with the rest of the operating system running as a number of isolated, protected, processes in user mode. It runs on x86 and ARM CPUs, is compatible with NetBSD, and runs thousands of NetBSD packages. Get MINIX 3 now and join our community!

```
Sta...  Meth...  Fil      Do    Cause     Type ▴  Transferr...  Size       0 ms      2.56 s     5.12 s
200     GET      colle... 🔒 w...img       gif     441 B         35 B                 → 234 ms
200     GET      /        🔒 ... document  html    2.74 KB       6.52 KB         → 468 ms
        GET      analy... 🔒 w...script    js      0 GB          43.10 KB               → 1 ms
200     GET      bg-p...  🔒 ... img       png     470 B         183 B          → 143 ms
200     GET      logo.... 🔒 ... img       png     9.88 KB       9.60 KB        → 276 ms
200     GET      bg-n...  🔒 ... img       png     3.91 KB       3.63 KB        → 433 ms
16 requests   125.76 KB / 0 GB transferred   Finish: 7.56 s   load: 2.20 s
```

```
Request URL: https://minix3.org/
Request method: GET
Remote address: 66.147.238.215:443
Status code: 200
Version: HTTP/1.1
Cookie: _ga=GA1.2.1369338964.155075523...
        d=GA1.2.1735395642.1550755236
```

Figure 8-23. *Viewing the HTTP headers from the Firefox browser*

Using PHP Sessions

Retaining data from the client and server interaction using cookies has some security drawbacks. First, because they are stored on the user's system, they are less secure against potential attacks that could modify the cookie contents. With PHP sessions, sensitive data is safely stored in a centralized way on the web server. There is also another disadvantage. With cookies, each time the client makes a request to the server for a specific URL, all the cookies for this site are carried to the server along with the request. For ten cookies, each one with a size of 4KB, the browser will upload 40KB of extra data for each page being viewed, which will decrease the performance of your site.

Data with PHP sessions, on the other hand, is stored to temporary text files locally on the web server. Only the session ID, which is the unique identity of the session, is saved on the client side, usually as a cookie. Therefore, all sensitive information is stored in a centralized place under the authority of the site administrator.

To begin a new session, use the PHP `session_start()` function, for instance:

```
<?php
session_start();
?>
```

The function `session_start()` checks whether the session is already established by searching for a session ID on the client computer with a value of an alphanumeric string. The session ID is the only piece of data that is stored on the client side. If a session ID is found, i.e., the session is already started, session variables stored on the server computer for the specific client can be set and retrieved. Otherwise, a new session is started by creating a new session ID and storing it on the client as a cookie with the name `PHPSESSID`. The file that stores the session variables is automatically created on the server in a designated directory and with a file name consisting of the ID value prefixed by `sess_`, e.g., `sess_hg7egmhroh4vbk9925v8vu8op4`.

The PHP function `session_start()` (for the same reasons as `setcookie()`) should be called at the beginning, before the HTML tags, of each page of your site that will participate in the given session. All session data, stored as variable-value pairs, are then shared among the current page and the other web pages of the site for the specific session. This session is identified by the `PHPSESSID` cookie, which is valid for a specific browser on the client's system for the specified period of time.

The global PHP variable `$_SESSION` is the array used to store the session variables. The following PHP code creates a session and stores the values `Henrik` and `Ibsen` in the session variables `firstname` and `lastname`, respectively:

```
<?php
session_start();
?>
<!DOCTYPE html>
<html>
<body>
<?php
$_SESSION["firstname"] = "Henrik";
```

```
$_SESSION["lastname"] = "Ibsen";
?>
</body>
</html>
```

The session is terminated with the `session_unset()` and `session_destroy()` PHP functions. The function `session_unset()` removes all session variables, and `session_destroy()` deletes the session.

```
<?php
session_start();
?>
<!DOCTYPE html>
<html>
<body>
<?php
session_unset();
session_destroy();
?>
</body>
</html>
```

Running a PHP Session Example

In the document root of your server (usually `/var/www/html` for both Apache and Lighttpd), create `sessions`, which is the new directory for this project.

```
$ sudo mkdir /var/www/html/sessions
```

Create a site consisting of three web pages: `index.php` used as the directory index and `page1.php` and `page2.php`, which are two web pages linked from the directory index.

```
$ cd /var/www/html/sessions
$ sudo touch index.php page1.php page2.php
```

On `index.php`, the site's home page, the user has the option to personalize the web pages and choose one of three available background colors (orange, light blue, and lime) by clicking the corresponding colored button. The user can also choose the white button to reset the background color to the initial one. By clicking a colored button, the corresponding color applies to not only the home page but also to any other web page of the site. In this example, the home page includes two links called Books and Magazines, leading to `page1.html` and `page2.html`, respectively. As displayed in Figure 8-24, light blue is selected after the user clicks the light blue button (the second one).

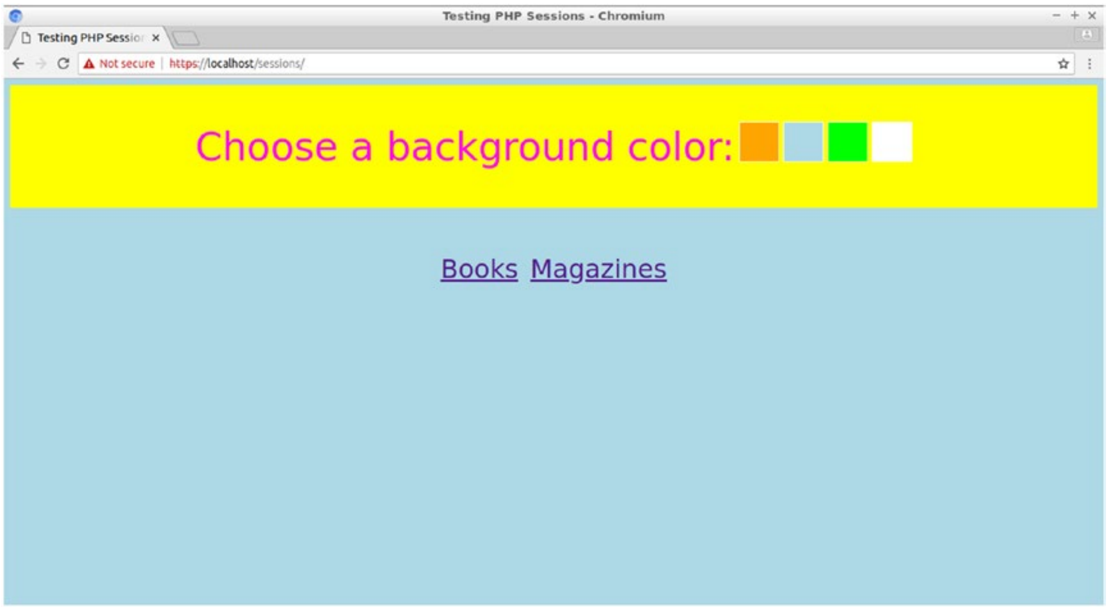

Testing PHP Sessions - Chromium
Testing PHP Sessio
Not secure
https://localhost/sessions/
Choose a background color:
Books
Magazines

***Figure 8-24.** The home page of the PHP sessions site with the light blue background color selected*

The user can click a link to see the background color of the corresponding web page. Figure 8-25 displays `page1.php` after the Books link is clicked.

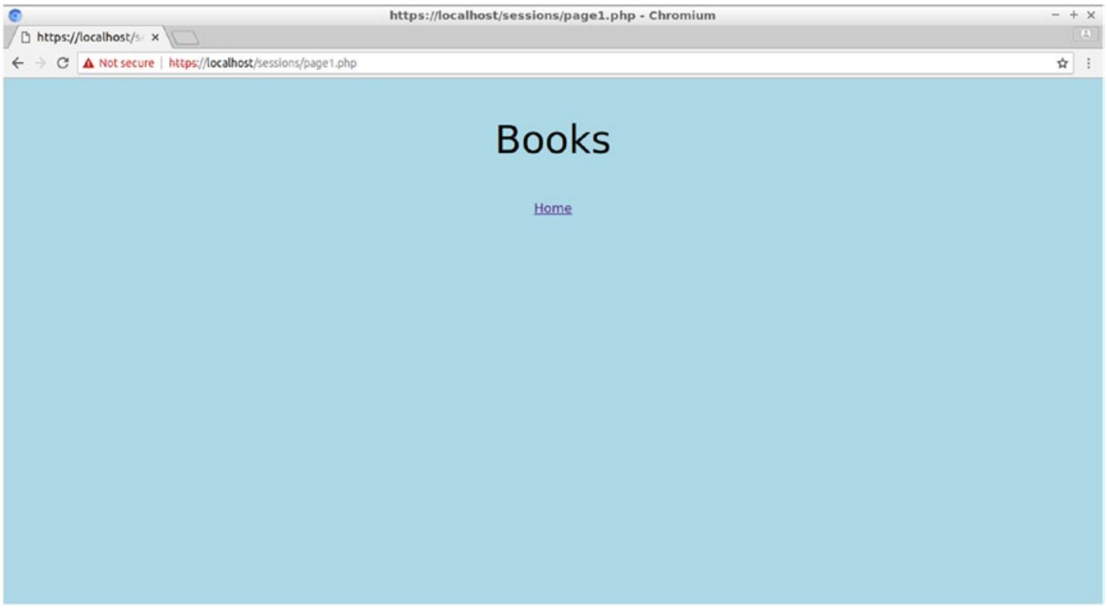

https://localhost/sessions/page1.php - Chromium
https://localhost/s
Not secure
https://localhost/sessions/page1.php
Books
Home

Figure 8-25. *The Books web page retains the user's color selection*

Figure 8-26 displays `page2.php` after the Magazines link is clicked.

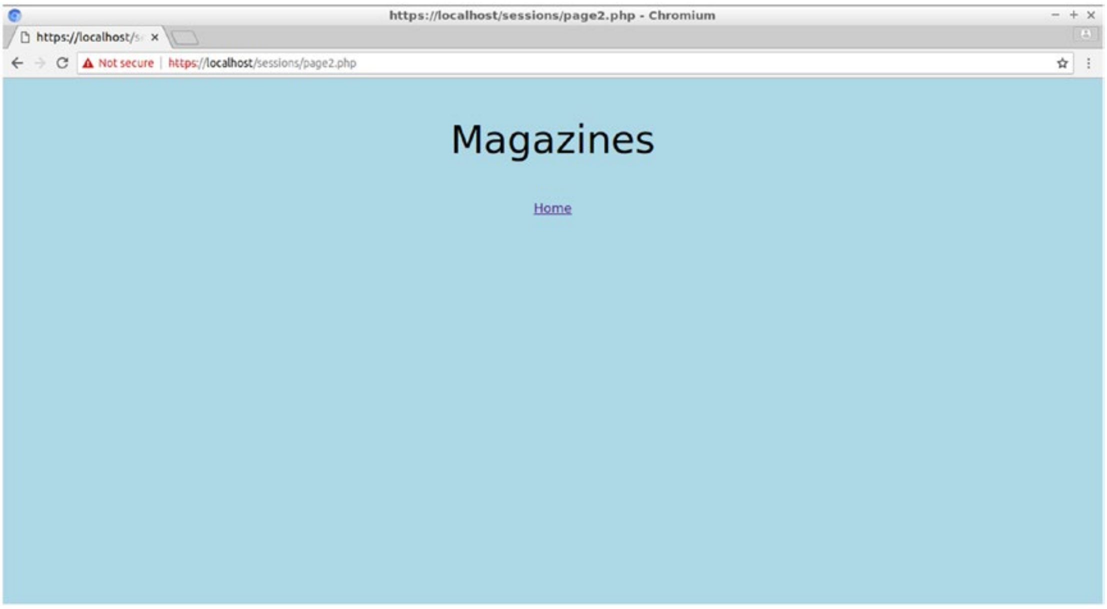

https://localhost/sessions/page2.php - Chromium
https://localhost/s
Not secure
https://localhost/sessions/page2.php
Magazines
Home

Figure 8-26. *The Magazines web page retains the user's color selection*

The PHP session mechanism is implemented in this project to store the user preferences as PHP session variables that are automatically available to any PHP web page of the site that calls the function `session_start()` in a PHP block before the web page's HTML source code. The session variable's value is used to change the background color of the current page but is also available to all other web pages of the site and is used as the `background-color` property of the body selector in the CSS section. Next you'll create the home page of the site.

The Source Code for index.php

Use the `gedit` command to edit `index.php`.

```
$ sudo gedit /var/www/html/sessions/index.php
```

Enter the following source code in the gedit window and click the Save button:

```
<?php
session_start();
?>

<!DOCTYPE html>
<html>
<head>
<title>Testing PHP Sessions</title>
<style>
a{
font-size:32px;
padding:5px;
}
body{
background-color:<?php
if(isset($_SESSION["favcolor"])){
echo $_SESSION["favcolor"] . ";";
} else {
echo "white;";
}
?>
}
```

```
p{
font-size:48px;
color:fuchsia;
}
.center{
text-align:center;
background-color:yellow;
}
.center2{
text-align:center;
}
.div1 {
    display: inline-block;
}
</style>
</head>
<body>

<?php
if(isset($_POST['s1'])){
$_SESSION["favcolor"] = "orange";
echo '
<script>
document.body.style.background = "orange";
</script>
';
} else if(isset($_POST['s2'])){
$_SESSION["favcolor"] = "lightblue";
echo '
<script>
document.body.style.background = "lightblue";
</script>
';
} else if(isset($_POST['s3'])){
$_SESSION["favcolor"] = "lime";
echo '
<script>
document.body.style.background = "lime";
</script>
';
} else if(isset($_POST['s4'])){
session_unset();
session_destroy();
echo '
<script>
document.body.style.background = "white";
</script>
';
}
?>

<div class="center">
<div class="div1">
<p>Choose a background color:</p>
</div>
<div class="div1">
<form method="POST" action="<?php echo htmlentities($_SERVER['PHP_SELF']); ?>">
<input type="submit" name="s1" value="" style="width:50px;height:50px;
border:0;background-color:orange;border:1px solid white;">
</div>
<div class="div1">
<input type="submit" name="s2" value="" style="width:50px;height:50px;
border:0;background-color:lightblue;border:1px solid white;">
</div>
<div class="div1">
<input type="submit" name="s3" value="" style="width:50px;height:50px;
border:0;background-color:lime;border:1px solid white;">
</div>
```

```
<div class="div1">
<input type="submit" name="s4" value="" style="width:50px;height:50px;
border:0;background-color:white;border:1px solid white;">
</form>
</div>
</div>

<br><br><br>
<div class="center2">
<div class="div1">
<a href="page1.php">Books</a>
</div>
<div class="div1">
<a href="page2.php">Magazines</a>
</div>
</div>
</body>
</html>
```

The first block of the PHP code starts a new session (if not already started).

```
 <?php
session_start();
?>
```

Next comes the CSS part inside the HTML head element. Certain styles are being applied, such as the position of the buttons and the links and the color and size of the text, but the noticeable part is the one that sets the background color of the page.

```
body{
background-color:<?php
if(isset($_SESSION["favcolor"])){
echo $_SESSION["favcolor"] . ";";
} else {
echo "white;";
}
?>
}
```

The first time the user views the home page—and until the user clicks a colored button—the web page's background color is white. The four colored buttons for selecting the background color are actually input elements of the `submit` type of the same form that submits the user selection to the same PHP page, as indicated by the global variable `$_SERVER['PHP_SELF']`. Each submit button is differentiated by a distinct name. The names used are `s1`, `s2`, `s3`, and `s4`. For instance, the second button is created with the following input element:

```
<input type="submit" name="s2" value="" style="width:50px;height:50px;
border:0;background-color:lightblue;border:1px solid white;">
```

Then, according to the button's name used for the data submission, the PHP and JavaScript source code runs.

With PHP, the PHP session variable `favcolor` is set. For instance, if `s2` (the light blue button) was the one submitted, the data `favcolor` is assigned to `lightblue`.

```
} else if(isset($_POST['s2'])){
$_SESSION["favcolor"] = "lightblue";
echo '
<script>
document.body.style.background = "lightblue";
</script>
```

Also, JavaScript runs locally in the web browser and sets instantly the background of the current web page to light blue.

Hint! As is the case with any other CSS property, `background-color` changes its name when accessed by JavaScript. For the `background-color` property, the name in JavaScript becomes `background`.

All other web pages of the site when visited retain the light blue background with the `favcolor` value setting in the CSS section of the `background-color` property of the body selector. The following code snippet can be used in any other web page of the site:

```
body{
background-color:<?php
if(isset($_SESSION["favcolor"])){
echo $_SESSION["favcolor"] . ";";
} else {
echo "white;";
}
?>
}
```

With the white button, there is an exception. By clicking this button, JavaScript is used locally on the client to set instantly the background color of the current web page, but the PHP code does not set `favcolor`; rather, it destroys the session. When `favcolor` is not set for any other web page visited, the `else` part of the previous source code runs, and the CSS `background-color` property for the body selector defaults to white.

```
?>
```

The last part of code in `index.php` creates two links to `page1.php` and `page2.php` called Books and Magazines, respectively.

```
<div class="center2">
<div class="div1">
<a href="page1.php">Books</a>
</div>
<div class="div1">
<a href="page2.php">Magazines</a>
</div>
</div>
```

You'll create the two web pages `page1.html` and `page2.html` next.

The Source Code for page1.html and page2.html

With the user selections, the `favcolor` PHP session variable obtains a value, and this value will be available to the other two web pages of the site, e.g., `page1.php` and `page2.php`, given that they also implement PHP sessions. Here you'll create `page1.html`, the Books page, and `page2.html`, the Magazines page.

At the Linux terminal, use gedit to insert the source code to `page1.php`.

```
$ sudo gedit /var/www/html/sessions/page1.php
```

Enter the following source code and save the file:

```
<?php
session_start();
?>

<!DOCTYPE html>
<html>
<head>
<style>
body{
background-color:<?php
if(isset($_SESSION["favcolor"])){
echo $_SESSION["favcolor"] . ";";
} else {
echo "white;";
}
?>
}
p{
text-align:center;
font-size:48px;
}
.center{
text-align:center;
}
</style>
</head>
<body>
<div>
<p>Books</p>
</div>
<div class="center">
<a href="index.php">Home</a>
</div>
</body>
</html>
```

The first PHP block connects to the session started from `index.php` using the same function call with `index.php`, `session_start()`.

```
<?php
session_start();
?>
```

After the function `session_start()` is called, if the PHP session variable `favcolor` was previously set in `index.php`, it becomes also available to `page1.php`. Its value is used to set the background color of `page1.php`. If the user decides to click the Books link and navigate to `page1.php` without first selecting one of the three colors, the `favcolor` variable is not set, and the default color (white) applies for the background color of the page.

```
body{
background-color:<?php
if(isset($_SESSION["favcolor"])){
echo $_SESSION["favcolor"] . ";";
} else {
echo "white;";
}
?>
```

In the body of `page1.php`, there is some text (Books) and a link for returning to the home page.

```
<body>
<div>
<p>Books</p>
</div>
<div class="center">
<a href="index.php">Home</a>
</div>
</body>
```

Create the web page `page2.php`.

```
$ sudo gedit /var/www/html/sessions/page2.php
```

Enter the following for the `page1.html` source code and save the file:

```
<?php
session_start();
?>

<!DOCTYPE html>
<html>
<head>
<style>
body{
background-color:<?php
if(isset($_SESSION["favcolor"])){
echo $_SESSION["favcolor"] . ";";
} else {
echo "white;";
}
?>
}
p{
text-align:center;
font-size:48px;
}
.center{
text-align:center;
}
</style>
</head>

<body>
<div>
<p>Magazines</p>
</div>
```

```
<div class="center">
<a href="index.php">Home</a>
</div>
</body>
</html>
```

From `index.html`, select one of the available background colors, and you'll see they also apply on `page1.html` and `page2.html` by visiting the corresponding links, Books and Magazines.

Experimenting with the Sessions Project

Comment out the `session_start()` function for `page2.php` to temporarily deactivate it.

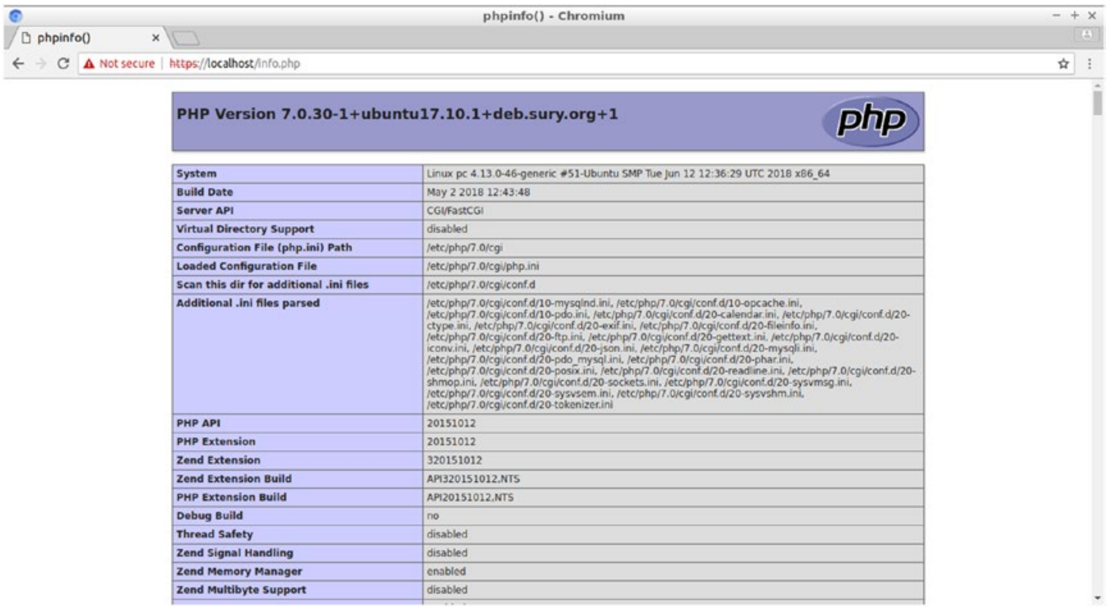
```
<?php
//session_start();
?>
```

Click one of the three colored buttons on the home page to select a color. Visit then the Books and Magazines links. As expected, only `page1.php` has the same color background as the one selected. Uncomment the `session_start` function to enable again the session for `page2.php`.

Visit the home page of the site and select a color, e.g., orange. Locate the file where the session data is stored and view its contents. You can find this information in the `php.ini` file, which is the PHP configuration file. Load the `info.php` web page created in Chapter 2 that evaluates the `phpinfo()` function, which displays lots of information about the PHP configuration. Use, for instance, the following in your browser's address bar:

```
https://localhost/info.php
```

Figure 8-27 shows the web page.



PHP Version 7.0.30-1+ubuntu17.10.1+deb.sury.org+1

System	Linux pc 4.13.0-46-generic #51-Ubuntu SMP Tue Jun 12 12:36:29 UTC 2018 x86_64
Build Date	May 2 2018 12:43:48
Server API	CGI/FastCGI
Virtual Directory Support	disabled
Configuration File (php.ini) Path	/etc/php/7.0/cgi
Loaded Configuration File	/etc/php/7.0/cgi/php.ini
Scan this dir for additional .ini files	/etc/php/7.0/cgi/conf.d
Additional .ini files parsed	/etc/php/7.0/cgi/conf.d/10-mysqlnd.ini, /etc/php/7.0/cgi/conf.d/10-opcache.ini, /etc/php/7.0/cgi/conf.d/10-pdo.ini, /etc/php/7.0/cgi/conf.d/20-calendar.ini, /etc/php/7.0/cgi/conf.d/20-ctype.ini, /etc/php/7.0/cgi/conf.d/20-exif.ini, /etc/php/7.0/cgi/conf.d/20-fileinfo.ini, /etc/php/7.0/cgi/conf.d/20-ftp.ini, /etc/php/7.0/cgi/conf.d/20-gettext.ini, /etc/php/7.0/cgi/conf.d/20-iconv.ini, /etc/php/7.0/cgi/conf.d/20-json.ini, /etc/php/7.0/cgi/conf.d/20-mysqli.ini, /etc/php/7.0/cgi/conf.d/20-pdo_mysql.ini, /etc/php/7.0/cgi/conf.d/20-phar.ini, /etc/php/7.0/cgi/conf.d/20-posix.ini, /etc/php/7.0/cgi/conf.d/20-readline.ini, /etc/php/7.0/cgi/conf.d/20-shmop.ini, /etc/php/7.0/cgi/conf.d/20-sockets.ini, /etc/php/7.0/cgi/conf.d/20-sysvmsg.ini, /etc/php/7.0/cgi/conf.d/20-sysvsem.ini, /etc/php/7.0/cgi/conf.d/20-sysvshm.ini, /etc/php/7.0/cgi/conf.d/20-tokenizer.ini
PHP API	20151012
PHP Extension	20151012
Zend Extension	320151012
Zend Extension Build	API320151012,NTS
PHP Extension Build	API20151012,NTS
Debug Build	no
Thread Safety	disabled
Zend Signal Handling	disabled
Zend Memory Manager	enabled
Zend Multibyte Support	disabled

Figure 8-27. *The info.php web page source code calls function phpinfo()*

As derived from this page in the system used for the project, the `php.ini` configuration file is as follows:

```
/etc/php7/cgi/php.ini
```

The file `php.ini` is a long one, so pipe its output to `grep` to search for keyword `save_path`.

```
$ sudo cat /etc/php7/cgi/php.ini | grep save_path
```

The command's output for this example is as follows:

```
;     session.save_path = "N;/path"
;     session.save_path = "N;MODE;/path"
;session.save_path = "/var/lib/php/sessions"
;       (see session.save_path above), then garbage collection does *not*
```

Run next `ls` to view the contents of the `/var/lib/php/sessions` directory.

```
$ sudo ls -l /var/lib/php/sessions
```

The command's output is as follows:

```
total 4
-rw------- 1 www-data www-data 22 Sep 25 16:38 sess_
hg7egmhroh4vbk9925v8vu8op4
```

The file name consists of the prefix `sess_` and the session ID:

```
hg7egmhroh4vbk9925v8vu8op4
```

To view the file's data, enter the following:

```
$ sudo cat /var/lib/php/sessions/sess_hg7egmhroh4vbk9925v8vu8op4
```

The output for the `favcolor` icon set to `orange` is as follows:

```
favcolor|s:6:"orange";
```

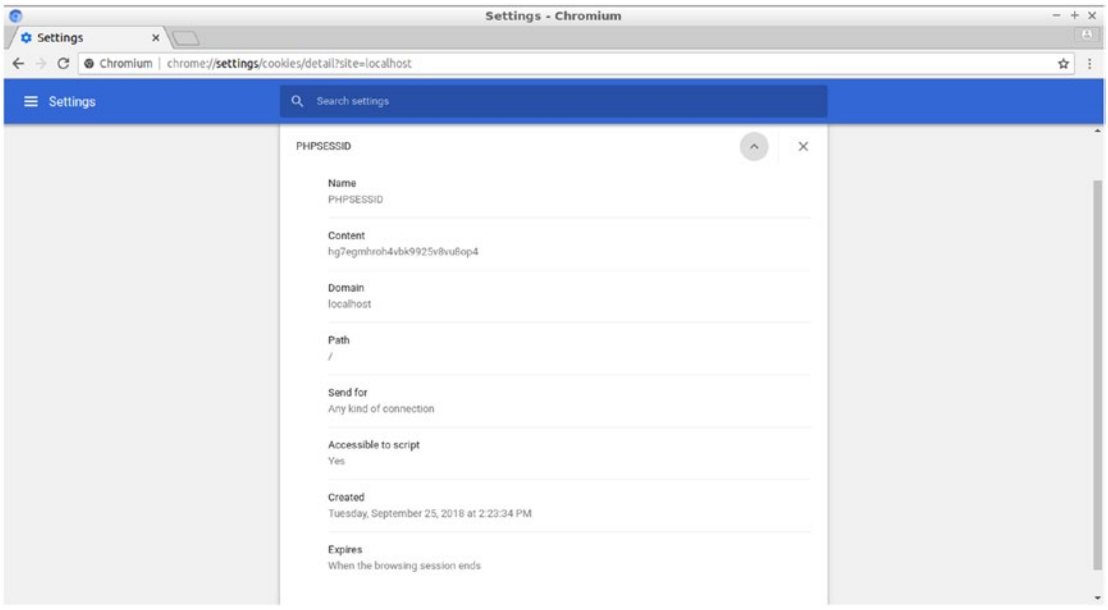
Switch to your browser and click the white button. The PHP session is destroyed, as revealed from the `ls -l` command:

```
$ sudo ls -l /var/lib/php/sessions
```

The command's output is as follows:

```
total 0
```

While all the information about the session is stored on the server side, the session ID is stored as a cookie on the client's computer. Use the settings of your browser to locate the specific cookie. For the Chromium browser, click the Customize and Control Chromium button (the one with the three dots in the upper right of the window) and select Settings. On the new Chromium tab that opens with the available settings, click the Advanced link at the bottom to expand the page contents. Under "Privacy and security," click "Content settings." Click Cookies and then "See all cookies and site data." In the list that appears, locate the URL used for the site, e.g., `localhost`. Click the URL and locate the cookie's name, which is `PHPSESSID`. Click the arrow at the right to view details about the cookie. Figure 8-28 displays the cookie properties.



PHPSESSID

Name
PHPSESSID

Content
hg7egmhroh4vbk9925v8vu8op4

Domain
localhost

Path
/

Send for
Any kind of connection

Accessible to script
Yes

Created
Tuesday, September 25, 2018 at 2:23:34 PM

Expires
When the browsing session ends

Figure 8-28. *Displaying the properties of the PHPSESSID cookie*

As expected, the value of the cookie is `hg7egmhroh4vbk9925v8vu8op4`.

This cookie for the default session remains until the time indicated in the Expires section under "When the browsing session ends." Close the browser and open again the Settings web page. The cookie is now deleted.

Summary

In this chapter, you did the following:

- Implemented SSL for your site using a self-signed certificate
- Used HTTP cookies to maintain the state of the otherwise stateless HTTP protocol by storing data across web pages on the client side
- Used PHP sessions to store to store sensitive data across web pages on the web server side

In the next chapter, you'll enhance your site's credibility by enabling HTTPS connections with an SSL certificate from a certificate authority.

CHAPTER 9

Running Your Site with a Certificate from a Certificate Authority

In this chapter, you will upgrade your site, which so far implements HTTPS with a self-signed certificate, by obtaining an SSL certificate from a certificate authority (CA). As a result, the web browser warnings about an insecure site will not appear, and instead a padlock icon, indicating secure communication, will appear on the left of the URL in the address bar of your browser. To obtain an SSL certificate, you usually need to own a second-level domain (SLD), like `httpsserver` in `httpsserver.eu`, as opposed to a name with the second-level domain owned by a DDNS company (like the names used in the previous chapters with the SLD `ddns.net`). For this reason, in this chapter, you'll learn how to obtain a domain name, and I'll discuss the process to obtain both the domain name and the SSL certificate. The cost at the time of this writing is about $8/year for the domain name and $19/year for the SSL certificate. However, it is not required that you register to run the projects. The source code for the projects used in this and the following chapter can run with the old server configuration; you will just continue to get the browser warnings.

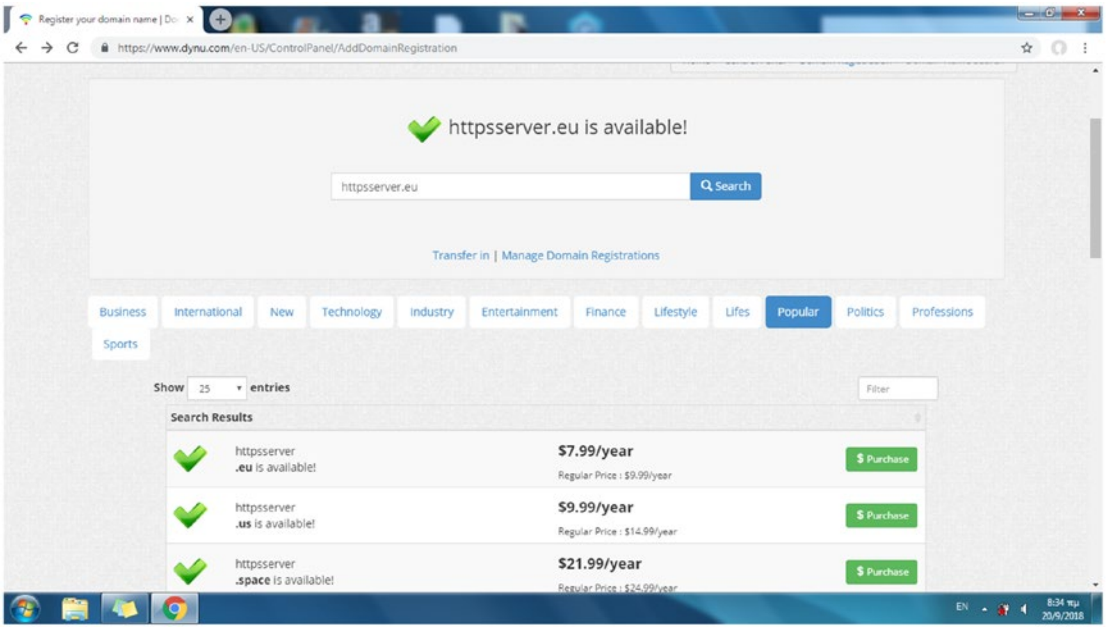
By obtaining an SSL certificate from a CA, you will create a site that provides a login connection. For a system requiring a user login, implementing SSL is an indispensable option because the password and all other sensitive data is transmitted encrypted. In this project, you will also learn how to encrypt the user password when stored in the database.

The user enters the username and the password, and by utilizing PHP sessions, the user will stay connected and can view user-specific data while browsing all the web pages of this site until a logout is issued.

Obtaining Your Own Domain Name

Plenty of companies offer domain name registration. You first have to search the company's site to see whether the name you want is available. An SLD name such as `httpsserver` may be available for certain top-level domains (TLDs) such as for `eu` but be unavailable for another TLD like `com`. Usually the prices for the domain names are different for the various TLDs.

Visit the Domains link at Dynu.com, the provider used in this example. In the textbox, enter your preferred domain name, e.g., `httpsserver.eu`, and click the Search button. Figure 9-1 displays the results indicating that `httpsserver.eu` is available for purchase.



Register your domain name | Do

https://www.dynu.com/en-US/ControlPanel/AddDomainRegistration

httpsserver.eu is available!

httpsserver.eu

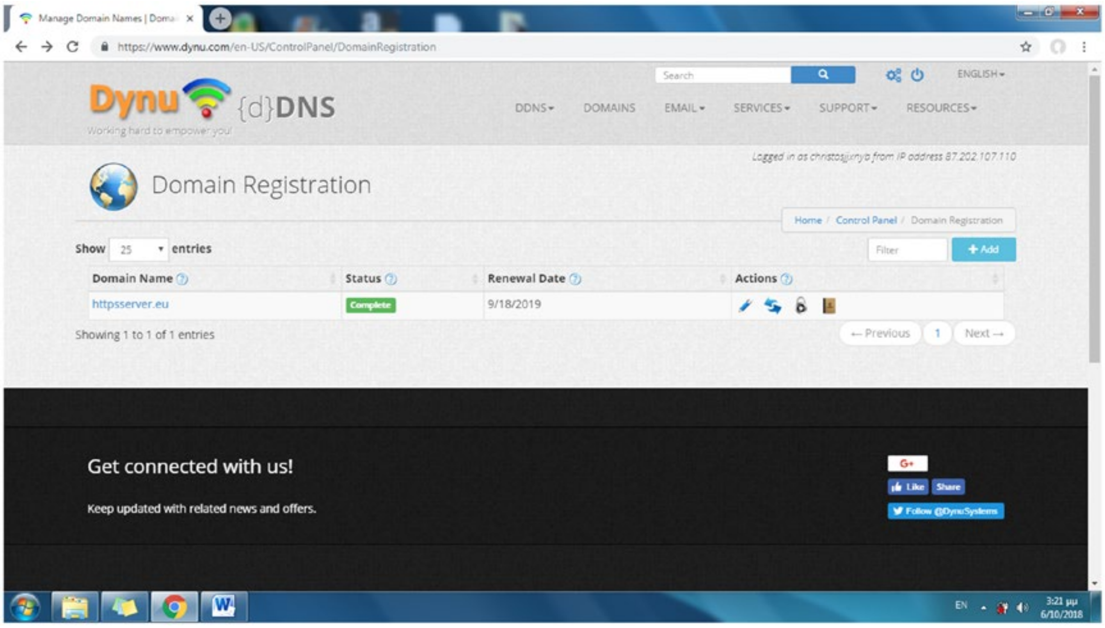
Transfer in | Manage Domain Registrations

Show 25 entries

Search Results		
httpsserver .eu is available!	$7.99/year Regular Price : $9.99/year	$ Purchase
httpsserver .us is available!	$9.99/year Regular Price : $14.99/year	$ Purchase
httpsserver .space is available!	$21.99/year Regular Price : $24.99/year	$ Purchase

Figure 9-1. Searching the availability of a domain name

By clicking the Purchase button corresponding to the TLD of your choice, e.g., `eu`, you can start the registration process at Dynu.com, which includes the payment process for obtaining the domain name. When you're finished, the domain is included in the list of your domain names as a link, as displayed in Figure 9-2. You can further manage your domain name by clicking this link.


Manage Domain Names | Doma
https://www.dynu.com/en-US/ControlPanel/DomainRegistration
Dynu {d}DNS
Working hard to empower you!
Search
ENGLISH
DDNS
DOMAINS
EMAIL
SERVICES
SUPPORT
RESOURCES
Logged in as christosjjxnyb from IP address 87.202.107.110
Domain Registration
Home / Control Panel / Domain Registration
Show 25 entries
Filter
+ Add
← Previous 1 Next →
Get connected with us!
Keep updated with related news and offers.
G+
Like Share
Follow @DynuSystems
EN
3:21 μμ
6/10/2018

Domain Name	Status	Renewal Date	Actions
httpsserver.eu	Complete	9/18/2019	

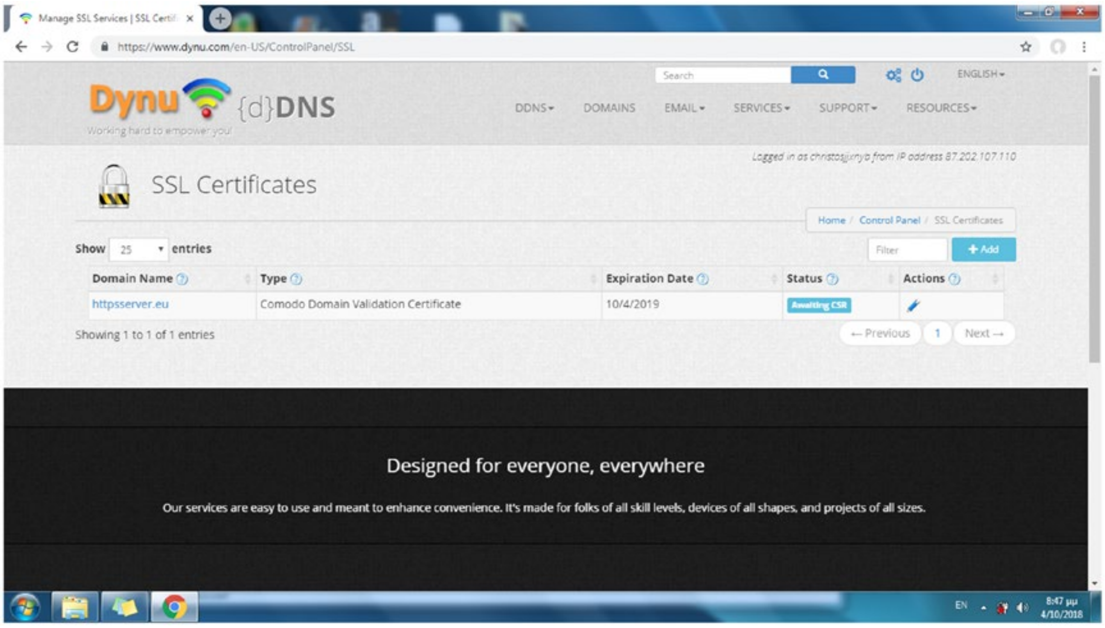
Showing 1 to 1 of 1 entries

Figure 9-2. *The newly registered domain name is added to the list of your domain names*

The next step for running a secure site is to acquire an SSL certificate from a certificate authority for your new domain name.

Obtaining a CA SSL Certificate for Your Domain Name

To go to the SSL certificates web page at Dynu.com, click the gears icon and then click the SSL Certificates link. Make a choice from the available SSL certificate offers and proceed with the payment. Figure 9-3 shows an SSL certificate from Comodo being used. The status of the SSL certificate is Awaiting CSR.


Manage SSL Services | SSL Certifi
https://www.dynu.com/en-US/ControlPanel/SSL
Search
ENGLISH
Dynu {d}DNS
Working hard to empower you!
DDNS
DOMAINS
EMAIL
SERVICES
SUPPORT
RESOURCES
Home / Control Panel / SSL Certificates
Filter
+ Add
Previous
1
Next
EN
8:47 μμ
4/10/2018

Logged in as christosjxnyb from IP address 87.202.107.110

SSL Certificates

Show 25 entries

Domain Name	Type	Expiration Date	Status	Actions
httpsserver.eu	Comodo Domain Validation Certificate	10/4/2019	Awaiting CSR	

Showing 1 to 1 of 1 entries

Designed for everyone, everywhere

Our services are easy to use and meant to enhance convenience. It's made for folks of all skill levels, devices of all shapes, and projects of all sizes.

Figure 9-3. *By purchasing an SSL certificate, your domain name status turns to Awaiting CSR*

A certificate-signing request (CSR) is an encoded file with your application form for the CA. It is usually generated on the web server and includes information such as your location, your e-mail, your organization, etc., and basically contains your public key that will be included in the SSL certificate. You can generate your key pair, consisting of the CSR file (that includes your public key) and also your private key, by using the following `openssl req` command at the Linux terminal:

```
$ sudo openssl req -new -newkey rsa:2048 -nodes -keyout server.key -out
server.csr
```

In this command, the following options are used:

- `new`: Generates a new certificate request
- `newkey rsa:2048`: Generates a new private key, an RSA key that is 2,048 bits in size, as its argument indicates
- `nodes`: Specifies that the private key created will not be encrypted

- `keyout server.key`: Specifies `server.key` as the file name to write the newly created private key to
- `out server.csr`: Specifies `server.csr` as the file name of the CSR file

OpenSSL asks about the following information:

- Country name (two-letter code)
- State or province name (full name)
- Locality name (e.g., city)
- Organization name (e.g., company)
- Organizational unit name (e.g., section)
- Common name (e.g., server FQDN or your name)
- E-mail address
- A challenge password
- An optional company name

Most of the previous information is self-explanatory. In the Common Name field, enter your domain name, e.g., **httpsserver.eu**. If you don't represent any company or organization, just enter your name because many CAs require that all the fields be completed. When you fill in all the fields, the `openssl` command terminates, and the two files `server.key` and `server.csr` are created in your working directory. Use the following command to view them:

```
$ ls -l
```

The command's output is as follows:

```
total 8
-rw-r--r-- 1 root root 1058 Feb 27 19:49 server.csr
-rw------- 1 root root 1704 Feb 27 19:49 server.key
```

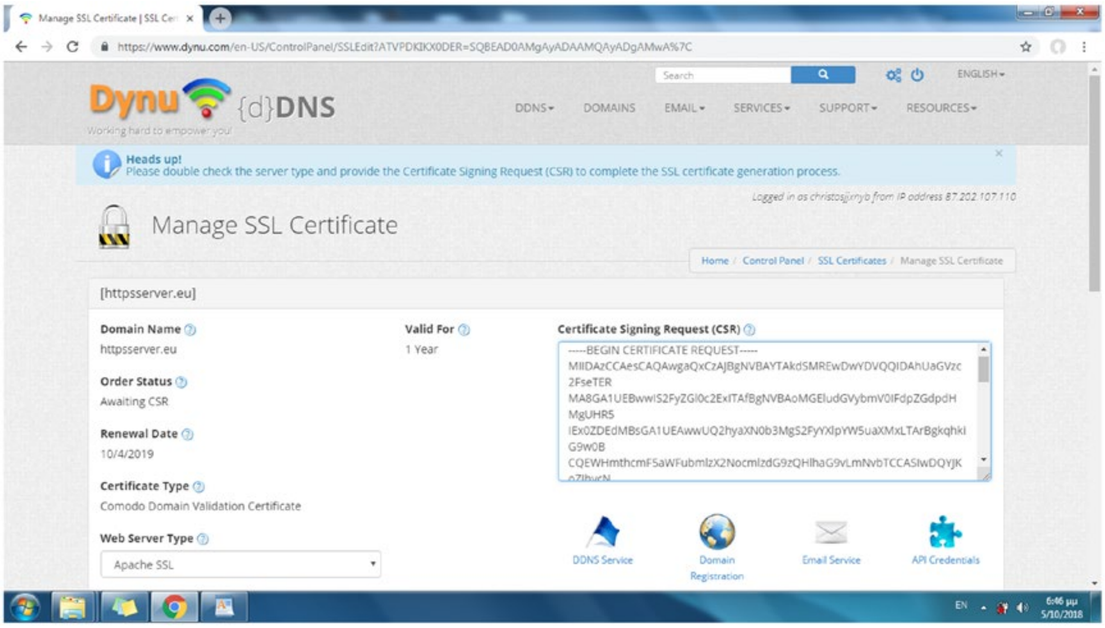
Change the `server.csr` file user rights so that only root has access to this file. File `server.key` has the user rights already set.

```
$ sudo chmod 0600 server.csr
Use the ls -l another time:
$ ls -l
```

The command's output is as follows:

```
total 8
-rw------- 1 root root 1058 Feb 27 19:49 server.csr
-rw------- 1 root root 1704 Feb 27 19:49 server.key
```

Of the two files generated, your private key (`server.key`) is the one that you keep secret. The other one (`server.csr`) is the CSR file that includes your public key, and it can be available to anyone. This is the file you have to submit to the CA. Open the CSR file with a text editor, copy the contents, and switch back to your browser. In the Actions column of the Dynu.com web page accessed previously, click the Manage button (the blue pencil) to submit your CSR file. Paste your CSR text in the Certificate Signing Request (CSR) window, as viewed in Figure 9-4, and click the Save button.


Manage SSL Certificate | SSL Cer

https://www.dynu.com/en-US/ControlPanel/SSLEdit?ATVPDKIKX0DER=SQBEAD0AMgAyADAAMQAyADgAMwA%7C

Heads up!
Please double check the server type and provide the Certificate Signing Request (CSR) to complete the SSL certificate generation process.

Logged in as christosjixnyb from IP address 87.202.107.110

Manage SSL Certificate

Home / Control Panel / SSL Certificates / Manage SSL Certificate

[httpsserver.eu]

Domain Name
httpsserver.eu

Valid For
1 Year

Order Status
Awaiting CSR

Renewal Date
10/4/2019

Certificate Type
Comodo Domain Validation Certificate

Web Server Type
Apache SSL

Certificate Signing Request (CSR)

```
-----BEGIN CERTIFICATE REQUEST-----
MIIDAzCCAesCAQAwgaQxCzAJBgNVBAYTAkdSMREwDwYDVQQIDAhUaGVzc
2FseTER
MA8GA1UEBwwIS2FyZGl0c2ExITAfBgNVBAoMGEludGVybmV0IFdpZGdpdH
MgUHR5
IEx0ZDEdMBsGA1UEAwwUQ2hyaXN0b3MgS2FyYXlpYW5uaXMxLTArBgkqhki
G9w0B
CQEWHmthcmF5aWFubmlzX2NocmlzdG9zQHlhaG9vLmNvbTCCASIwDQYJK
```

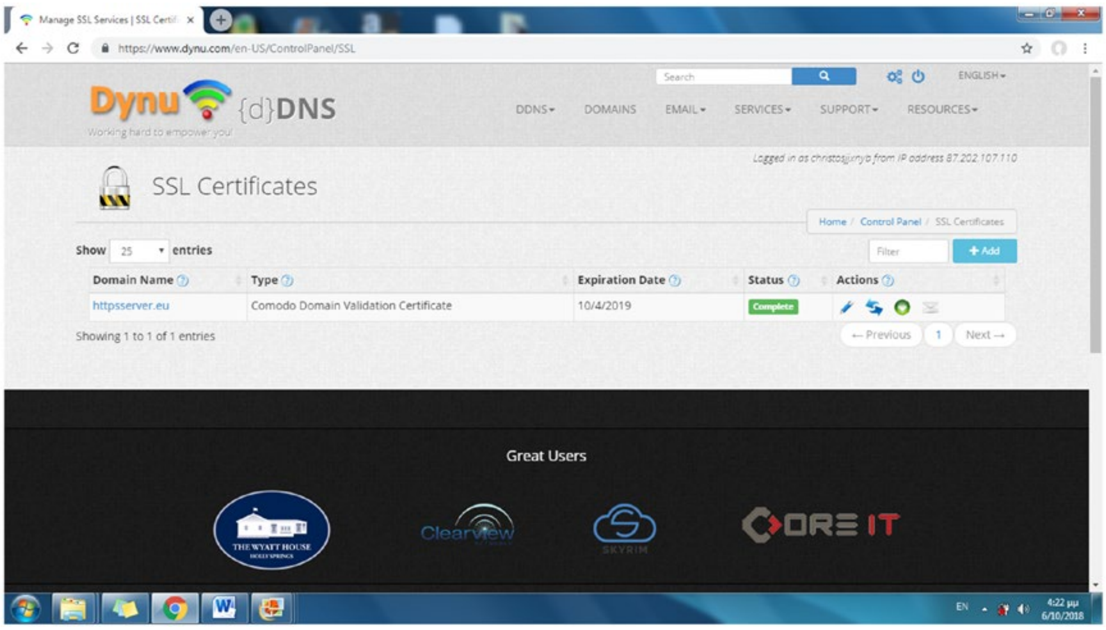
Figure 9-4. *Providing the CSR file contents to the CA*

In the Web Server Type list, select Apache SSL. Also, in the Approved Email list, select admin@httpsserver.eu. Unless you run a mail server, you probably do not have an e-mail address that uses your domain name. Such an e-mail address is, however, required by CAs for the verification process. SSL certification providers like Dynu.com create a temporary e-mail account for you to receive e-mail from the CA, via the Dynu.com webmail interface. The username and the password for the Dynu.com webmail site are provided by Dynu.com so that you can reply to the CA's e-mail and thus complete the SSL certificate registration process.

You'll receive an e-mail from Dynu.com that includes your certificate (e.g., `httpsserver.eu_2018.cer`) and a bundle file (e.g., `httpsserver-eu.ca-bundle`) with all the intermediate certificates. For security reasons, the CA uses a *chain of trust*, where one intermediate certificate signs the next. At one end of the chain is the root certificate, which is the CA identity, and at the other end is your domain certificate, which is the certificate you purchase from a CA.

Hint! Sometimes the SSL certificate provider sends the root and intermediate certificates instead of a bundle file. You have to copy and paste the contents of the files in the order suggested by the SSL certificate provider into the `.ca-bundle` file. You can skip this and ask your SSL provider to send you a ready-to-use bundle file instead.

Since the SSL certificate is already provided, the status of the SSL Certificates web page of Dynu.com changes to Complete, as displayed in Figure 9-5.


Manage SSL Services | SSL Certi
https://www.dynu.com/en-US/ControlPanel/SSL
Search
ENGLISH
Dynu {d}DNS
Working hard to empower you!
DDNS
DOMAINS
EMAIL
SERVICES
SUPPORT
RESOURCES
Home / Control Panel / SSL Certificates
Filter
+ Add
← Previous
1
Next →
Great Users
THE WYATT HOUSE
ClearView
SKYRIM
CORE IT

Logged in as christosjjxnyb from IP address 87.202.107.110

SSL Certificates

Show 25 entries

Domain Name	Type	Expiration Date	Status	Actions
httpsserver.eu	Comodo Domain Validation Certificate	10/4/2019	Complete	

Showing 1 to 1 of 1 entries

Figure 9-5. *With the SSL certificate granted, the status of the domain name on the SSL Certificates web page becomes Complete*

In the following section, you'll install the SSL certificate on the Apache and Lighttpd web servers so you can have a secure communication for the client login project.

Configuring SSL on the Web Servers

For both Apache and Lighttpd, three files are required for using HTTPS.

- The server's private key
- The SSL certificate for the domain name
- The bundle file that includes the root certificate and the intermediate certificates

Download the files sent with the e-mail from the SSL certificate provider and rename the certificate file using the `.crt` file extension.

```
$ cp httpsserver.eu_2018.cer ssl.crt
Next the installation process for Apache and then for the Lighttpd web
servers are discussed.
```

Installing the CA Certificate on the Apache Web Server

Create a new directory named `ca` in `/etc/apache2` and copy the certificates and your private key into it. In the following `cp` commands, the files are assumed to be copied from the home directory. Use `sudo  su` to avoid including `sudo` in the rest of the commands.

```
$ sudo su
# mkdir /etc/apache2/ca
# cp ~/server.key /etc/apache2/ca
# cp ~/ssl.crt /etc/apache2/ca

# cp ~/httpsserver_eu.ca-bundle /etc/apache2/ca
```

Edit the default Apache SSL configuration file.

```
# gedit default-ssl.conf
```

In the configuration file, make sure the following directives are added:

```
ServerName httpsserver.eu
SSLCertificateFile      /etc/apache2/ca/ssl.crt
SSLCertificateKeyFile   /etc/apache2/ca/server.key
SSLCertificateChainFile /etc/apache2/ca/httpsserver_eu.ca-bundle
```

The whole file should look like the following:

```
<IfModule mod_ssl.c>
    <VirtualHost _default_:443>
        ServerAdmin webmaster@localhost

        DocumentRoot /var/www/html/login

        # Available loglevels: trace8, ..., trace1, debug, info, notice, warn,
        # error, crit, alert, emerg.
        # It is also possible to configure the loglevel for particular
        # modules, e.g.
        #LogLevel info ssl:warn

        ErrorLog ${APACHE_LOG_DIR}/error.log
        CustomLog ${APACHE_LOG_DIR}/access.log combined

        # For most configuration files from conf-available/, which are
        # enabled or disabled at a global level, it is possible to
        # include a line for only one particular virtual host. For example the
        # following line enables the CGI configuration for this host only
        # after it has been globally disabled with "a2disconf".
        #Include conf-available/serve-cgi-bin.conf

        #   SSL Engine Switch:
        #   Enable/Disable SSL for this virtual host.
        SSLEngine on

        #   A self-signed (snakeoil) certificate can be created by installing
        #   the ssl-cert package. See
        #   /usr/share/doc/apache2/README.Debian.gz for more info.
        #   If both key and certificate are stored in the same file, only the
        #   SSLCertificateFile directive is needed.
        #SSLCertificateFile    /etc/ssl/certs/ssl-cert-snakeoil.pem
        #SSLCertificateKeyFile /etc/ssl/private/ssl-cert-snakeoil.key
#####################
        ServerName httpsserver.eu
        SSLCertificateFile    /etc/apache2/ca/ssl.crt
        SSLCertificateKeyFile /etc/apache2/ca/server.key
        SSLCertificateChainFile /etc/apache2/ca/httpsserver_eu.ca-bundle
####################
        #   Server Certificate Chain:
        #   Point SSLCertificateChainFile at a file containing the
        #   concatenation of PEM encoded CA certificates which form the
        #   certificate chain for the server certificate. Alternatively
        #   the referenced file can be the same as SSLCertificateFile
        #   when the CA certificates are directly appended to the server
        #   certificate for convinience.
        #SSLCertificateChainFile /etc/apache2/ssl.crt/server-ca.crt

        #   Certificate Authority (CA):
        #   Set the CA certificate verification path where to find CA
        #   certificates for client authentication or alternatively one
        #   huge file containing all of them (file must be PEM encoded)
        #   Note: Inside SSLCACertificatePath you need hash symlinks
        #         to point to the certificate files. Use the provided
        #         Makefile to update the hash symlinks after changes.
        #SSLCACertificatePath /etc/ssl/certs/
        #SSLCACertificateFile /etc/apache2/ssl.crt/ca-bundle.crt

        #   Certificate Revocation Lists (CRL):
        #   Set the CA revocation path where to find CA CRLs for client
        #   authentication or alternatively one huge file containing all
        #   of them (file must be PEM encoded)
        #   Note: Inside SSLCARevocationPath you need hash symlinks
        #         to point to the certificate files. Use the provided
        #         Makefile to update the hash symlinks after changes.
```

```
#SSLCARevocationPath /etc/apache2/ssl.crl/
#SSLCARevocationFile /etc/apache2/ssl.crl/ca-bundle.crl

#   Client Authentication (Type):
#   Client certificate verification type and depth.  Types are
#   none, optional, require and optional_no_ca.  Depth is a
#   number which specifies how deeply to verify the certificate
#   issuer chain before deciding the certificate is not valid.
#SSLVerifyClient require
#SSLVerifyDepth  10

#   SSL Engine Options:
#   Set various options for the SSL engine.
#   o FakeBasicAuth:
#     Translate the client X.509 into a Basic Authorisation.  This
      means that
#     the standard Auth/DBMAuth methods can be used for access
      control.  The
#     user name is the `one line' version of the client's X.509
      certificate.
#     Note that no password is obtained from the user. Every entry
      in the user
#     file needs this password: `xxj31ZMTZzkVA'.
#   o ExportCertData:
#     This exports two additional environment variables: SSL_
      CLIENT_CERT and
#     SSL_SERVER_CERT. These contain the PEM-encoded certificates
      of the server (always existing) and the client (only existing
#     when client
#     authentication is used). This can be used to import the
      certificates
#     into CGI scripts.
#   o StdEnvVars:
#     This exports the standard SSL/TLS related `SSL_*' environment
      variables.
```

```
#      Per default this exportation is switched off for performance
       reasons, because the extraction step is an expensive
       operation and is usually useless for serving static content.
       So one usually enables the exportation for CGI and SSI
       requests only.
#    o OptRenegotiate:
#      This enables optimized SSL connection renegotiation handling
       when SSL
#      directives are used in per-directory context.
#SSLOptions +FakeBasicAuth +ExportCertData +StrictRequire
<FilesMatch "\.(cgi|shtml|phtml|php)$">
        SSLOptions +StdEnvVars
</FilesMatch>
<Directory /usr/lib/cgi-bin>
        SSLOptions +StdEnvVars
</Directory>

#    SSL Protocol Adjustments:
#    The safe and default but still SSL/TLS standard compliant shutdown
#    approach is that mod_ssl sends the close notify alert but
     doesn't wait for
#    the close notify alert from client. When you need a different
     shutdown
#    approach you can use one of the following variables:
#    o ssl-unclean-shutdown:
#      This forces an unclean shutdown when the connection is
       closed, i.e. no SSL close notify alert is send or allowed to
#      received.  This violates the SSL/TLS standard but is needed
       for some brain-dead browsers. Use this when you receive I/O
#      errors because of the standard approach where
#      mod_ssl sends the close notify alert.
#    o ssl-accurate-shutdown:
#      This forces an accurate shutdown when the connection is
       closed, i.e. a
#      SSL close notify alert is send and mod_ssl waits for the
       close notify
```

```
        #     alert of the client. This is 100% SSL/TLS standard compliant,
              but in
        #     practice often causes hanging connections with brain-dead
              browsers. Use
        #     this only for browsers where you know that their SSL
              implementation
        #     works correctly.
        #   Notice: Most problems of broken clients are also related to the HTTP
        #   keep-alive facility, so you usually additionally want to
            disable
        #   keep-alive for those clients, too. Use variable "nokeepalive"
            for this.
        #   Similarly, one has to force some clients to use HTTP/1.0 to
            workaround
        #   their broken HTTP/1.1 implementation. Use variables
            "downgrade-1.0" and
        #   "force-response-1.0" for this.
        # BrowserMatch "MSIE [2-6]" \
        #       nokeepalive ssl-unclean-shutdown \
        #       downgrade-1.0 force-response-1.0

    </VirtualHost>
</IfModule>

# vim: syntax=apache ts=4 sw=4 sts=4 sr noet
```

For the Apache configuration, it is assumed that the SSLEngine directive in the configuration file is set to on and also that the ssl module is enabled, as described in the previous chapter. If it is not enabled, enable it now using the following:

```
$ sudo a2enmod ssl
$ service apache2 force-reload
```

The DocumentRoot directive was also set to /var/www/html/login, which will be the root directory used next in this chapter's project.

To enable redirection to the HTTPS protocol (`https://`) when a user connects using the HTTP protocol (`http://`), edit the corresponding configuration file, e.g., `000-default.conf`, and add the following directive:

```
Redirect / https://httpsserver.eu
```

The file should look like the following:

```
<VirtualHost *:80>
    # The ServerName directive sets the request scheme, hostname and port that
    # the server uses to identify itself. This is used when creating
    # redirection URLs. In the context of virtual hosts, the ServerName
    # specifies what hostname must appear in the request's Host: header to
    # match this virtual host. For the default virtual host (this file) this
    # value is not decisive as it is used as a last resort host regardless.
    # However, you must set it for any further virtual host explicitly.
    #ServerName www.example.com
    ServerAdmin webmaster@localhost
    DocumentRoot /var/www/html/login
         Redirect / https://httpsserver.eu
    # Available loglevels: trace8, ..., trace1, debug, info, notice, warn,
    # error, crit, alert, emerg.
    # It is also possible to configure the loglevel for particular
    # modules, e.g.
    #LogLevel info ssl:warn

    ErrorLog ${APACHE_LOG_DIR}/error.log
    CustomLog ${APACHE_LOG_DIR}/access.log combined

    # For most configuration files from conf-available/, which are
    # enabled or disabled at a global level, it is possible to
    # include a line for only one particular virtual host. For example the
    # following line enables the CGI configuration for this host only
    # after it has been globally disabled with "a2disconf".
    #Include conf-available/serve-cgi-bin.conf
</VirtualHost>

# vim: syntax=apache ts=4 sw=4 sts=4 sr noet
```

With the redirection directive, the client request shown here:

```
http://httpsserver.eu
```

is redirected by the server to the following request:

```
https://httpsserver.eu
```

When a URL is entered with the `http://` protocol (or no protocol at all), the HTTP status code returned directs the client to a different URL (the connection in this case) with the `https://` protocol.

Reload Apache to validate the new configuration.

```
# service apache2 force-reload
```

Installing the CA Certificate on the Lighttpd Web Server

Use the certificates and the server's private key to enable SSL on the Lighttpd web server. If you didn't previously, enter `sudo  su` to become the root user and avoid prepending `sudo` in the commands that follow.

```
$ sudo su
```

Stop Apache from running so you can work next with Lighttpd.

```
# service apache2 stop
```

Next, start the Lighttpd web server.

```
# service lighttpd start
```

Create a new directory for storing the private key and the certificates.

```
# mkdir /etc/lighttpd/ca
```

Copy the files of the `/etc/apache2/ca` directory to the new `ca` directory.

```
# cp /etc/apache2/ca  /etc/lighttpd/ca
```

Create the PEM file with the private key and the domain certificate.

```
# cd /etc/lighttpd/ca
# cat server.key ssl.crt > server.pem
```

Edit the Lighttpd configuration file.

```
# gedit /etc/lighttpd/lighttpd.conf
```

Enter the following lines and save the file:

```
$SERVER["socket"] == ":443" {
  server.document-root        = "/var/www/html/login"
  ssl.engine                  = "enable"
  server.username             = "www-data"
  server.groupname            = "www-data"
  ssl.pemfile = "/etc/lighttpd/ca/server.pem"
  ssl.ca-file = "/etc/lighttpd/ca/httpsserver_eu.ca-bundle"
  server.name = "httpsserver.eu"
}
```

Also, to redirect the HTTP requests to HTTPS, include the following lines in the conditional configuration for port 80:

```
  $HTTP["host"] =~ "(.*)" {
    url.redirect = ( "^/(.*)" => "https://%1/$1" )
  }
```

Set the document root from `/var/www/html/` to `/var/www/html/login` in the conditional configurations for ports 80 and 443, which will be the one used next in the project.

The file `lighttpd.conf` should look like the following:

```
server.modules = (
        "mod_access",
        "mod_alias",
        "mod_accesslog",
        "mod_compress",
        "mod_redirect",
)

server.document-root        = "/var/www/html"
server.upload-dirs          = ( "/var/cache/lighttpd/uploads" )
server.errorlog             = "/var/log/lighttpd/error.log"
server.pid-file             = "/var/run/lighttpd.pid"
server.username             = "www-data"
server.groupname            = "www-data"
#server.port                 = 8080
#server.port                 = 443
#server.bind                = "webtoolsonline.servehttp.com"
server.errorfile-prefix     = "/srv/www/errors/status-"

dir-listing.activate        = "disable"


accesslog.filename          = "/var/log/lighttpd/access.log"
#accesslog.format            = "%V %h %l %u %t \"%r\" %>s %b \"%{Referer}
                               i\" \"%{User-Agent}i\""

index-file.names            = ( "index.php", "index.html", "index.lighttpd.
                              html" )
url.access-deny             = ( "~", ".inc" )
static-file.exclude-extensions = ( ".php", ".pl", ".fcgi" )

compress.cache-dir          = "/var/cache/lighttpd/compress/"
compress.filetype           = ( "application/javascript", "text/css",
                                "text/html", "text/plain" )

$SERVER["socket"] == ":443" {
  server.document-root        = "/var/www/html/login"
  ssl.engine                  = "enable"
  server.username             = "www-data"
  server.groupname            = "www-data"

################################################
  ssl.pemfile = "/etc/lighttpd/ca/server.pem"
  ssl.ca-file = "/etc/lighttpd/ca/httpsserver_eu.ca-bundle"
  server.name = "httpsserver.eu"
################################################

}
```

```
$SERVER["socket"] == ":80" {
server.document-root          = "/var/www/html/login"
server.upload-dirs            = ( "/var/cache/lighttpd/uploads" )
server.errorlog               = "/var/log/lighttpd/error.log"
server.pid-file               = "/var/run/lighttpd.pid"
server.username               = "www-data"
server.groupname              = "www-data"

##################################################
  $HTTP["host"] =~ "(.*)" {
    url.redirect = ( "^/(.*)" => "https://%1/$1" )
  }
##################################################

}


# default listening port for IPv6 falls back to the IPv4 port
## Use ipv6 if available
#include_shell "/usr/share/lighttpd/use-ipv6.pl " + server.port
include_shell "/usr/share/lighttpd/create-mime.assign.pl"
include_shell "/usr/share/lighttpd/include-conf-enabled.pl"

#include "vhost.conf"
```

Enable the new configuration by reloading Lighttpd.

```
# service lighttpd force-reload
```

Testing the SSL CA Certificate

Figure 9-6 displays the home page of `httpsserver.eu`. This is the home page of the project that you'll create next in this chapter.

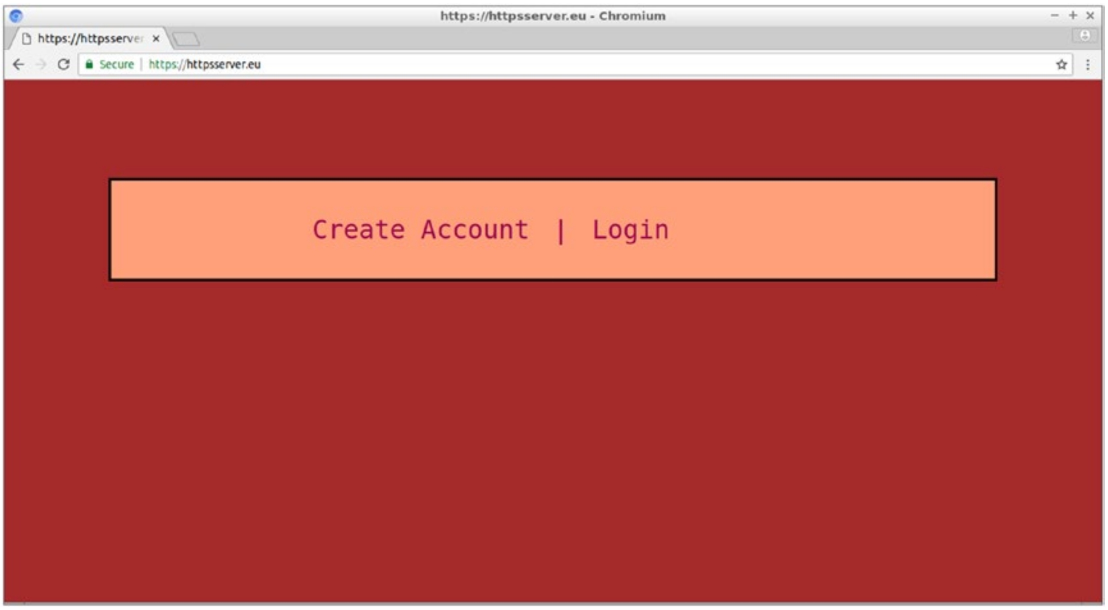

https://httpsserver.eu - Chromium
https://httpsserver
Secure | https://httpsserver.eu
Create Account | Login

Figure 9-6. *The home web page of the project's site*

The browser warnings about entering an insecure site do not appear anymore. A padlock icon, indicating a secure connection, appears in the address bar of the browser, and the `https://` protocol is not struck through as previously, with the self-signed certificate. Click the padlock icon to find out some details about the current secure connection. For the Chromium browser, the menu options appear as displayed in Figure 9-7.

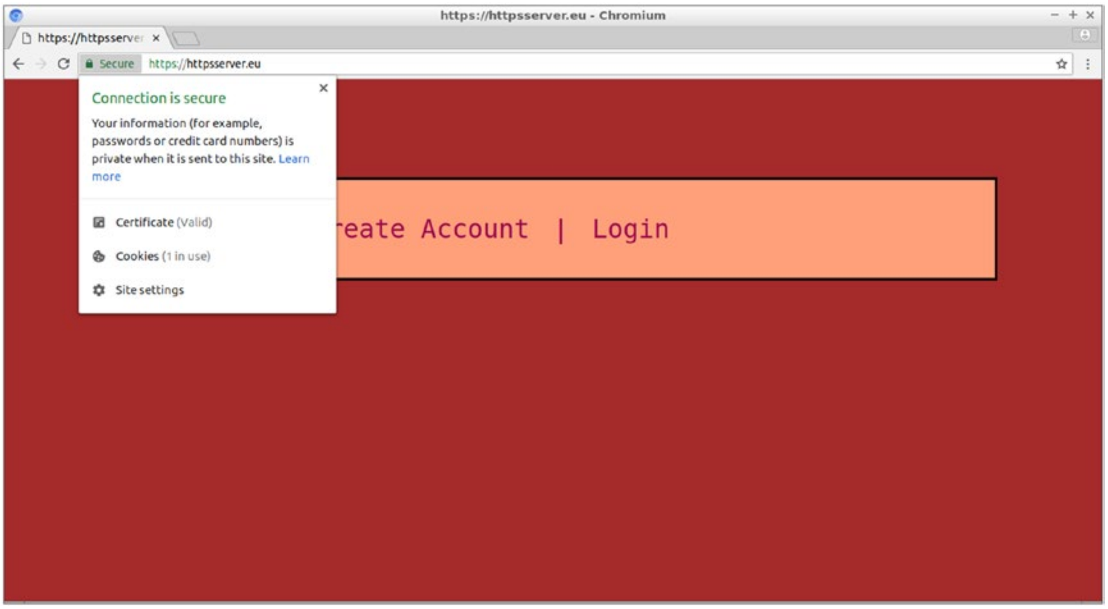
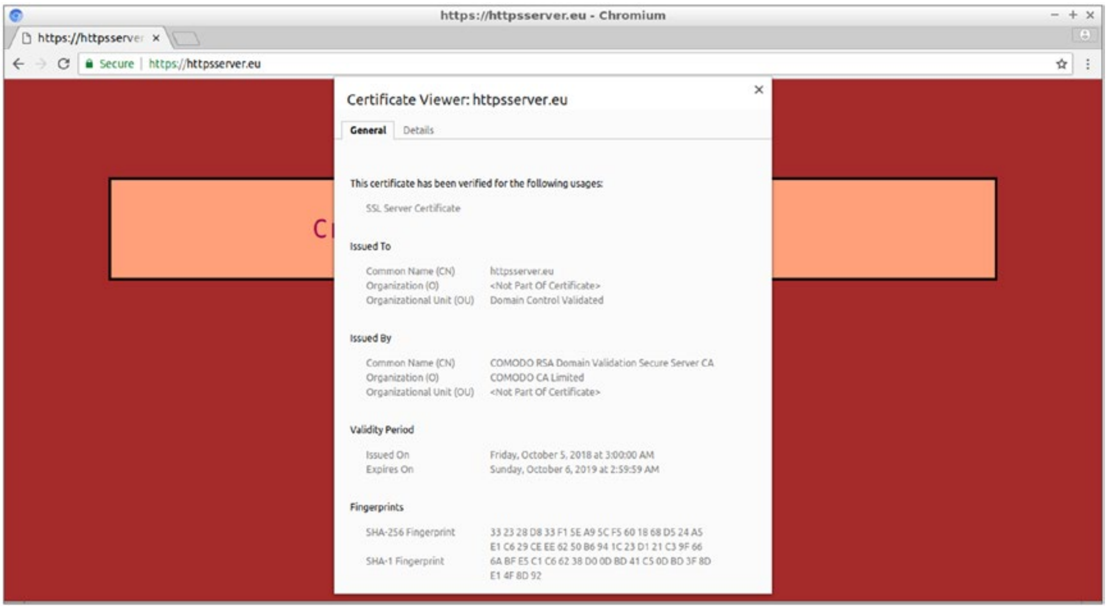

https://httpsserver.eu - Chromium
https://httpsserver
Secure
https://httpsserver.eu
Connection is secure
Your information (for example, passwords or credit card numbers) is private when it is sent to this site. Learn more
Certificate (Valid)
Cookies (1 in use)
Site settings
reate Account | Login

Figure 9-7. *Clicking the green padlock allows you to get information about the secure connection*

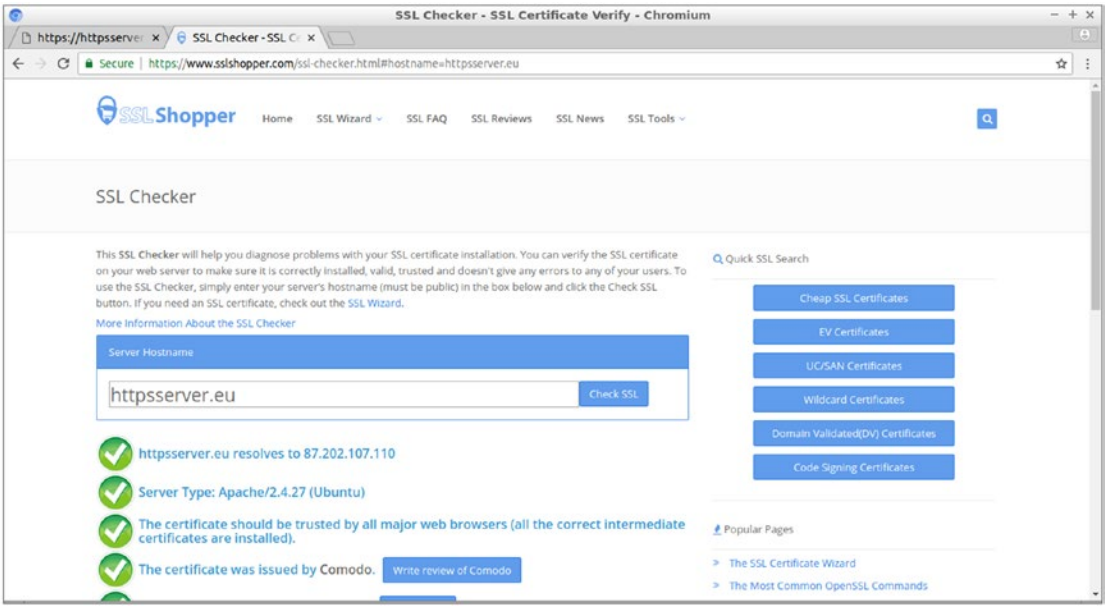
Click the Certificate (Valid) option, as displayed in Figure 9-8, to open the certificate viewer and find details about the current certificate.


https://httpsserver.eu - Chromium
https://httpsserver
Secure
https://httpsserver.eu
Certificate Viewer: httpsserver.eu
General
Details

```
This certificate has been verified for the following usages:
    SSL Server Certificate

Issued To
    Common Name (CN)            httpsserver.eu
    Organization (O)            <Not Part Of Certificate>
    Organizational Unit (OU)    Domain Control Validated

Issued By
    Common Name (CN)            COMODO RSA Domain Validation Secure Server CA
    Organization (O)            COMODO CA Limited
    Organizational Unit (OU)    <Not Part Of Certificate>

Validity Period
    Issued On                   Friday, October 5, 2018 at 3:00:00 AM
    Expires On                  Sunday, October 6, 2019 at 2:59:59 AM

Fingerprints
    SHA-256 Fingerprint         33 23 28 D8 33 F1 5E A9 5C F5 60 18 68 D5 24 A5
                                E1 C6 29 CE EE 62 50 B6 94 1C 23 D1 21 C3 9F 66
    SHA-1 Fingerprint           6A BF E5 C1 C6 62 38 D0 0D BD 41 C5 0D BD 3F 8D
                                E1 4F 8D 92
```

Figure 9-8. *Using the Certificate Viewer in Chromium*

Next use an online tool that tests and analyzes the web server certificates, for instance SSL Checker (`www.sslshoper.com`). In the Server Hostname textbox, enter your domain name, e.g., `httpsserver.eu`, and click the Check SSL button. Figure 9-9 displays the results, indicating no problems were diagnosed.


SSL Checker - SSL Certificate Verify - Chromium
https://httpsserver
SSL Checker - SSL C
Secure | https://www.sslshopper.com/ssl-checker.html#hostname=httpsserver.eu
SSL Shopper
Home
SSL Wizard
SSL FAQ
SSL Reviews
SSL News
SSL Tools
Quick SSL Search
Cheap SSL Certificates
EV Certificates
UC/SAN Certificates
Wildcard Certificates
Domain Validated(DV) Certificates
Code Signing Certificates
Popular Pages
The SSL Certificate Wizard
The Most Common OpenSSL Commands

SSL Checker

This SSL Checker will help you diagnose problems with your SSL certificate installation. You can verify the SSL certificate on your web server to make sure it is correctly installed, valid, trusted and doesn't give any errors to any of your users. To use the SSL Checker, simply enter your server's hostname (must be public) in the box below and click the Check SSL button. If you need an SSL certificate, check out the SSL Wizard.

More Information About the SSL Checker

Server Hostname: httpsserver.eu [Check SSL]

✓ httpsserver.eu resolves to 87.202.107.110

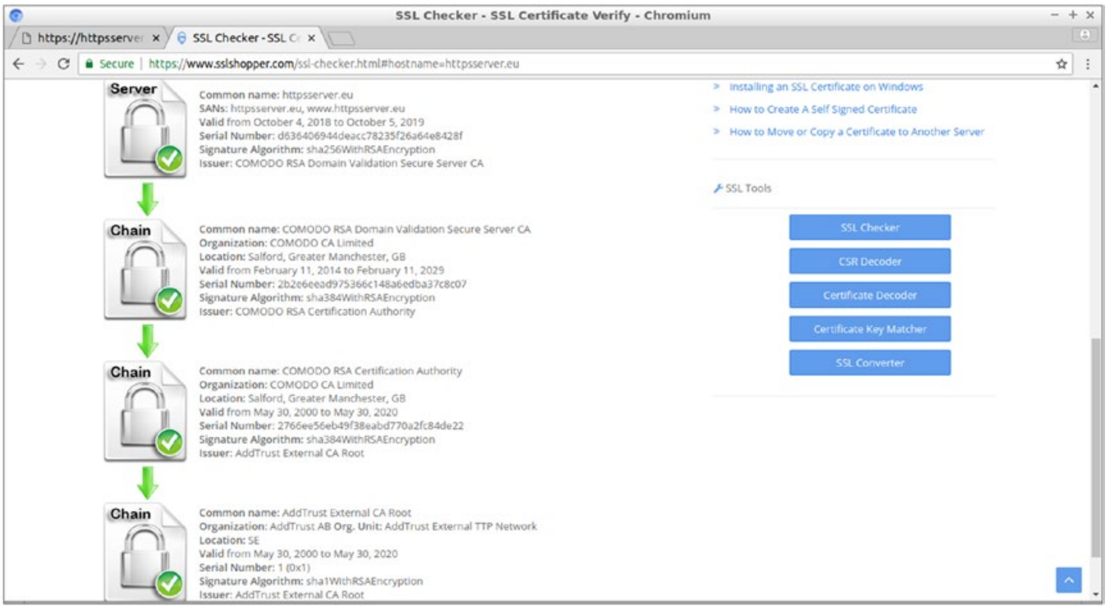
✓ Server Type: Apache/2.4.27 (Ubuntu)

✓ The certificate should be trusted by all major web browsers (all the correct intermediate certificates are installed).

✓ The certificate was issued by Comodo. [Write review of Comodo]

Figure 9-9. *Using an online tool to check your SSL certificate*

Scroll down to view the chain of trust for your site, as displayed in Figure 9-10.


SSL Checker - SSL Certificate Verify - Chromium
https://httpsserver
SSL Checker - SSL C
Secure
https://www.sslshopper.com/ssl-checker.html#hostname=httpsserver.eu
Installing an SSL Certificate on Windows
How to Create A Self Signed Certificate
How to Move or Copy a Certificate to Another Server
SSL Tools
SSL Checker
CSR Decoder
Certificate Decoder
Certificate Key Matcher
SSL Converter
Server
Chain
Chain
Chain

Common name: httpsserver.eu
SANs: httpsserver.eu, www.httpsserver.eu
Valid from October 4, 2018 to October 5, 2019
Serial Number: d63640694deacc78235f26a64e8428f
Signature Algorithm: sha256WithRSAEncryption
Issuer: COMODO RSA Domain Validation Secure Server CA

Common name: COMODO RSA Domain Validation Secure Server CA
Organization: COMODO CA Limited
Location: Salford, Greater Manchester, GB
Valid from February 11, 2014 to February 11, 2029
Serial Number: 2b2e6eead975366c148a6edba37c8c07
Signature Algorithm: sha384WithRSAEncryption
Issuer: COMODO RSA Certification Authority

Common name: COMODO RSA Certification Authority
Organization: COMODO CA Limited
Location: Salford, Greater Manchester, GB
Valid from May 30, 2000 to May 30, 2020
Serial Number: 2766ee56eb49f38eabd770a2fc84de22
Signature Algorithm: sha384WithRSAEncryption
Issuer: AddTrust External CA Root

Common name: AddTrust External CA Root
Organization: AddTrust AB Org. Unit: AddTrust External TTP Network
Location: SE
Valid from May 30, 2000 to May 30, 2020
Serial Number: 1 (0x1)
Signature Algorithm: sha1WithRSAEncryption
Issuer: AddTrust External CA Root

Figure 9-10. *Displaying the chain of trust for your SSL certificate*

The chain from your domain name certificate leads, in this example, through two intermediate certificates to the CA root certificate.

You will test your SSL certificate next with the project in the following section.

Project: Securely Logging In to a Site

By enhancing your site with an SSL certificate, obtained from a CA, you can now create a site that securely allows the user to create an account and log in to view some personal information. You do this by implementing a MySQL database that stores all the user accounts. The user can remain connected while browsing the site's pages until finally logging out. For simplicity, this example will just have one page, but you could expand it to more web pages. By implementing PHP sessions, you'll allow PHP session variables to be shared between the PHP source code of the site's web pages. In this project, the `session_user` variable set by the username when the user logs in successfully is shared among the web pages. In web pages like `profile.php`, which appears when the user logs in, the `session_user` value is the ticket to querying a database and displaying user-specific information. This can be extended to other web pages and thus allow the user to access more information while connected.

The project requires the following five PHP files:

- `index.php`, the home web page that allows the user to either create an account or connect to the site using this account
- `account.php`, the web page that creates the account
- `login.php`, the web page that logs the user in to the site
- `profile.php`, the web page the user is transferred to after a successful login to view user-specific information
- `logout.php`, the file that uses the PHP code for the logout process, which also transfers the user from `profile.php` to `login.php`

Designing the Project's Site

Figure 9-11 displays the four web pages and the way they are linked together to form the site.

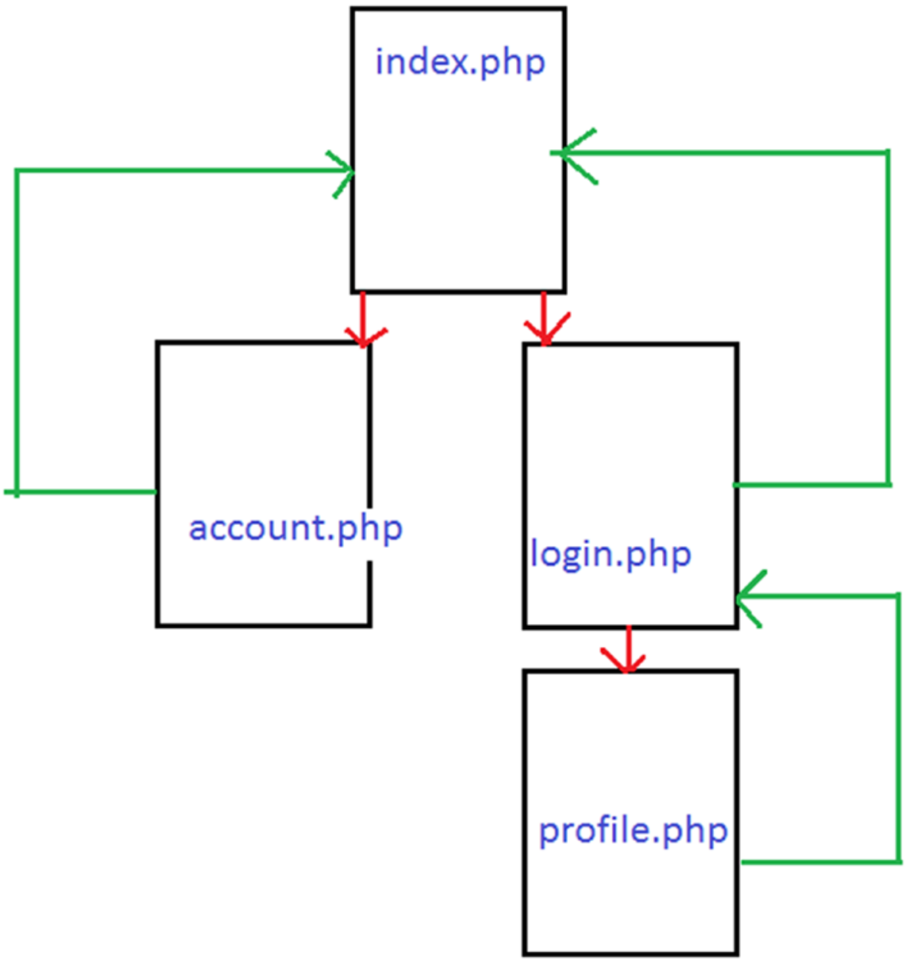


Figure 9-11. *The design of the project's site*

The login project site will be placed in a new directory, called `login`, in the document root. Create this directory with the following command:

```
$ sudo mkdir /var/www/html/login
```

You can use either web server you've been using in this book, but these instructions will use Apache. The directory `/var/www/html/login` is already set as the document root of the site for the Apache web server in the `default-ssl.conf` configuration file with the `DocumentRoot` directive.

```
DocumentRoot /var/www/html/login
```

If Apache is not running currently, enable it now using this:

```
$ sudo service lighttpd stop
$ sudo service apache2 start
```

The Source Code for the Home Page of the Site

Next, create the directory index, `index.php`, so that the site can be accessed from the address bar of the browser simply as follows:

```
https://httpsserver.eu
or since redirection applies simply as:
httpsserver.eu
```

Create `index.php` by entering the following command at the Linux terminal:

```
$ sudo gedit /var/www/html/login/index.php
```

Enter the following code and save the file:

```
<!DOCTYPE html>
<html>
<head>
<style>
body{
background-color:brown;
}
.center {
    margin: auto;
    width: 80%;
    border: 3px solid black;
    padding: 10px;
    background-color:lightsalmon;
}
p{
text-align:center;
font-family: Courier New,Courier,Lucida Sans Typewriter,Lucida
Typewriter,monospace;
font-size:32px;
color:#9F0251;
font-weight:italic;
}
span{
padding:10px;
}
a{
text-decoration:none;
}
a:link, a:visited {
    color: #9F0251;;
}
a:hover {
    color: black;
}
</style>
</head>

<body>
<br><br><br><br><br><br>
<div class="center">
<p>
<span>
<a href="account.php">Create Account</a>
</span>
|
<span>
<a href="login.php">Login&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;</
a>
</span>
</p>
</div>
</body>
</html>
```

As indicated in its source code, `index.php` is a simple web page that basically includes two links. Create Account leads to `account.php`, which is the PHP file that evaluates to the web page used for creating the user account, and Login leads to `login.php`, which is the PHP file that evaluates to the web page where the user logs in to the site (Figure 9-12).

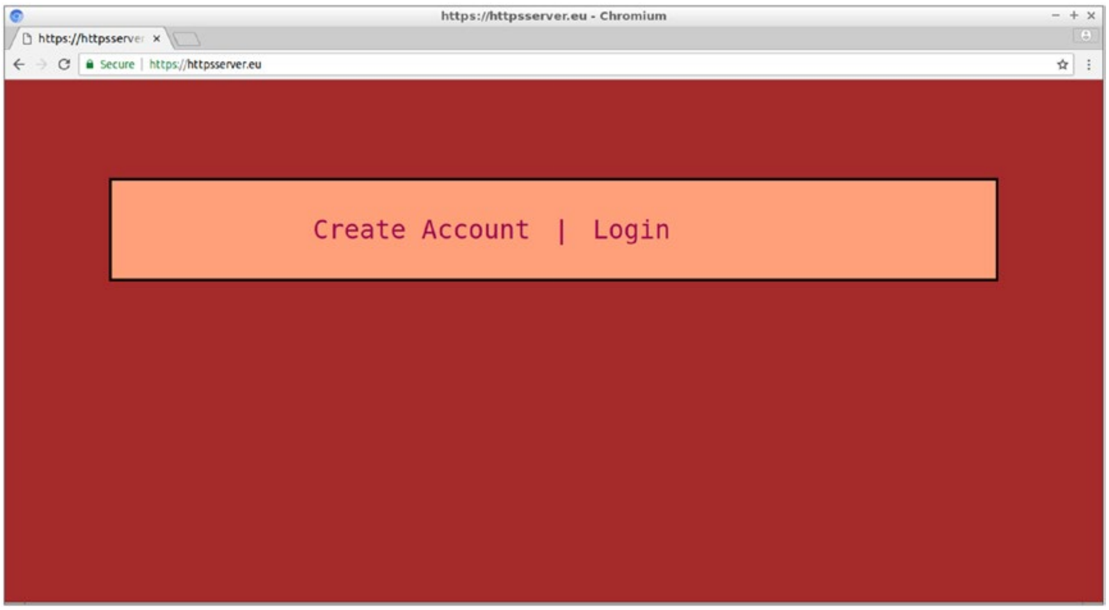

https://httpsserver.eu - Chromium
https://httpsserver
Secure | https://httpsserver.eu
Create Account | Login

Figure 9-12. *The home page includes two links for creating user accounts and for user login*

Next, you will create two more web pages: `account.php` and `login.php`.

The Web Page for Creating the User Account

By following the Create Account link, the user goes from `index.php` to the `account.php` page, displayed in Figure 9-13, where the account for the specific web service is created. In this example, the service is about securely logging in to a site, where the user can view some details about the books loaned from a local library.

The user is required to enter the following details in the HTML form of `account.php` (which will be stored in the `user` table of the `login` database created in the following section with MySQL):

- First
- Last name
- E-mail address
- Username
- Password
- Password retyped

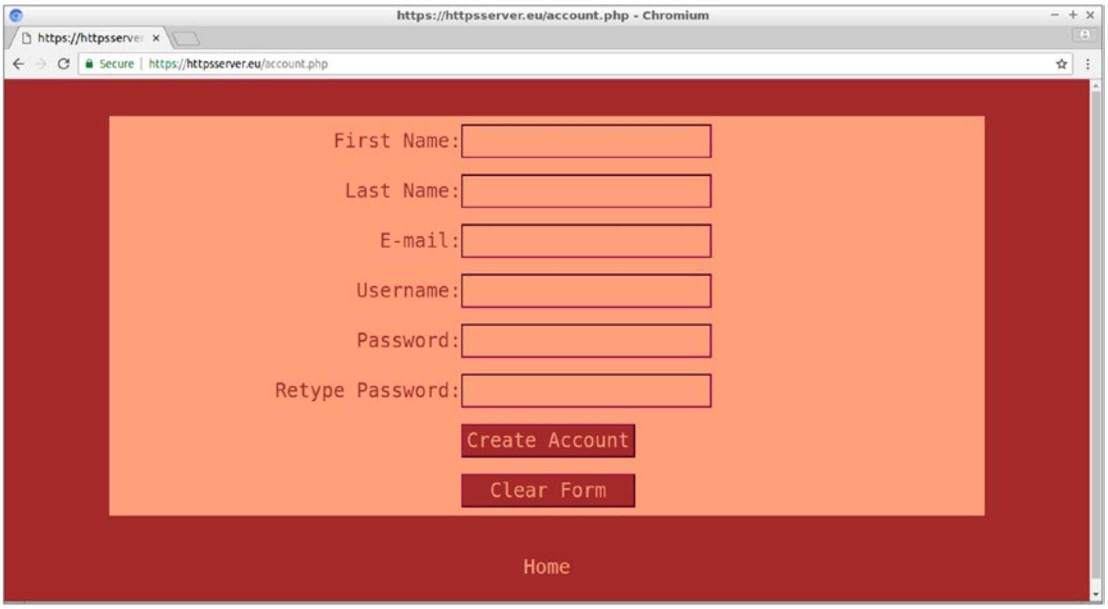
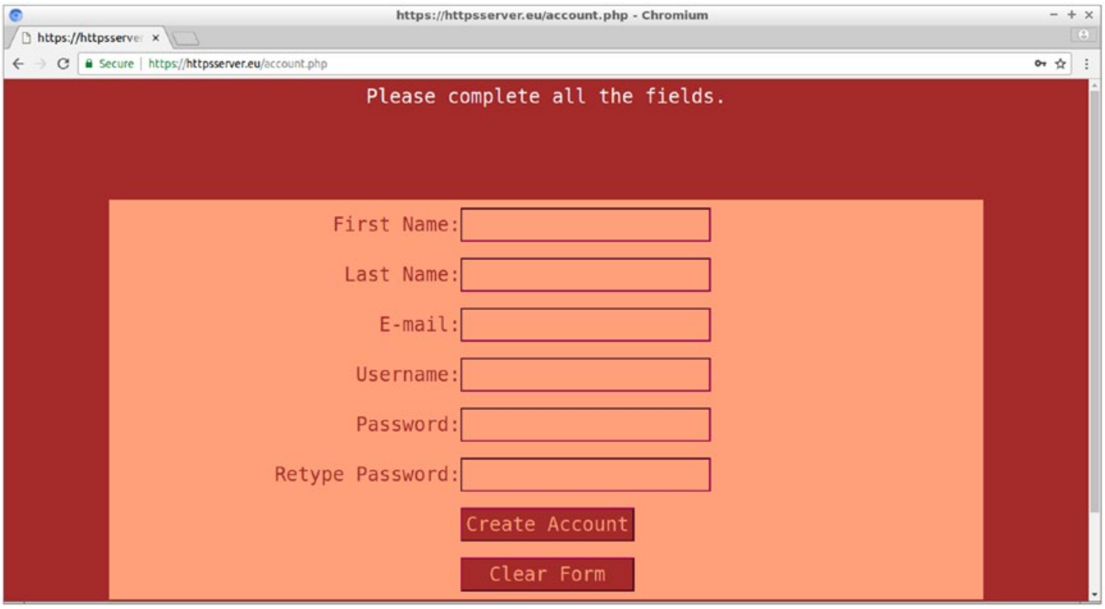


Figure 9-13. *The account.php web page of the site*

All form objects are of type `text`, except the e-mail, which is of type `email`, and the two password fields, of type `password`. The e-mail field requires an entry of the form `X@Y.Z`, and the password fields hide the characters by replacing them with bullets. The password has to be retyped to validate the first password entry. Two checks are done in the PHP form validation process: that all fields are nonempty and that the two password entries match. If those conditions are not met, the appropriate message appears at the top of the web page, as displayed in Figure 9-14.


https://httpsserver.eu/account.php - Chromium
https://httpsserver
Secure | https://httpsserver.eu/account.php
Create Account
Clear Form

Please complete all the fields.

First Name:
Last Name:
E-mail:
Username:
Password:
Retype Password:

Figure 9-14. *Error messages are displayed when the form is incomplete or when the password entries are not identical*

To create the file `account.php`, enter the following command at the Linux terminal:

```
$ sudo gedit /var/www/html/login/account.php
```

Enter the following source code and save the file:

```
<!DOCTYPE html>
<html>
<head>
<style>
body{
background-color:brown;
}
.center {
    margin: auto;
    width: 80%;
    border: none;
    padding: 10px;
    background-color:lightsalmon;
}
```

```
.center2 {
    margin: auto;
    width: 80%;
    border: none;
    padding: 10px;
    background-color:brown;
}
p{
text-align:center;
font-family: Courier New,Courier,Lucida Sans Typewriter,Lucida
Typewriter,monospace;
font-size:24px;
color:white;
font-weight:italic;
}
input{
border-color:#9F0251;
font-family: Courier New,Courier,Lucida Sans Typewriter,Lucida
Typewriter,monospace;
font-size:24px;
color:black;
padding:5px;
background-color:lightsalmon;
}
input[type=submit],[type=reset]{
background-color:brown;
color:lightsalmon;
padding:5px;
}
a{
text-decoration:none;
}
a:link, a:visited {
    color: lightsalmon;
}
```

```
a:hover {
    color: black;
}
label {
  font-family: Courier New,Courier,Lucida Sans Typewriter,Lucida
Typewriter,monospace;
  display: inline-block;
  width: 40%;
  text-align: right;
  color:brown;
  font-size:24px;
}
</style>
</head>

<body>

<?php

 $errormsg1 = "";
 $errormsg2 = "";
 $valid1 = 0;
 $valid2 = 0;

if (isset($_POST['s1'])) {

 $first = $_POST["first"];
 $last = $_POST["last"];
 $email = $_POST["email"];
 $user = $_POST["user"];
 $pass1 = $_POST["pass1"];
 $pass2 = $_POST["pass2"];

if((empty($first)) || (empty($last)) || (empty($email)) || (empty($user))
|| (empty($pass1)) || (empty($pass2))) {
$errormsg1 = '<p>Please complete all the fields. </p>';
} else {
$valid1 = 1;
}
```

```
if((strcmp($pass1, $pass2))) {
$errormsg2 = '<p>Please enter the same password at the Password fields. </
p>';
} else {
$valid2 = 1;
}

}


if (($valid1 == 1) && ($valid2 == 1)) {
create_entry($first, $last, $email, $user, $pass1);
}

function create_entry ($first, $last, $email, $user, $pass1) {

$servername = "localhost";
$username = "root";
$password = "";
$dbname = "login";

$mysqli = new mysqli($servername, $username, $password, $dbname);


if ($mysqli->connect_error) {
    die("Connection failed: " . $mysqli->connect_error);
}

$hashed_password = password_hash($pass1, PASSWORD_DEFAULT);
$sql = "INSERT INTO user (first, last, email, username, password) VALUES
('$first', '$last', '$email', '$user', '$hashed_password')";

if(mysqli_query($mysqli, $sql)){
    //echo "Records inserted successfully.";
}else{
      if(mysqli_errno($mysqli) == 1062) {
        echo "<p>Username already inserted (duplicate entry)</p>";
      }else{
         echo "ERROR: Could not able to execute $sql. " . mysqli_
         error($mysqli);
      }
 }
$mysqli->close();
}
?>

<?php
 if(($errormsg1 != "") && isset($_POST['s1']))
 echo $errormsg1;
 if(($errormsg2 != "") && isset($_POST['s1']) && ($errormsg1 == ""))
 echo $errormsg2;
?>

<br><br>
<form name="form1" method="post" action="<?php echo htmlspecialchars
($_SERVER["PHP_SELF"]); ?>">
<div class="center">
<label for="first">First Name: </label><input type="text" name="first">
</div>
<div class="center">
<label for="last">Last Name: </label><input type="text" name="last">
</div>
<div class="center">
<label for="email">E-mail: </label><input type="email" name="email">
</div>
<div class="center">
<label for="user">Username: </label><input type="text" name="user">
</div>
<div class="center">
<label for="pass1">Password: </label><input type="password" name="pass1">
</div>
<div class="center">
<label for="pass2">Retype Password: </label><input type="password"
name="pass2">
</div>
```

```
<div class="center">
<label for="s1">&nbsp;</label><input type="submit" name="s1" value="Create
Account">
</div>
<div class="center">
<label for="r1">&nbsp;</label><input type="reset" name="r1"
value="&nbsp;&nbsp;Clear Form&nbsp;&nbsp;">
</div>
</form>
<div class="center2">
<p><a href="index.php">Home</a></p>
</p>
</body>
</html>
```

A large part of the code is for formatting the web page with CSS and creating the HTML form. PHP code blocks are also used in various positions in the body section of the HTML source code. In the HTML form, the `action` attribute, indicating the file that will receive the form's data, is set to `account.php`.

```
<form name="form1" method="post" action="<?php echo htmlspecialchars
($_SERVER["PHP_SELF"]); ?>">
```

When the form is completed by the user and the form data is submitted from `account.php` to itself, the PHP code included in the following `if` statement runs:

```
if (isset($_POST['s1'])) {
...
}
```

This `if` condition checks whether data is submitted by the `s1` named button of the form, with the `POST` method, and therefore whether the `$_POST['s1']` PHP global variable is set. Notice that `s1` is the name of the form's submit button. The HTTP request method `POST` is preferred over method `GET` to send SSL data, because although the `GET` data is also encrypted, it may be visible to server logs or the browser's history. Moreover, `GET` exposes the data to the URL, so the query string may be visible to anyone standing next to you. Also, `GET` limits the data sent by applying a maximum data length.

The next lines of the same PHP block assign the variables `$first`, `$last`, `$email`, `$user`, `$pass1`, and `$pass2` to the corresponding values that the form's fields send. Two checks are performed with the form validation process. First you ensure that the values sent are not empty and, if all the form data is completed, that the two password fields' values match. If the checks succeed, the function `create_entry()` is called with the arguments `$first`, `$last`, `$email`, `$user`, and `$pass1`.

`create_entry()` connects to the `login` MySQL database (which will be created in the following section) and inserts the row provided by the `create_entry()` arguments in the table `user`. These rows correspond to the table columns `first`, `last`, `email`, `username`, and `password`. Before inserting the values into the database, the PHP function `password_hash()` is called to encrypt the password value.

```
$hashed_password = password_hash($pass1, PASSWORD_DEFAULT);
$sql = "INSERT INTO user (first, last, email, username, password) VALUES
('$first', '$last', '$email', '$user', '$hashed_password')";
```

All passwords included in the database are therefore hashed to a value with a constant size (e.g., 60 characters when `password_hash()` is applied with the `PASSWORD_DEFAULT` argument). Hashed values are theoretically irreversible, which means you can't obtain the password from the password's hashed value. What you can do is hash the value of the user's entry and compare it with the hashed value already stored in the database.

The function `mysqli_query()` submits the query to the database. If this function returns false, the error with the number 1062 is checked, which indicates a duplicate entry. A duplicate entry for the username is not allowed by the database design, which is discussed in the following section.

In this case, an appropriate message is printed at the top of the window. Also, for other reasons of failure, the corresponding error number is printed.

Creating the Database Used for the Project

To test `account.php`, create the database used in the project. Connect with the `mysql` client to the MySQL server using the following at the command line:

```
$ sudo mysql -u root
```

At the `mysql>` prompt that appears, enter the following command to create the new database called `login`:

```
mysql> create database login;
```

The MySQL server responds with the following message:

```
Query OK, 1 row affected (0.00 sec)
```

Select the new database to work with.

```
mysql> use login;
```

The MySQL server responds with the following message:

```
Database changed
```

Create the table `user` with the column `id` as the primary key. The `id` field will increment each time automatically by one, starting from one, and therefore you don't have to provide it when you insert a new record into this table.

```
mysql> CREATE TABLE user(id int NOT NULL AUTO_INCREMENT, PRIMARY KEY
(id), username varchar(255) NOT NULL, UNIQUE KEY (username), password
varchar(255) NOT NULL, email varchar(255) NOT NULL, first varchar(255) NOT
NULL, last varchar(255) NOT NULL);
```

The MySQL server responds with a message similar to the following:

```
Query OK, 0 rows affected (0.43 sec)
```

At this point, you may want to view the page's structure. You can enter the following:

```
mysql> describe user;
```

The command's output is as follows:

```
+----------+--------------+------+-----+---------+----------------+
| Field    | Type         | Null | Key | Default | Extra          |
+----------+--------------+------+-----+---------+----------------+
| id       | int(11)      | NO   | PRI | NULL    | auto_increment |
| username | varchar(255) | NO   | UNI | NULL    |                |
| password | varchar(255) | NO   |     | NULL    |                |
| email    | varchar(255) | NO   |     | NULL    |                |
| first    | varchar(255) | NO   |     | NULL    |                |
| last     | varchar(255) | NO   |     | NULL    |                |
+----------+--------------+------+-----+---------+----------------+
6 rows in set (0.00 sec)
```

In the CREATE TABLE SQL command, the UNIQUE KEY constraint was used for the username column in the user table (displayed with the UNI keyword in the table's structure) to ensure that there are no two identical usernames. Any attempts to insert a duplicate value is detected in the source code of the function create_entry() in account.php, and an appropriate error message is displayed at the top of the window.

Do not exit mysql yet since the MySQL client connection to the database is required for the next section.

Testing the PHP to MySQL Connection

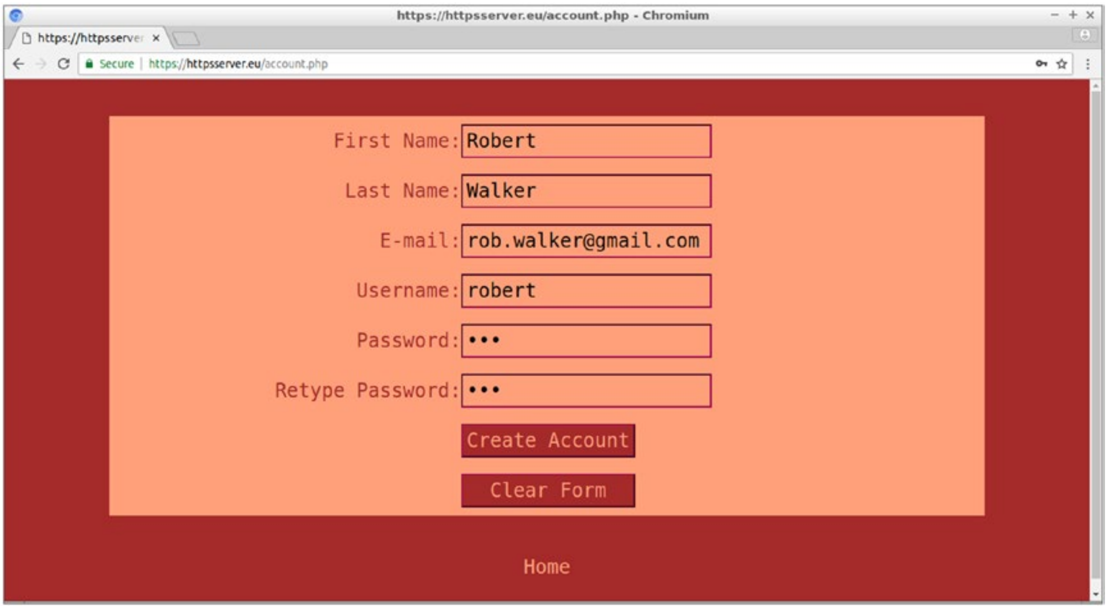
In this section, you'll enter some records in the user table of the database from the account.php form. In your browser, display the directory index, index.php, by entering the following address in the address bar:

```
https://httpsserver.eu/
```

Then follow the Create Account link. You can also view the account page directly, without using the directory index first, by entering the following:

```
https://httpsserver.eu/account.php
```

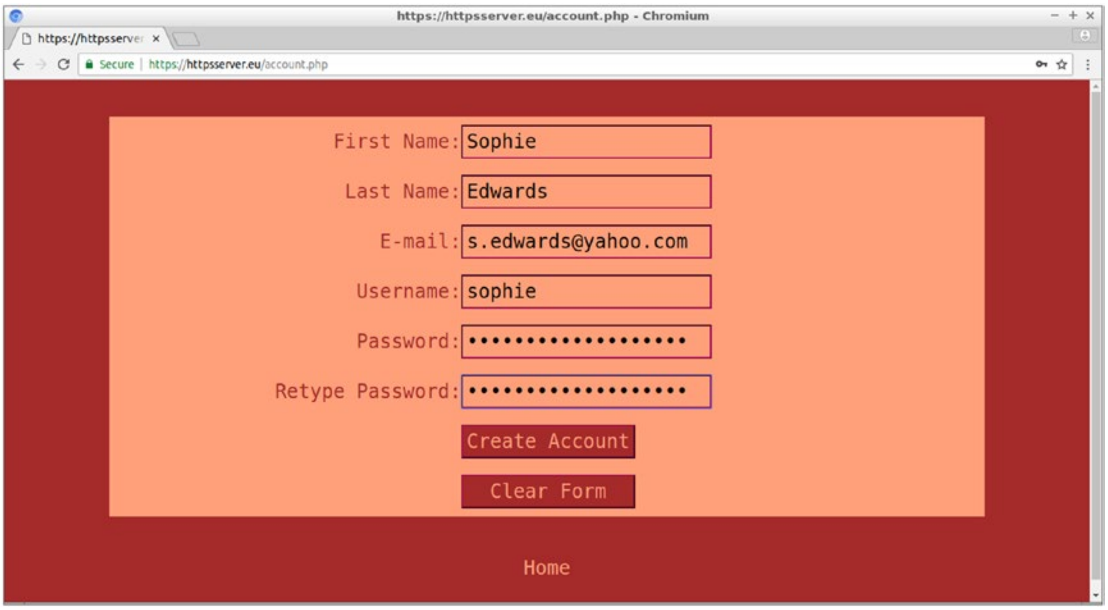
Enter in the form's fields the details of some test users and submit them by clicking the Create Account button. For instance, you can create two users: Robert and Sophie. Figure 9-15 displays the values inserted in the form fields for user Robert.


https://httpsserver.eu/account.php - Chromium
https://httpsserver
Secure | https://httpsserver.eu/account.php
Create Account
Clear Form
Home

First Name:	Robert
Last Name:	Walker
E-mail:	rob.walker@gmail.com
Username:	robert
Password:	•••
Retype Password:	•••

Figure 9-15. *The values entered in the account.php form for user Robert*

Although generally not recommended, to compare the output of hashing two different-sized passwords, use a simple password for Robert, such as `123`, and then a stronger one for Sophie, such as `supersophie3mi8#m&&`. Figure 9-16 shows the values entered in the form for user Sophie.


https://httpsserver.eu/account.php - Chromium
https://httpsserve
Secure | https://httpsserver.eu/account.php

First Name: Sophie

Last Name: Edwards

E-mail: s.edwards@yahoo.com

Username: sophie

Password: ••••••••••••••••••

Retype Password: ••••••••••••••••••

Create Account
Clear Form
Home

***Figure 9-16.** The values entered in the account.php form for user Sophie*

Switch to the terminal and connect to the MySQL client. Use the following command to view the new contents of the table `user`:

```
mysql> select * from user;
```

The command's output is as follows:

```
+----+----------+----------------------+----------------------+--------+---------+
| id | username | password             | email                | first  | last    |
+----+----------+-----------       ----+----------------------+--------+---------+
|  1 | robert   | $2y$10$UWc3eeIjxFlbF
                  j75muUiF.wweL2VSpk7b7
                  ytsApi5rBGQtGLLCLda  | rob.walker@gmail.com | Robert | Walker  |
|  2 | sophie   | $2y$10$nNTcBgLkzpSbk
                  CZTcjmdVetzk2/KYsOq2o
                  YyZpQTJIO5hghzkaJwS  | s.edwards@yahoo.com  | Sophie | Edwards |
+----+----------+----------------------+----------------------+--------+---------+
2 rows in set (0.00 sec)
```

As you'll notice, regardless of their initial size, both passwords after hashing have a constant length of 60 characters. For instance, for Robert, the password `123` after the hashing process has the following value:

```
$2y$10$UWc3eeIjxFlbFj75muUiF.wweL2VSpk7b7ytsApi5rBGQtGLLCLda
```

where:

- `$2y$` is the algorithm used, which is the bcrypt algorithm for the `PASSWORD_DEFAULT` argument of `password_hash()`.
- `10$` is the algorithm cost.
- `UWc3eeIjxFlbFj75muUiF.` is the salt.
- `wweL2VSpk7b7ytsApi5rBGQtGLLCLda` is the hashed password.

Password hashing is a nice solution for maintaining password security even when the database is compromised. The one-way hashing applied by `password_hash()` leads to a result that cannot be reversed from the original password. Since the hashed password, and not the original one, is stored in the database, to verify the password of the user who log ins to the site, the entered password has to be hashed and then compared with the stored password.

The hashing procedure is enforced by using a salt. Applying a common hash algorithm to a password always leads to the same result for the given password. This might be proved insecure, since an attacker might try a number of passwords, hashed with the same algorithm until he succeeds. A collection of hashed passwords used for the attack is called a *rainbow table*. By attaching a salt to the password, which is a random string either generated by the hashing method or provided by the user, the hashing outcome will be different even when the same password is hashed twice. When comparing the stored password with the password entered by the visitor of the site, the latter is hashed with the salt stored in the hashed password of the database.

Before testing the user login functionality of the site, you need to create a second table for the login database with details about the books loaned by the users. Then on login, the personal information will be available for each user at the web page that the login connection leads to.

At the Linux terminal, with `mysql` open, enter the following:

```
mysql> create table book_loan (book_id char(13), primary key(book_id),
loan_date date, user_id int, foreign key(user_id) references user(id));
```

The MySQL server responds with a similar output:

```
Query OK, 0 rows affected (0.47 sec)
```

Enter a number of `insert` operations on the database like the following:

```
mysql> insert into book_loan(book_id, loan_date, user_id)
values(6183443458964, NOW(), 1);
mysql> insert into book_loan(book_id, loan_date, user_id)
values(3487368817469, NOW(), 1);
```

In the previous commands, the MySQL function `NOW()` returns the current date and time as a `YYYY-MM-DD` string.

View next the contents of the table `book_loan` by using the following:

```
mysql> select * from book_loan;
```

The MySQL server outputs the following table:

```
+---------------+------------+---------+
| book_id       | loan_date  | user_id |
+---------------+------------+---------+
| 3487368817469 | 2018-10-04 |       1 |
| 6183443458964 | 2018-10-04 |       1 |
+---------------+------------+---------+
2 rows in set (0.00 sec)
```

Therefore, the user with an `id` value of 1 (user `robert`) is billed with two books so far. In the next section, this information will be available to Robert, and the information that no books are loaned will be also available to Sophie.

The Source Code of the Login Web Page

Figure 9-17 displays the `login.php` page that appears when the user clicks the Login link on `index.php`.

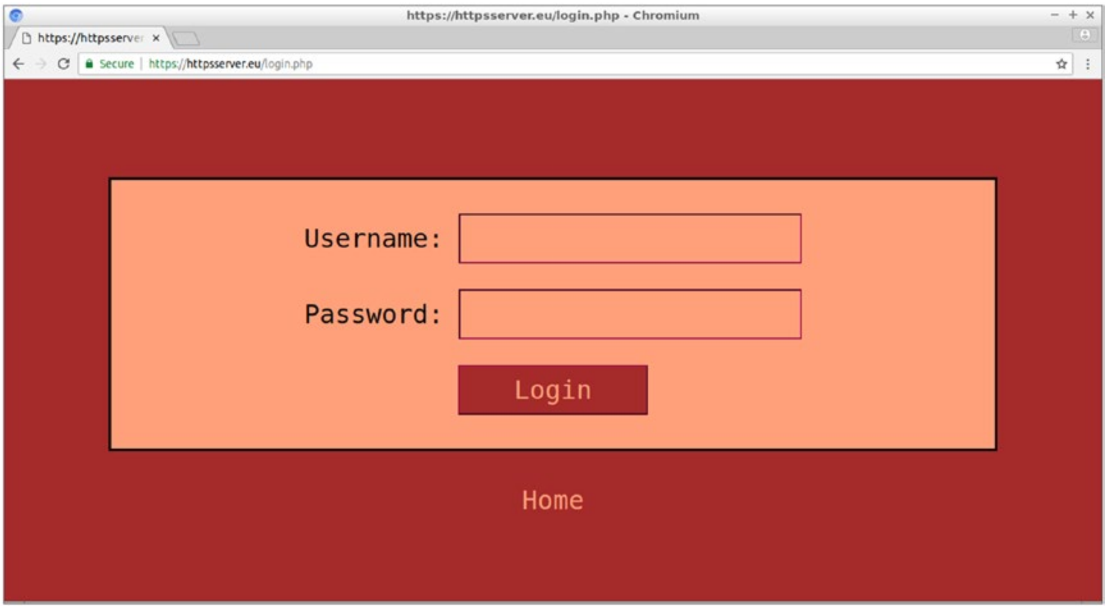

https://httpsserver.eu/login.php - Chromium
https://httpsserver
Secure | https://httpsserver.eu/login.php
Username:
Password:
Login
Home

***Figure 9-17.** The login.php web page allows the user to log in to the site*

To create the file `login.php`, enter the following command at the Linux terminal:

```
$ sudo gedit /var/www/html/login/login.php
```

Enter the following source code and save the file:

```
<?php
session_start();
?>
<!DOCTYPE html>
<html>
<head>
<style>
body{
background-color:brown;
}
.center {
    margin: auto;
    width: 80%;
    border: 3px solid black;
    padding: 10px;
    background-color:lightsalmon;
}
.center2 {
    margin: auto;
    width: 70%;
    border: none;
    padding: 10px;
    background-color:brown;
}
p{
text-align:center;
font-family: Courier New,Courier,Lucida Sans Typewriter,Lucida
Typewriter,monospace;
font-size:32px;
font-weight:italic;
}
input{
border-color:#9F0251;
font-family: Courier New,Courier,Lucida Sans Typewriter,Lucida
Typewriter,monospace;
font-size:32px;
color:black;
padding:10px;
background-color:lightsalmon;
}
input[type=submit]{
background-color:brown;
color:lightsalmon;
}
a{
text-decoration:none;
}
```

```
a:link, a:visited {
    color: lightsalmon;
}
a:hover {
    color: black;
}
</style>
</head>

<body>

<?php
if (isset($_POST['s1'])) {
 $user = $_POST["user"];
 $pass = $_POST["pass"];

if((empty($user)) || (empty($pass))) {
echo '<p style="color:white">Please complete the username and the password.
</p>';
} else {
verify_password($user, $pass);
}
}

function verify_password($user, $pass) {

$dbserver = "localhost";
$dbuser = "root";
$dbpass = "";
$dbname = "login";

$mysqli = new mysqli($dbserver, $dbuser, $dbpass, $dbname);


if ($mysqli->connect_error) {
    die("Connection failed: " . $mysqli->connect_error);
}

$user = mysqli_real_escape_string($mysqli, $user);
$sql = "SELECT password FROM user WHERE username='$user'";
if($query = mysqli_query($mysqli, $sql)) {
$rows = mysqli_num_rows($query);
}

if ($rows == 1) {
$row = mysqli_fetch_assoc($query);
$dbstored_pass=$row['password'];
$isValid = password_verify($pass, $dbstored_pass);
if ($isValid){
$_SESSION['session_user']=$user;
header("location: profile.php");
}
} else {
echo '<p>Username or Password is invalid</p>';
}

$mysqli->close();


}
?>

<br><br><br><br><br><br>
<div class="center">
<form name="f1" method="post" action="<?php echo htmlspecialchars($_
SERVER["PHP_SELF"]); ?>">
<p>Username: <input type="text" name="user">
</p>
<p>Password: <input type="password" name="pass">
</p>
<p><input type="submit" name="s1" value="&nbsp;&nbsp;&nbsp;Login&nbsp;&nbsp
;&nbsp;">
</p>
</form>
</div>
```

```
<div class="center2">
<p><a href="index.php">Home</a></p>
</p>
</body>
</html>
```

Like with `account.php` and `index.php`, CSS attributes are implemented to style the login web page. Like `account.php`, an HTML form is used that implements the `POST` method to submit the values to `login.php` and validate the data passed. The form validation checks whether the two fields are empty, and its source code is included in the PHP block that runs when the form with the submit button `s1` has sent data back to the same web page.

```
if (isset($_POST['s1'])) {
...
}
```

In the case of nonempty fields, the following function is called:

```
verify_password($user, $pass);
```

Here, `$user` and `$pass` are the PHP variables for the username and the password sent by the form:

```
$user = $_POST["user"];
$pass = $_POST["pass"];
```

What `verify_password()` does is connect to the MySQL server and specifically to the login database and run the following query, which retrieves the stored password in the database of the specific user:

```
SELECT password FROM user WHERE username='$user'
```

Before `$user` is passed to the SQL query, `mysqli_real_escape_string()` applies to this variable to escape some characters, that is, to prepend a backslash before any special character, taking into account the character set of the current database connection, which appears as the first parameter of `mysqli_real_escape_string()`. The function `mysqli_real_escape_string()` is used for security reasons and especially for avoiding SQL injections, that is, executing commands hidden in the SQL query.

With the function `mysqli_num_rows()`, the number of rows of the query is returned, and if the row number is one (there is a password of the specific user), the row is retrieved as the `$row` array, and the password is retrieved as the array's item stored in index `password`.

```
$row = mysqli_fetch_assoc($query);
$dbstored_pass=$row['password'];
```

The following command calls the PHP function `password_verify()` to verify the password provided by the user and sent by the login form (`$pass`), with the password stored in the database (`$dbstored_pass`).

```
$isValid = password_verify($pass, $dbstored_pass);
```

As mentioned in the previous section, `$pass` is the plaintext password (e.g., 123), while `$dbstored_pass` is the hashed password. The function `password_verify()` compares the entered password with the stored one after it hashes the former using the salt stored along with the latter.

If the two passwords match, the value of `$user` is assigned to the PHP session variable `session_user`. At this point, more session variables could be used if required. Therefore, the username will be available to all other web pages of the site while the user is connected, and its unique value will be the key, which is where all information about the user will be derived from. The session variable, available for all web pages of the site that join the session, is stored on the server side, and the user cannot have any access to it and cannot substitute it with another user's.

After a successful login, the web browser redirects to `profile.php`.

```
if ($isValid){
$_SESSION['session_user']=$user;
header("location: profile.php");
```

Recall also that for the session to function as expected, the following PHP block that creates the session should be at the top of the web page:

```
<?php
session_start();
?>
```

The Source Code for the User Profile Page

Next, create `profile.php`, which is the web page the user redirects to on login. At the Linux terminal, enter the following:

```
$ sudo gedit /var/www/html/login/profile.php
```

Enter the following source code and save the file:

```
<?php
session_start();
$user=$_SESSION['session_user'];
?>
<!DOCTYPE html>
<html>
<head>
<style>
body{
background-color:brown;
}
.right {
    margin: auto;
    width: 100%;
    border: none;
    padding-right: 20px;
    text-align:right;
    background-color:lightsalmon;
    font-size:24px;
}
table{
background-color:lightsalmon;
color:black;
font-size:24px;
width:70%;
margin: 0 auto;
padding:20px;
}
```

```
td{
text-align:center;
}
h1{
text-align:center;
}
</style>
</head>

<body>


<p class="right">
You are currently logged in as user <?php echo $user ?>
<a href="logout.php">Logout</a>
</p>
<br><br><br>
<h1>Books Loaned</h1>

<?php

display_books($user);

function display_books($user) {

$servername = "localhost";
$username = "root";
$password = "";
$dbname = "login";

$mysqli = new mysqli($servername, $username, $password, $dbname);


if ($mysqli->connect_error) {
    die("Connection failed: " . $mysqli->connect_error);
} else {
$sql = "SELECT book_loan.book_id, book_loan.loan_date FROM user INNER JOIN
book_loan ON user.id = book_loan.user_id WHERE user.username='$user'";
if($result=mysqli_query($mysqli, $sql)){
  if (mysqli_num_rows($result)>=1){
    echo "<table>";
    echo "<tr><td>" . "ISBN" . "</td><td>" . "Loan Date" . "</td></tr>";
    while ($row=mysqli_fetch_assoc($result))
      {
        echo "<tr><td>" . $row['book_id'] . "</td><td>" . $row['loan_date'] .
        "</td></tr>";
      }
    echo "</table>";
    mysqli_free_result($result);
  } else{
    echo "<h1>No results found</h1>";
  }
} else{
    echo "ERROR: Could not able to execute $sql. " . mysqli_error($mysqli);
}
$mysqli->close();

}
}
?>

</body>
</html>
```

The first block of PHP source code allows `profile.php` to join the PHP session and also retrieves from variable `$user` the value set by `login.php` for the session variable `session_user`.

```
<?php
session_start();
$user=$_SESSION['session_user'];
?>
```

In the top-right area of the web page, the message “You are currently logged in as user” appears followed by the username of the logged-in user, provided by the `$user` value. Next to the name, a Logout link appears. (I’ll discuss later in this section how this link works.)

Under the heading “Books Loaned” is a list with the book ISBNs that correspond to the `book_id` column of the `book_loan` table and also the date loaned that corresponds to the `loan_date` column of the same table. If the user has not currently loaned any books, as in the example with the user Sophie, the message “No results found” appears instead.

Like the source code in the files `account.php` and `login.php`, a connection with the `login` database is established with the function `mysqli()`.

```
$servername = "localhost";
$username = "root";
$password = "";
$dbname = "login";

$mysqli = new mysqli($servername, $username, $password, $dbname);
```

On a successful connection, the following SQL command is executed, using the function `mysqli_query()`:

```
$sql = "SELECT book_loan.book_id, book_loan.loan_date FROM user INNER JOIN
book_loan ON user.id = book_loan.user_id WHERE user.username='$user'";
```

This time, data from two tables is required, and an inner join between the two tables is formed. With the inner join, a new result table is created that selects only the rows from the two tables that match the join condition. In the previous SQL command, the join condition is equality among the primary key of table `user` and the foreign key of table `book_loan`. This type of join based on equality is often referred as *equijoin*, and this is often used to denormalize data. The term *normalizing* refers to the process of storing data in different tables. With the denormalizing process, data from different tables can be retrieved.

With the previous SQL command, the `book_id` and `loan_date` columns from the `book_loan` table are selected for the matching columns of `user_id` (of table `book_loan`) and `id` (of table `user`) from the rows where the `username` column (of table `user`) is the value of `$user` (e.g., `robert`). The query depends therefore on the PHP session variable `session_user`, whose value is assigned to the PHP variable `$user`.

If the return value of `mysqli_num_rows()` holds one or more rows, the results (`$row['book_id']` and `$row['loan_date']`) are included in an HTML table.

```
  if (mysqli_num_rows($result)>=1){
    echo "<table>";
    echo "<tr><td>". "ISBN" . "</td><td>" . "Loan Date" . "</td></tr>";
    while ($row=mysqli_fetch_assoc($result))
      {
        echo "<tr><td>". $row['book_id'] . "</td><td>" . $row['loan_date'] .
        "</td></tr>";
      }
    echo "</table>";
```

The function `mysqli_fetch_assoc()` is used to provide the result rows. If no rows are returned, no table is formed, and the message "No results found" appears in a heading element.

```
} else{
    echo "<h1>No results found</h1>";
  }
```

The user-specific data is thus displayed. In the following section, you'll create the web page that logs the user out.

Allowing the User to Log Out

On `profile.php`, the PHP session is maintained, and the session variable `session_user` indicates the user who logged in and provides information specific to this user. Other web pages of the site could also be used to access the `session_user` variable and allow the user to stay connected and view user-specific data while visiting the site.

As mentioned previously, a message at the top right reminds the user of their name, and also a link called Logout allows the user to disconnect. This link leads to `logout.php`.

```
<p class="right">
You are currently logged in as user <?php echo $user ?>
<a href="logout.php">Logout</a>
</p>
```

Create the file `logout.php` using the following command at the Linux terminal:

```
$ sudo gedit /var/www/html/login/logout.php
```

Enter the following PHP code and save the file:

```
<?php
session_start();
setcookie(session_name(), ", 100);
unset($_SESSION['session_user']);
session_destroy();
header('Location: login.php');
exit;
?>
```

The previous PHP source code snippet uses the function `session_start()` to join the current session and then deletes the cookie from the user's browser by setting the expiration time to a value in the past. By setting the expiration time to 100, you indicate value 100 as a Unix timestamp, which corresponds to the number of seconds after the Unix epoch, which is January 1, 1970 00:00:00 UTC. The session variable `session_user` is destroyed with the function `unset()`, and the PHP session is terminated by calling the function `session_destroy()`. With the `header()` function, the web page redirects to `login.php`.

Testing the User Connection to the Site

To test the two users, you can use the `login.php` page, which appears when you return to the home page. Just click the Home link on `account.php` and then use the Login link. Or, since you already know the site's structure, enter the following:

```
https://httpsserver.eu/login.php
```

Enter the username, e.g., **robert**, and the user's password, e.g., **123**, for Robert, and click the Login button, as displayed in Figure 9-18.

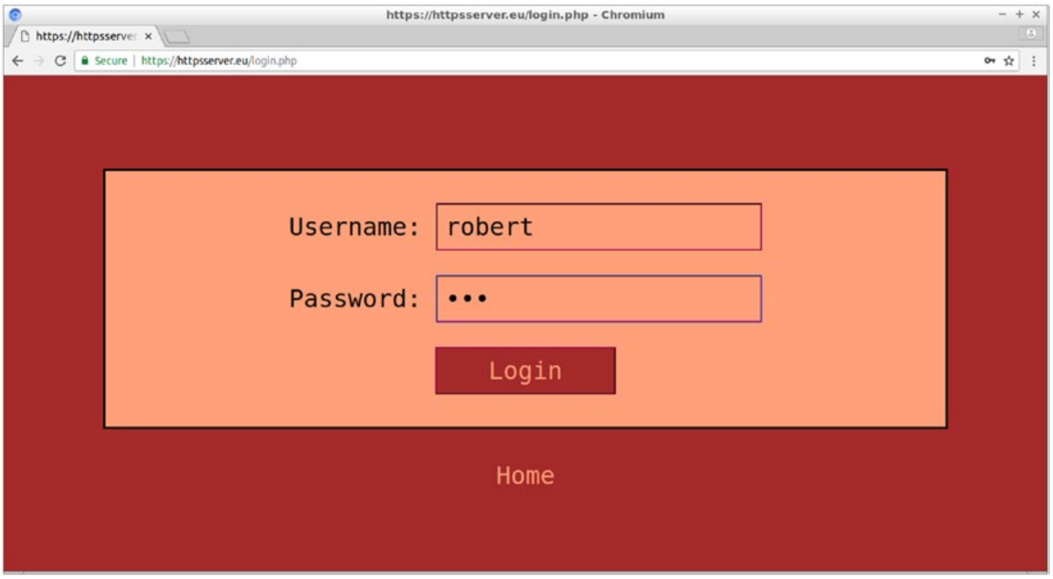
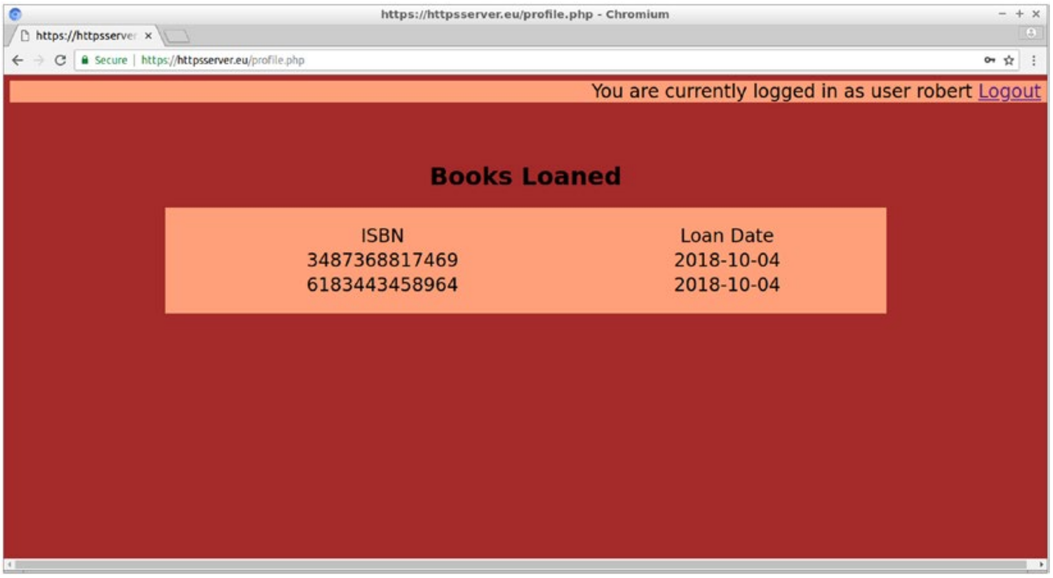

https://httpsserver.eu/login.php - Chromium
https://httpsserver.eu/login.php
Username: robert
Password: •••
Login
Home

Figure 9-18. *Testing the site by connecting as Robert*

User Robert gets connected to his profile page with personal information about his recent activity. In the top-right area of the page, the message "You are currently logged in as user robert" appears.


https://httpsserver.eu/profile.php - Chromium
https://httpsserver.eu/profile.php

You are currently logged in as user robert Logout

Books Loaned

ISBN	Loan Date
3487368817469	2018-10-04
6183443458964	2018-10-04

Figure 9-19. *The profile web page for Robert, displaying the ISBN and loan date of loaned books*

For books currently loaned to user Robert, the ISBN and loan date appear.

The Logout link leads to `logout.php`, where its evaluated PHP source code logs out the user by terminating the current session. The user then gets transferred back to the `login.php` web page.

Improving the profile.php Web Page

The data format for the loan date, appearing in `profile.php`, is the default one used by MySQL. To change this to a more readable format and also add a new column called Due Date, replace the `display_book()` function with the following new version:

```
function display_books($user) {

$servername = "localhost";
$username = "root";
$password = "";
$dbname = "login";

$mysqli = new mysqli($servername, $username, $password, $dbname);

if ($mysqli->connect_error) {
    die("Connection failed: " . $mysqli->connect_error);
} else {
$sql = "SELECT book_loan.book_id, book_loan.loan_date FROM user INNER JOIN
book_loan ON user.id = book_loan.user_id WHERE user.username='$user'";
if($result=mysqli_query($mysqli, $sql)){
  if (mysqli_num_rows($result)>=1){
    echo "<table>";
    echo "<tr><td>". '<b>ISBN</b>' . "</td><td>" . '<b>Loan Date</b>' .
    "</td><td>" . '<b>Due Date</b>' . "</td></tr>";
    while ($row=mysqli_fetch_assoc($result))
      {
        $date1 = strtotime($row['loan_date']);
        $newformat1 = date('l, j F Y', $date1);
        $date2 = strtotime("+ 21 days", $date1);
        $newformat2 = date('l, j F Y',$date2);
        echo "<tr><td>". $row['book_id'] . "</td><td>" . $newformat1 . "</
        td><td>" . $newformat2 . "</td></tr>";
      }
    echo "</table>";
    mysqli_free_result($result);
  } else{
    echo "<h1>No results found</h1>";
  }
} else{
    echo "ERROR: Could not able to execute $sql. " . mysqli_error($mysqli);
}
$mysqli->close();

}
}
```

The first call to the PHP function `strtotime()` converts the string `$row['loan_date']` to a Unix timestamp and returns this value to the variable `$date1`. The function `date()` is called to change `$date1`, passed as its second parameter, from a Unix timestamp to a readable format, indicated by the first parameter, (`'l, j F Y'`).

```
        $date1 = strtotime($row['loan_date']);
        $newformat1 = date('l, j F Y', $date1);
```

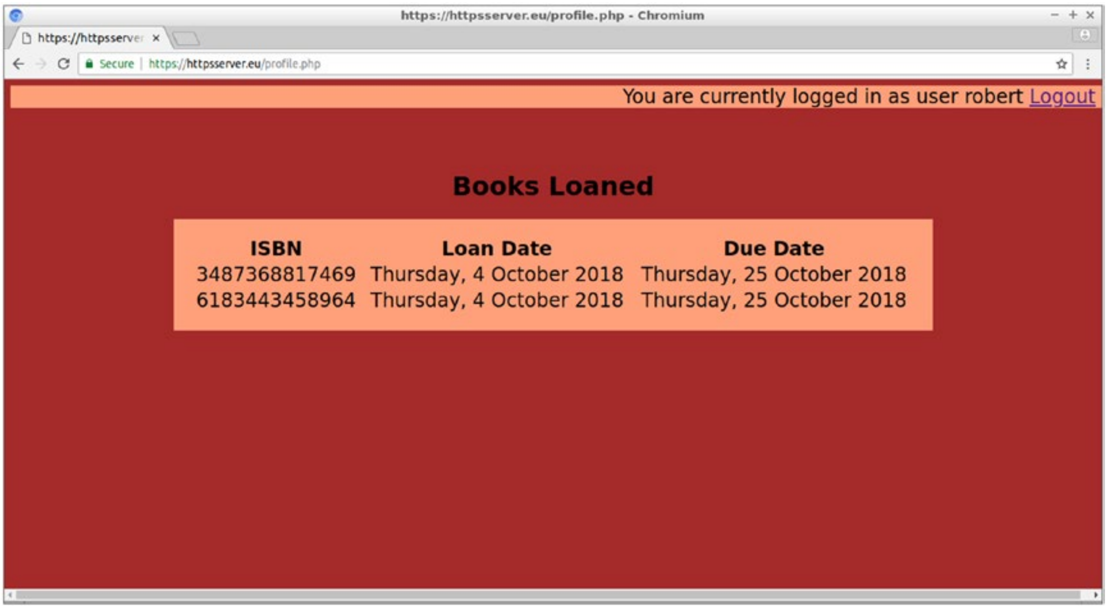
In the example of the source code, the following characters are used for the format parameter:

- `l`, a full textual representation of the day of the week
- `j`, the day of the month without leading zeros
- `F`, a full textual representation of a month
- `Y`, a full numeric representation of a year

The second time `strtotime()` is called, it results in a Unix timestamp increased by 21 days, which is the specified period in the local library in this example for book loans. The `date()` call converts the Unix timestamp to the previous readable format:

```
        $date2 = strtotime("+ 21 days", $date1);
        $newformat2 = date('l, j F Y',$date2);
```

Finally, `$newformat1` and `$newformat2` are printed in the Loan Date and Due Date columns, respectively, as viewed in Figure 9-20.


https://httpsserver.eu/profile.php - Chromium
https://httpsserver
Secure | https://httpsserver.eu/profile.php

You are currently logged in as user robert Logout

Books Loaned

ISBN	Loan Date	Due Date
3487368817469	Thursday, 4 October 2018	Thursday, 25 October 2018
6183443458964	Thursday, 4 October 2018	Thursday, 25 October 2018

Figure 9-20. *The new version of profile.php includes a Due Date column*

Summary

In this chapter, you obtained an SSL certificate from a certificate authority to enable your site to implement cryptography without getting any browser warnings, just like well-known commercial sites.

You also created a project that allows the users to log in and remain connected to your site until they log out. While connected, they can view user-specific data provided by the site.

The most common ways to exchange data between the client-side JavaScript and server-side PHP language are discussed in the next chapter.

CHAPTER 10

Running Online Services Using PHP Sockets

In this final chapter of the book, you will use either web server, Apache or Lighttpd, with the SSL certificate obtained in the previous chapter. You'll start by configuring and running a DDNS client program to update your public IP address to the DDNS server provider instead of relying the IP address of your router.

The projects in this chapter require socket programming so that the PHP code executing on the server side can connect to other Internet services.

Specifically, for this chapter's projects, the web server uses PHP sockets to connect to other Internet services. As an example of applying socket programming, you'll create a PHP server first that listens to a specific port number and is tested with Telnet and then with a PHP client program. Then the web server is used to connect to this PHP server, thus implementing a web interface to the service that the PHP server offers.

In the second project, socket programming is used to create a site that simulates an open port check, similar to the online service used in Chapter 8, and a site where the web server connects to an existing quote of the day (QOTD) server.

Finally, for each site you will create in this chapter, a separate FQDN is assigned.

Updating the Domain Name IP Address with ddclient

At this point, you have a site that is enabled to run either on Apache or on Lighttpd, and both servers use the PHP language to connect to the MySQL server and provide dynamic content. For the site, you used DDNS domain names (e.g., `christos.ddns.net`), and you optionally purchased a second-level domain name (e.g., `httpsserver.eu`) so that the web servers can implement HTTPS with an SSL certificate from a CA. Also, all HTTP requests redirect to HTTPS via port 443. You can use both servers by starting and stopping them accordingly.

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C. Karayiannis, *Web-Based Projects that Rock the Class*, https://doi.org/10.1007/978-1-4842-4463-0_10

Hint! If you don't recall which server currently is running, use the following command to find out whether any Lighttpd or Apache process is running on your system:

```
ps xa | grep -E 'apache2 | lighttpd'
```

To toggle between Apache and Lighttpd, use `servicecommand` to stop the server running and start the inactive one. For instance, if Lighttpd currently is running, enter the following at the Linux terminal:

```
$ sudo service lighttpd stop
$ sudo service apache2 start
```

Both Apache and Lighttpd currently are serving the site displayed in Figure 10-1, which has the document root `/var/www/html/login` and the file `index.php` as the directory index.

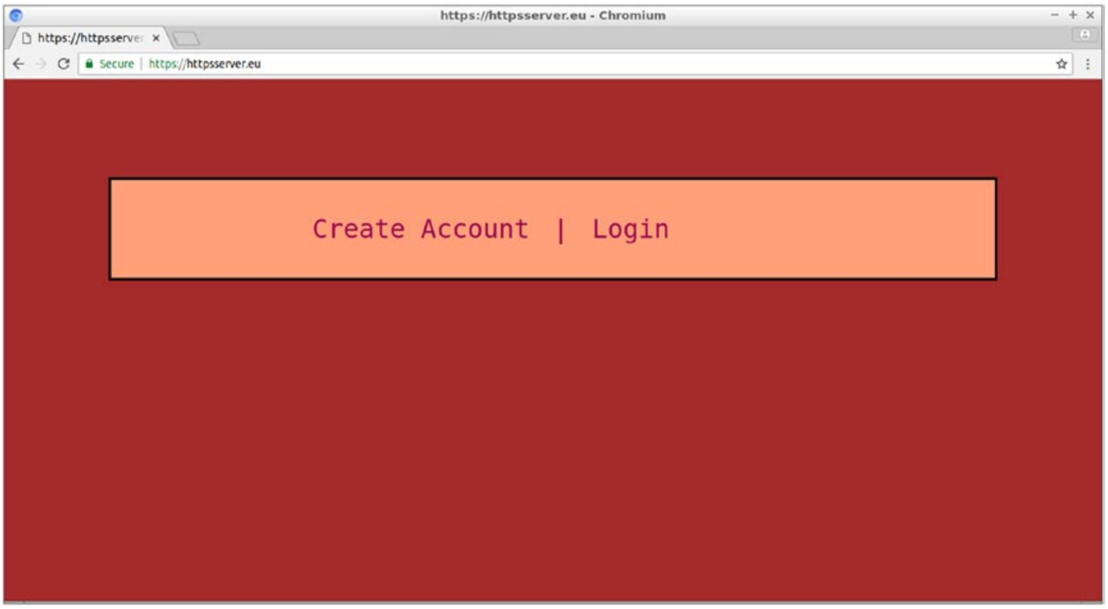
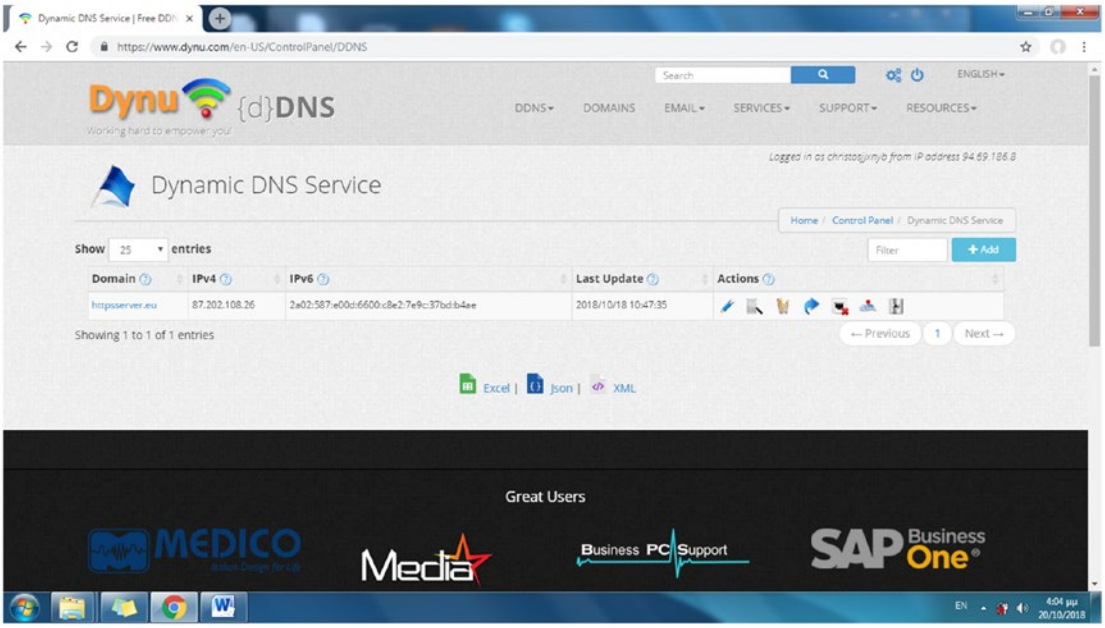

https://httpsserver.eu - Chromium
https://httpsserve
Secure | https://httpsserver.eu
Create Account | Login

***Figure 10-1.** The web site currently running for both web servers*

Before continuing with the projects in this chapter, let's ensure that the domain name obtained (e.g., `httpsserver.eu`) is still usable. If your ISP uses a dynamic IP address service, the domain name is expected sooner or later. For example, when the router restarts, your router's public IP address changes, and the domain name used with the DDNS service will not correspond anymore to your public IP address used when the domain was registered.

Chapter 3 discussed the router service for updating the public IP address on the domain name provider. However, if the router model does not support that specific provider, you can't rely on the router for the update. In that case, you have two options. The first is to ask your ISP to upgrade to a static IP address service. This is the best solution, especially if you really want to run a site 24/7. In that case, on your domain name's provider site, after logging into your account, you can bind the static IP address to your domain name. For instance, for the domain name provider used in the examples of this chapter, the configuration page looks like the one in Figure 10-2.



Dynamic DNS Service | Free DDN

https://www.dynu.com/en-US/ControlPanel/DDNS

Logged in as christosjxnyb from IP address 94.69.186.8

Dynamic DNS Service

Home / Control Panel / Dynamic DNS Service

Show 25 entries

Domain	IPv4	IPv6	Last Update	Actions
httpsserver.eu	87.202.108.26	2a02:587:e00d:6600:c8e2:7e9c:37bd:b4ae	2018/10/18 10:47:35	

Showing 1 to 1 of 1 entries

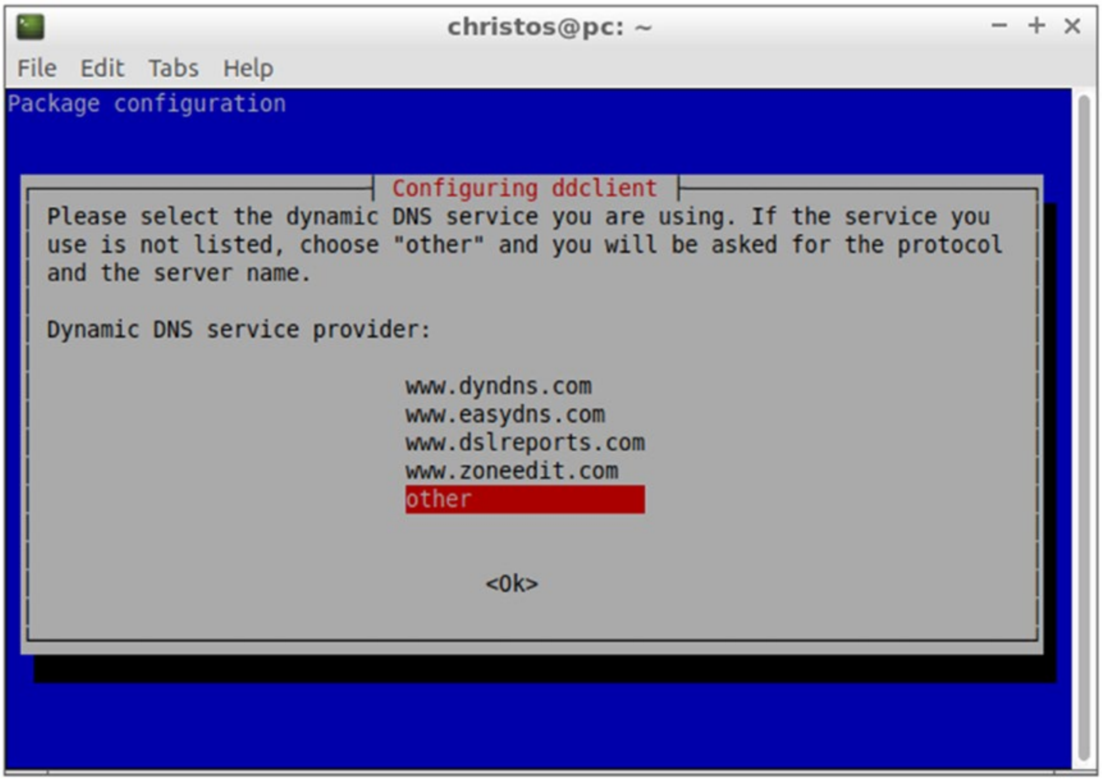
Figure 10-2. *Displaying the current IP address that is bound to the domain name on the domain name provider's site*

The other option is to install and run on your server a utility such as `ddclient` to do DDNS updates. You can run `ddclient` as a daemon process that periodically checks your public IP address and informs the domain name provider when this changes.

To install `ddclient`, enter the following at the Linux terminal:

```
$ sudo apt-get install ddclient
```

The installation process starts with the window in Figure 10-3, which asks you whether your provider appears in the included list. Use the keyboard arrows to choose Other, click the Tab key to select OK, and press Enter.

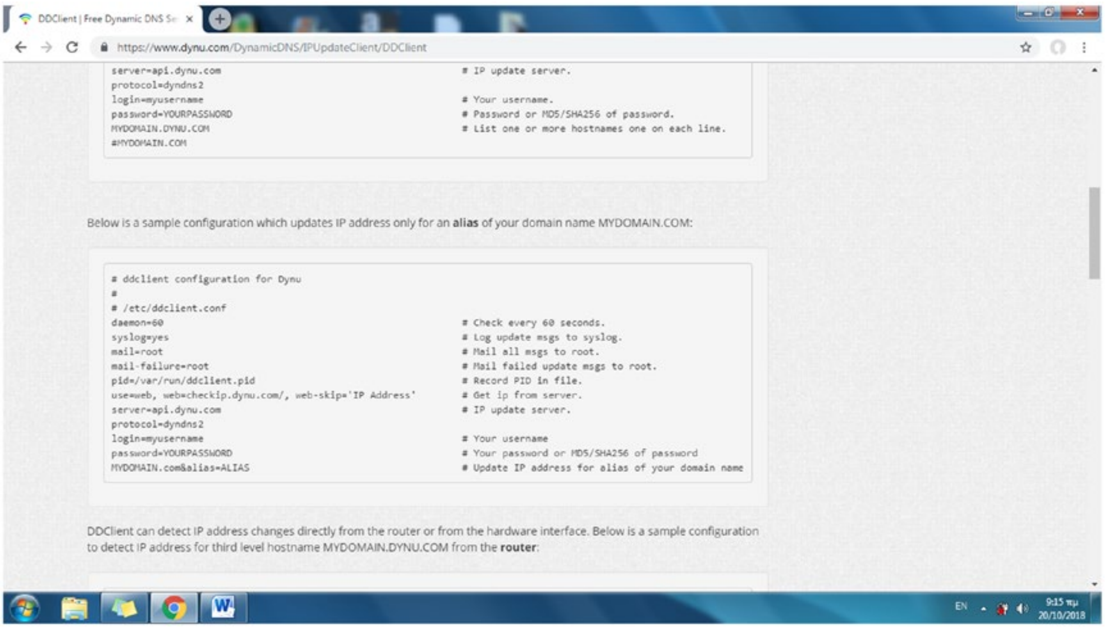


```
Package configuration

                    Configuring ddclient
 Please select the dynamic DNS service you are using. If the service you
 use is not listed, choose "other" and you will be asked for the protocol
 and the server name.

 Dynamic DNS service provider:

                           www.dyndns.com
                           www.easydns.com
                           www.dslreports.com
                           www.zoneedit.com
                           other

                              <Ok>
```

Figure 10-3. *The first dialog in the ddclient installation*

The installation process continues with a number of windows that retrieve information for the `ddclient` configuration file. At this point, you can skip each window by pressing the Esc key until the installation is complete, and then you can use one of the predefined `ddclient` configuration files that your domain name provider offers.

Most domain name providers provide complete guidance for setting up `ddclient` to use with their service, like the ones displayed in Figure 10-4.



DDClient | Free Dynamic DNS Se

https://www.dynu.com/DynamicDNS/IPUpdateClient/DDClient

```
server=api.dynu.com                                 # IP update server.
protocol=dyndns2
login=myusername                                    # Your username.
password=YOURPASSWORD                               # Password or MD5/SHA256 of password.
MYDOMAIN.DYNU.COM                                   # List one or more hostnames one on each line.
#MYDOMAIN.COM
```

Below is a sample configuration which updates IP address only for an **alias** of your domain name MYDOMAIN.COM:

```
# ddclient configuration for Dynu
#
# /etc/ddclient.conf
daemon=60                                           # Check every 60 seconds.
syslog=yes                                          # Log update msgs to syslog.
mail=root                                           # Mail all msgs to root.
mail-failure=root                                   # Mail failed update msgs to root.
pid=/var/run/ddclient.pid                           # Record PID in file.
use=web, web=checkip.dynu.com/, web-skip='IP Address'   # Get ip from server.
server=api.dynu.com                                 # IP update server.
protocol=dyndns2
login=myusername                                    # Your username
password=YOURPASSWORD                               # Your password or MD5/SHA256 of password
MYDOMAIN.com&alias=ALIAS                            # Update IP address for alias of your domain name
```

DDClient can detect IP address changes directly from the router or from the hardware interface. Below is a sample configuration to detect IP address for third level hostname MYDOMAIN.DYNU.COM from the **router**:

Figure 10-4. *Viewing instructions for ddclient configuration from the DDNS provider's site*

To edit the `ddclient` configuration file, enter the following at the Linux terminal:

```
$ sudo gedit /etc/ddclient.conf
```

Enter the settings recommended by your domain name provider; replace the username, password, and domain name with yours; and save the file. In the following sample file, used for Dynu.com, the three last lines were changed. You can also modify the time interval that `ddclient` uses to check for changed IP addresses. In the following configuration file, the time interval is set to 60 seconds.

```
daemon=60
syslog=yes
mail=root
mail-failure=root
pid=/var/run/ddclient.pid
use=web, web=checkip.dynu.com/, web-skip='IP Address'
server=api.dynu.com
protocol=dyndns2
```

```
login=christosffxdyv
password=somePsw
httpsserver.eu
```

Configure `ddclient` to run as a daemon process. Run the following to edit the `/etc/default/ddclient` configuration file:

```
$ sudo gedit  /etc/default/ddclient
```

Change `false` to `true` in the following line:

```
run_daemon="false"
```

Save the file and run the following commands at the Linux terminal:

```
$ sudo update-rc.d ddclient enable
$ sudo  systemctl start ddclient.service
```

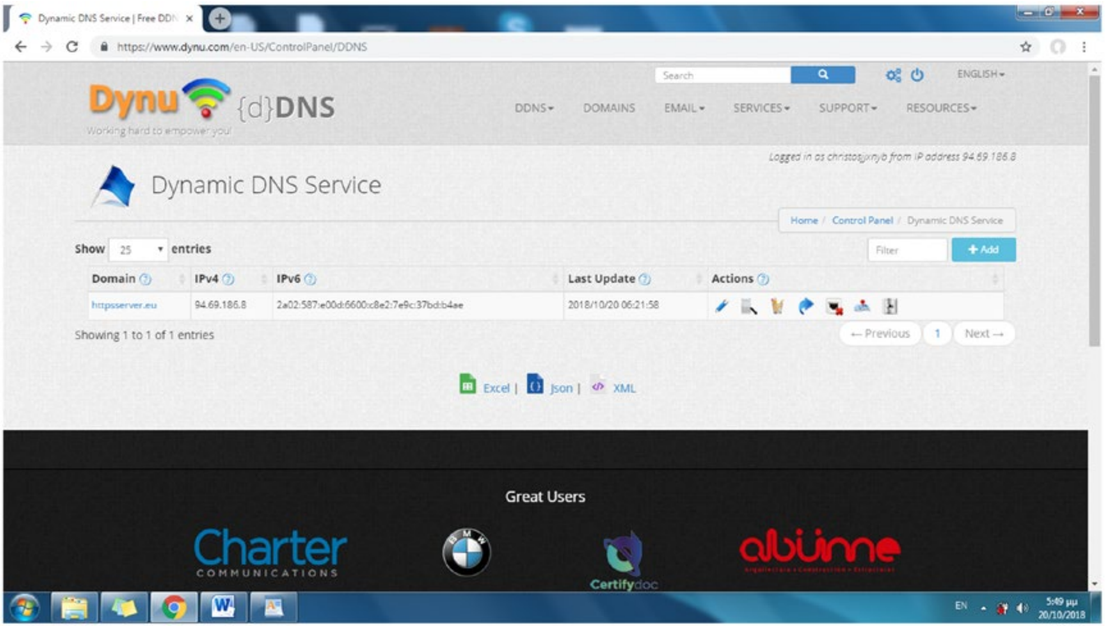
Test next the `ddclient` daemon. Switch off your router so that the public IP address of your router renews and then switch it back on. Run the following command that filters the lines with the word `SUCCESS` on it, created by `ddclient`:

```
$ sudo cat /var/log/syslog | grep SUCCESS
```

The output indicates the successful update of the IP address.

```
Oct 20 16:21:44 pc ddclient[4014]: SUCCESS:  updating httpsserver.eu: good:
IP address set to 94.69.186.8
```

View also the DNS configuration web page at your DNS provider, as displayed in Figure 10-5.


Dynamic DNS Service | Free DDN
https://www.dynu.com/en-US/ControlPanel/DDNS
Dynu {d}DNS
Working hard to empower you!
DDNS
DOMAINS
EMAIL
SERVICES
SUPPORT
RESOURCES
ENGLISH
Home / Control Panel / Dynamic DNS Service
Great Users

Logged in as christosjxnyb from IP address 94.69.186.8

Dynamic DNS Service

Show 25 entries

Domain	IPv4	IPv6	Last Update	Actions
httpsserver.eu	94.69.186.8	2a02:587:e00d:6600:c8e2:7e9c:37bd:b4ae	2018/10/20 06:21:58	

Showing 1 to 1 of 1 entries

← Previous 1 Next →

Excel | Json | XML

Figure 10-5. *Displaying the new public IP address of your router, corresponding to your domain name at the DDNS service provider's site*

As viewed in the web page, the IP address corresponding to the domain name `httpsserver.eu` is indeed successfully updated to 94.69.186.8.

With your domain name always corresponding to the public IP address of your router, even when the IP address changes, you can use this domain name for the sites that run the chapter's projects. Because the projects are based on TCP/IP sockets, the basic notions of the socket programming are discussed next.

Utilizing PHP Sockets

A *socket* as a networking term is a pair of an IP address and a port number that belongs to each one of the two ends of a network connection, e.g., a client and a server socket for a client-server connection. The socket in an application programming interface (API) provides the routines for interprocess communication between applications at the TCP/IP or at the UNIX local level.

The PHP language supports a full-fledged sockets library similar to the one introduced with Berkeley Sockets (POSIX Sockets). Berkeley Sockets were initially released in 1983 as a library of the C language. Since then, many other programming languages include the Sockets API. Sockets are usually implemented as system calls, routines that allow a programming language to interact with the operating system (OS), and request services, in the case of socket networking services. With PHP sockets, you may connect to a port number at a given IP address and connect therefore to any service bound on the specific port number on that system. Your browser uses sockets to connect to a given web server. With sockets you can implement a client or a server for any Internet service: email, DNS, a network online game, and so on.

The ability for the PHP code to connect to Internet services with sockets is very important to web development because the web server may interact with other services. You have already created a few sites where the web server exchanges information with the MySQL server. Consider also another example like the project of Chapter 8, where a user account is created by submitting personal details such as the first name, the last name, and the e-mail address. Most sites verify the e-mail address of a new member by submitting an e-mail to the client that includes a link, which activates the account. As with the MySQL interaction the PHP code of the web server to provide e-mail handling it must interact with the e-mail services. The final project included in the current site enables the web server PHP code to connect as a client with an Internet service using a more simplified protocol like the quote of the day (QOTD).

In the following section, you will create a PHP command-line program that implements a server listening to a specific port number, used as a first example for connections to non-HTTP services.

The Code for the Command-Line PHP Socket Server

You will create a server listening to a specific port number with a PHP terminal program. In the following example, the server listens to port 33000 and does not implement any well-known service but simply returns to the client the message previously sent in uppercase characters. At the Linux command line, enter the following:

```
$ gedit server.php
```

Enter the following PHP source code and save the file:

```
<?php

// Set the IP address and port number the server will listen on
$address = '192.168.1.100';
```

```
$port = 33000;

// Create the server socket, a TCP Stream socket
$server = socket_create(AF_INET, SOCK_STREAM, 0);

// Bind the socket to an IP address / port number pair
socket_bind($server, $address, $port) or die('Could not bind to address');

// Start listening for connections
socket_listen($server);

//loop for and listen for connections
while (true) {

// Accept incoming requests and handle them as child processes
    $client = socket_accept($server) or die("Could not accept incoming
    connection\n");

   if($client){
    // Read client input of 1024 bytes
    $input = socket_read($client, 1024) or die("Could not read input\n");

    // Strip all white spaces from input
    $output = strtoupper($input);

    // Send $output back to client
    socket_write($client, "you wrote " . $output . "\n") or die("Could not
    write output\n");

    // Close the client socket
   socket_close($client);
   }
}

?>
```

The PHP program creates a socket descriptor (a notion similar to a file descriptor for accessing a connection) `$server` with the function `socket_create()`. The first parameter of `socket_create()` is `AF_INET`, which indicates that the IPv4 protocol will be used. Other options are `AF_INET6` for IPv6 Internet-based protocols and `AF_UNIX` for process communication in the same computer. The second parameter is set to

`SOCK_STREAM`, used for TCP connections. Other options are the `SOCK_DGRAM` for UDP connections, `SOCK_SEQPACKET`, `SOCK_RAW`, and `SOCK_RDM`.

The socket is then bound, with `socket_bind()`, to the private IP address of the computer, 192.168.1.100 in this example, and to port number 33000, which is randomly selected out of the range of the system ports numbers (0–1023).

With the function `socket_listen()`, the server socket listens for connections and enters an infinite loop where if a client connects, the function `socket_accept()` returns `$client` as its socket descriptor.

Next, with the function `socket_read()`, the socket reads user data up to 1,024 bytes in this example, and with the PHP function `strtoupper()` converts the lowercase characters entered by the client to uppercase. The function `socket_write()` sends a message back to the client, which includes the client's text in uppercase characters. Finally, the function `socket_close()` closes the client socket descriptor.

Testing the PHP Command-Line Socket Server

To test the command-line PHP server, you can create a PHP command-line client. However, instead of this, you will simulate a client by using Telnet, the Swiss Army knife for networking. At the Linux terminal, enter the following command to start `server.php`:

```
$ php server.php
```

Next, switch to another terminal by using Ctrl+Alt+T and run Telnet as follows:

```
$ telnet 192.168.1.100 33000
```

Telnet responds with the following message, which indicates that a connection is issued to IP address 192.168.1.100, the host of the server program in this example, at the selected port number (33000):

```
Trying 192.168.1.100...
Connected to 192.168.1.100.
Escape character is '^]'.
```

Enter some text and press Enter.

```
hello world
```

The server responds with the following message:

```
you wrote HELLO WORLD
Connection closed by foreign host.
```

In the following section, you'll connect to the PHP server by implementing a PHP client.

Implementing a Command-Line PHP Client

Next, you'll create a command-line sockets client with PHP code. Similar source code will be used in the PHP source code of the web server to make a connection to the command-line PHP server.

To create a PHP client program, use the following command at the Linux terminal:

```
$ gedit client.php
```

Enter the following PHP source code and save the file:

```
<?php

$host = "192.168.1.100";
$port = 33000;

$server = socket_create(AF_INET, SOCK_STREAM, 0) or die("Could not create
socket\n");

$result = socket_connect($server, $host, $port) or die("Could not connect
to server\n");

$prompt = "Write your message here: ";

$message = readline($prompt);

socket_write($server, $message, strlen($message)) or die("Could not send
data to server\n");

$result = socket_read($server, 1024) or die("Could not read server response\n");

echo "Reply: " . $result;

socket_close($server);

?>
```

The `socket_create()` function returns `$server`, which is a socket descriptor and is used by the function `socket_connect()` to connect to IP address 192.168.1.100 on port 33000, where the PHP server listens. A message is then entered by the user with the PHP function `readline()`, and this message is sent to the server with the function `socket_write()`. Then `socket_read()` function returns the server's response, up to 1,024 bytes in this example, to the client. The reply is printed to the terminal with the `echo` command, and the `$server` socket closes with `socket_close()`.

Now test the command-line server with the command-line client. Start the PHP server using the following command at the Linux terminal:

```
$ php server.php
```

Then switch to a different terminal and start the PHP client using the following command:

```
$ php client.php
```

The client responds with the following message:

```
Write your message here:
```

Enter your message. For instance, enter `hello world` at the client's prompt and press Enter.

```
Write your message here: hello world
```

The response from the PHP command-line server client with PHP code. Similar source code will be used in the to the client terminal is as follows:

```
Reply: you wrote HELLO WORLD
```

Next, you will connect to the terminal PHP server from the PHP source code run by the PHP engine of the web server. You have to create a new site to allow the web interface into the terminal PHP server, but first you have to set up the web servers.

Configuring the Web Servers for the New Site

Now you'll create another site to use for the chapter's projects in which I'll show the directory index and document roots for the next three projects. The site will be served from both the Apache and Lighttpd servers. Create a subdirectory called `sockets` of the default document root used for those servers, /var/www/html/, and set this directory as the document root. At the Linux terminal, enter the following:

```
$ sudo mkdir /var/www/html/sockets
```

Edit the configuration files of the two web servers so that both are enabled to run the site, although only one of the two will be active. For Apache, edit default-ssl.conf, which is the configuration file for HTTPS, using the following:

```
$ sudo gedit /etc/apache2/sites-available/default-ssl.conf
```

Set the new document root with the DocumentRoot directive and save the file.

```
DocumentRoot /var/www/html/sockets
```

Reload the Apache server so that the new configuration is enabled.

```
$ sudo service apache2 force-reload
```

Edit next the Lighttpd configuration file. Use the following:

```
$ sudo gedit /etc/lighttpd/lighttpd.conf
```

Set the value of the server.document-root directive to the new document root and save the file.

```
server.document-root        = "/var/www/html/sockets"
```

Reload the Lighttpd server to enable the changes in the configuration file.

```
$ sudo service lighttpd force-reload
```

Create the Site That Interfaces with the Command-Line Server

One option for connecting a remote client to the PHP command-line server is to use a client program that connects to the public IP address of the router and uses port forwarding for port 33000 to access the computer that hosts server.php. The other option used in this section is to create a web-based interface that connects to the command-line server via port 33000 with no specialized client program required.

Create the web page message.php, which will include an HTML form with a textbox for the user to type a message. The message is then submitted to client.php, the action file of the form on the web server. This file uses PHP source code to interface as a client with the Linux terminal program `server.php`. The user's message from `client.php` is relayed to the terminal server, and the resulting uppercase message is returned to `client.php` and displayed on the evaluated HTML web page.

In the document root, create two PHP files. Use the following commands on the Linux terminal to create `message.php`:

```
$ cd /var/www/html/sockets
$ sudo gedit message.php
```

Enter the following source code and save the file:

```
<!DOCTYPE html>
<html>
<head>
<style>
body{
background-color:lightsteelblue;
}
p{
text-align:center;
font-size:32px;
}
</style>
</head>
<body>

<?php

  if(isset($_POST["t1"])) {
  $text = $_POST["t1"];
  }

  $host = "192.168.1.100";
  $port = 33000;

  $socket = socket_create(AF_INET , SOCK_STREAM , 0);
  $connection = socket_connect($socket , $host ,  $port);
```

```
    socket_write($socket, $text, strlen($text));
    $result = socket_read ($socket, 1024);
    socket_close($socket);

    echo "<p>" . $result . "</p>";

?>

</body>
</html>
```

Test the client-server system. First open `server.php` at the Linux terminal as follows:

```
$ php server.php
```

Switch next to the browser and enter the following URL:

```
https://httpsserver.eu/sockets/message.php
```

Figure 10-6 shows the web page `message.php`.

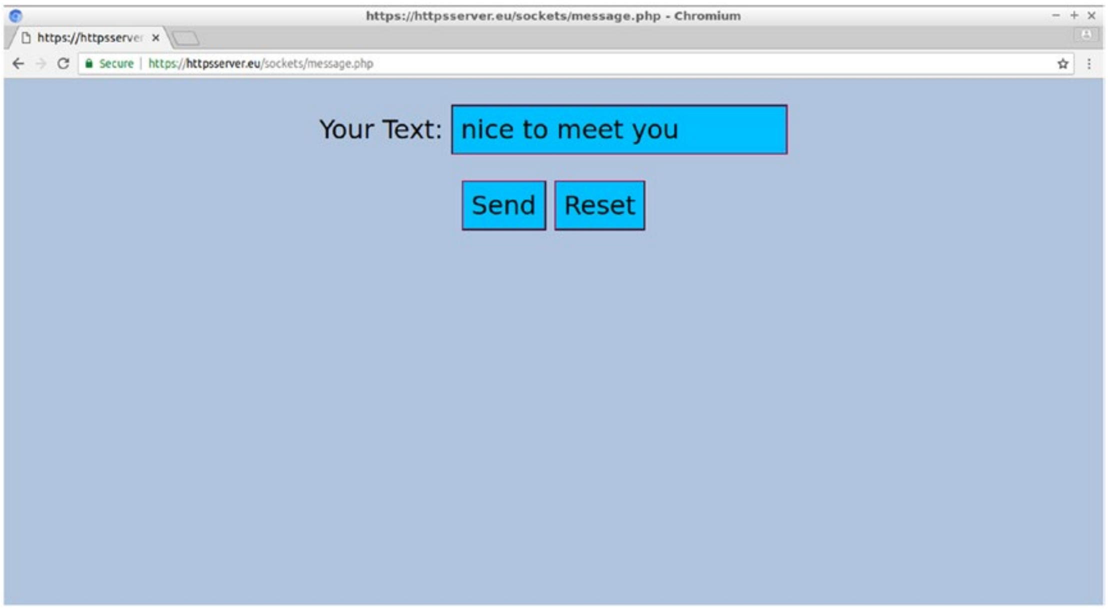
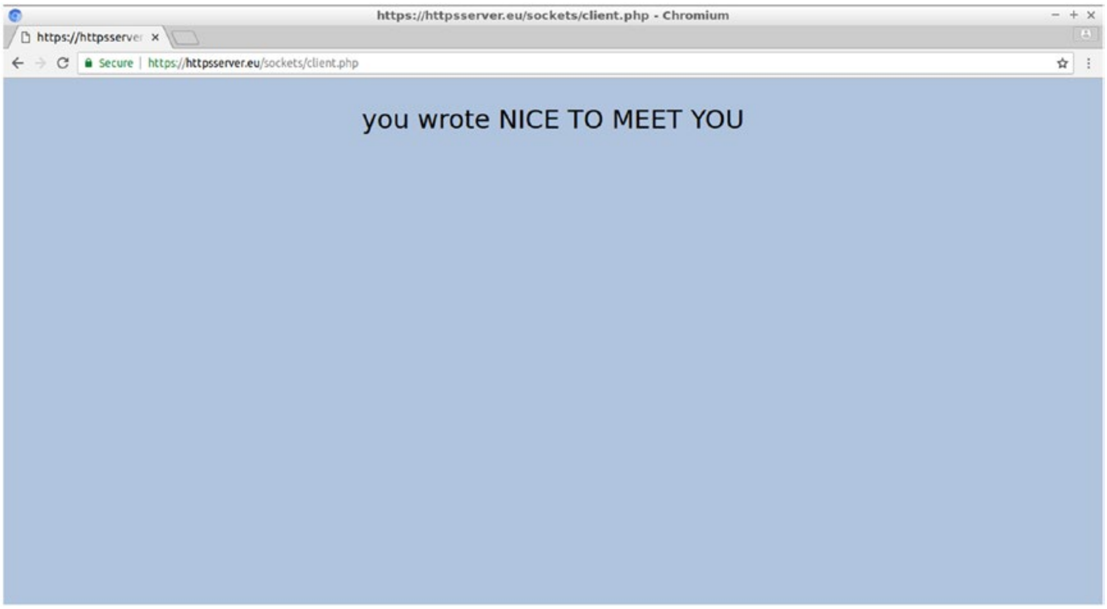

https://httpsserver.eu/sockets/message.php - Chromium
https://httpsserver ×
Secure | https://httpsserver.eu/sockets/message.php
Your Text:
nice to meet you
Send
Reset

Figure 10-6. *The HTML form that submits the user's text to client.php, which connects with sockets to the terminal server*

In the textbox, enter some text, such as **nice to meet you**. Click the Send button. The server's response, which is the message in capital letters, is shown in Figure 10-7.


https://httpsserver.eu/sockets/client.php - Chromium
https://httpsserve
Secure | https://httpsserver.eu/sockets/client.php

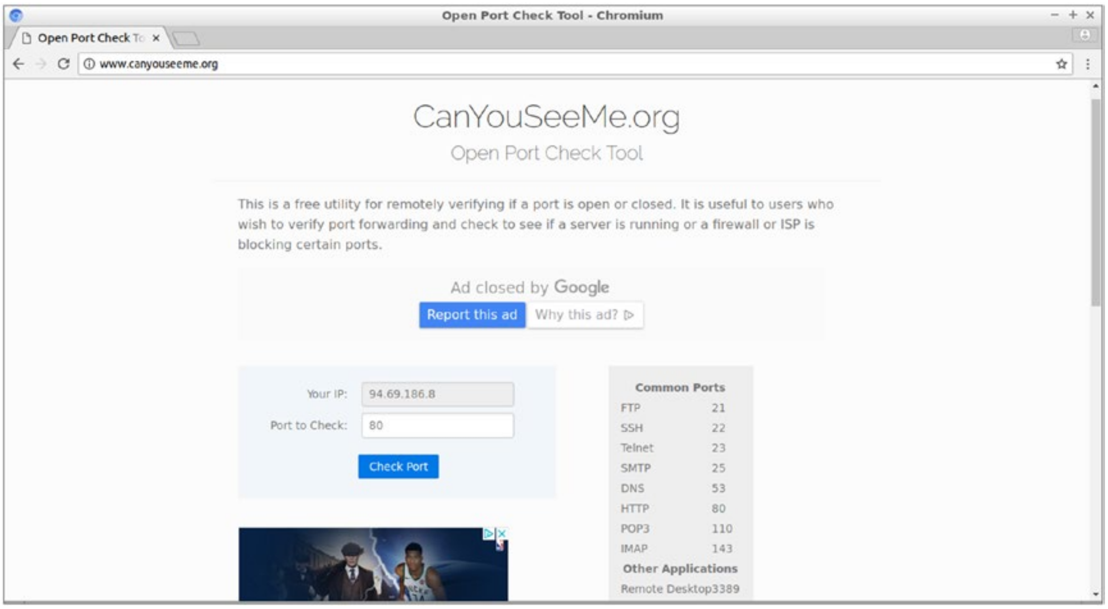
you wrote NICE TO MEET YOU

Figure 10-7. *The terminal server's output as it appears to the evaluated client.php*

In the following section, you'll create the first of the two main projects for this chapter, where the server-side programs use sockets to connect to remote computers.

A TCP Port Check Site

Create a project that uses TCP/IP sockets to simulate an online service and checks whether a port on the client system is open. This is similar to the service used in Chapter 8 (e.g., `www.yougetsignal.com` or `www.canyouseeme.org`), as displayed in Figure 10-8.



This is a free utility for remotely verifying if a port is open or closed. It is useful to users who wish to verify port forwarding and check to see if a server is running or a firewall or ISP is blocking certain ports.

Your IP: 94.69.186.8

Port to Check: 80

Common Ports	
FTP	21
SSH	22
Telnet	23
SMTP	25
DNS	53
HTTP	80
POP3	110
IMAP	143
Other Applications	
Remote Desktop	3389

Figure 10-8. *An online open port check tool*

Two PHP files are required for this file. The file `index.php`, displayed in Figure 10-9, is the directory index that the user views when it uses the domain name of the site as the URL, as shown here:

```
https://httpsserver.eu
```

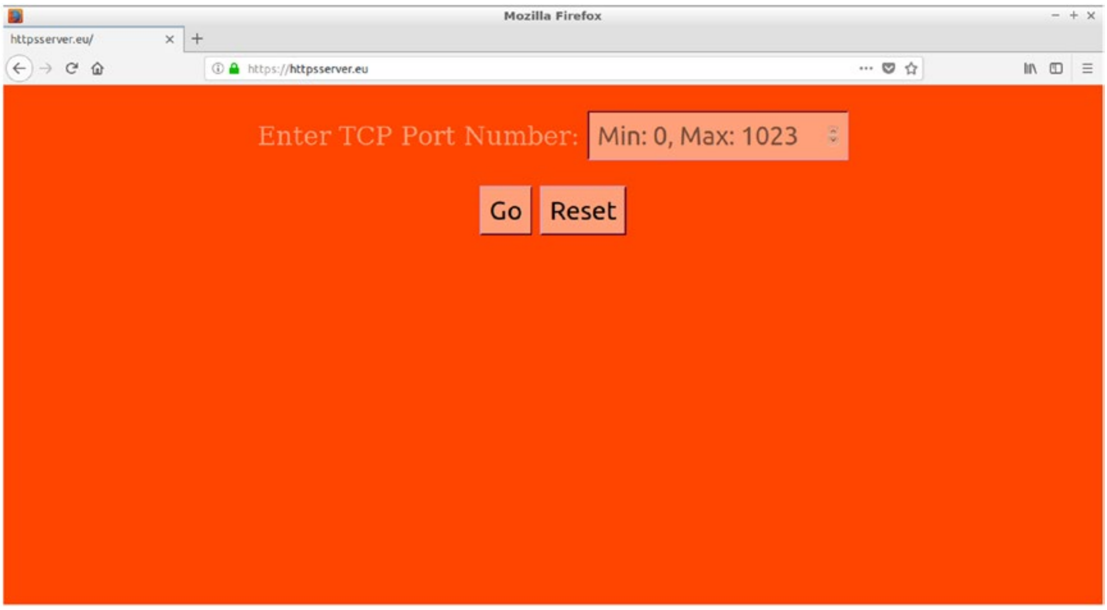


Figure 10-9. *The home page of the open port check tool site*

On `index.php`, the user enters the port number to be checked and clicks the Go button. The form data is submitted to `ports.php`, the second PHP file used in this project, and the PHP code connects to the client computer via the specific port number. According to the connection status, the port is considered open or closed. The server's response message is displayed in a dialog that is created by the JavaScript source code injected in PHP.

The Source Code for index.php and ports.php

Create the first PHP file using the following command in the Linux terminal:

```
$ sudo gedit /var/www/html/sockets/index.php
```

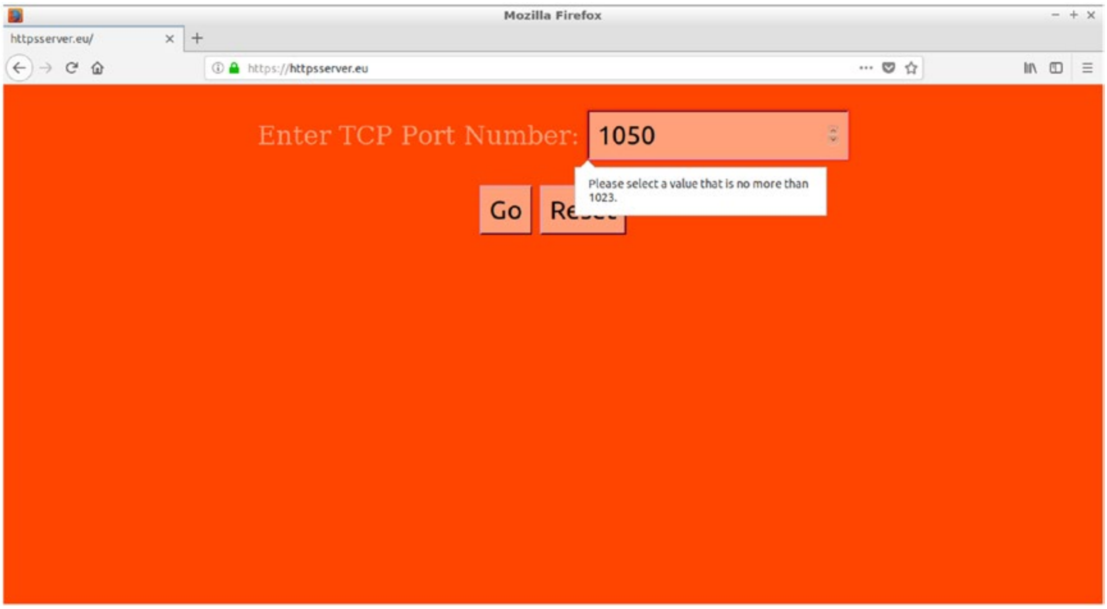
Enter the following source code and save the file:

```
<!DOCTYPE html>
<html>
<head>
<style>
```

```
body{
background-color:orangered;
}
input[type=number]{
    width: 300px;
}
p{
text-align:center;
font-size:32px;
color:lightsalmon;
}
input{
border-color:#9F0251;
font-size:32px;
color:black;
padding:10px;
background-color:lightsalmon;
}
</style>
</head>
<body>
<form method="post" action="ports.php">
<p>
<label for="port">Enter TCP Port Number:</label>
<input name="port" type="number" placeholder="Min: 0, Max: 1023" min="0"
max="1023" maxlength="25">
</p>
<p>
<input type="submit" name="s1" value="Go">
<input type="reset" value="Reset">
</p>
</form>
</div>

</body>
</html>
```

The web page created with the `index.php` source code consists of a form that includes three objects: one field of type `number`, and two buttons, one of `typesubmit` and one of type `reset`. By using the `input` element of type `number`, you apply the restriction that the value entered by the user should be an integer number. In addition, the `max` and `min` attributes of the element are set to the upper and lower limits of the number entered. The range is between TCP port numbers 0 and 1023, the *well-known ports*, also known as *system ports*. The well-known ports are assigned to commonly used types of Internet services. For instance, the web server utilized two system ports, ports 80 and 443, in the previous chapters.

When the number entered by the user in the number field exceeds the well-known port number range, a warning message is displayed, as viewed in Figure 10-10.



Please select a value that is no more than 1023.

Figure 10-10. *A warning message is displayed when the user exceeds the system port number limits*

A similar message appears when a non-numeric value is entered. Also, the arrows that appear in the Firefox browser on the right of the number field increase/decrease the number entered by one.

The `method` attribute of the form is set to `POST`, and the `action` attribute is set to `ports.php`. Create this file using the following:

```
$ sudo gedit /var/www/html/sockets/ports.php
```

Enter the following source code and save the file:

```
<!DOCTYPE HTML>
<html>
<head>
<title>Port Scanning</title>
</head>
<body>

<?php

$host = $_SERVER['REMOTE_ADDR'];

if (isset($_POST['s1'])){

  $port = intval($_POST["port"]);
  if (isset($port)) {

  $socket = socket_create(AF_INET , SOCK_STREAM , SOL_TCP);
  $connection = socket_connect($socket , $host ,  $port);

  echo '
  <script>
  alert("Port number ';
  echo $port;
  echo ' is';

  if (!$connection){
    echo ' not';
  }

  echo ' open.");
  window.location = "index.php";
  </script>';

  }
}

?>

</body>
</html>
```

The PHP source code of `ports.php` creates a TCP socket that binds to the IP address of the visitor's computer and also to the port number to be tested. The IP address is assigned to the PHP variable `$host` by the PHP global variable `$_SERVER['REMOTE_ADDR']`, and the TCP port number is assigned to the PHP variable `$port` from the data submitted by the HTML, `$_POST["port"]`. The value is typecast to an integer with the PHP function `intval()`. A socket connection is created as follows:

```
$connection = socket_connect($socket , $host ,  $port);
```

If the value returned to the `$connection` variable is `true`, a connection to the specified IP address on the tested port succeeds, and the port is considered open to the client computer. Otherwise, it is considered closed. The PHP code prints with the `echo` command some JavaScript source code that will be executed on the client side by the client's browser. The script creates a dialog that reports the state of the specific port. Also, the following JavaScript command redirects the web page to `index.php`, where another port can be tested:

```
window.location = "index.php";
```

Testing the Online Open Port Check Site Locally

Enter the URL of your site in the address bar of your browser.

```
https://httpsserver.eu
```

Test first a port number that is open. If your router, for instance, port forwards to ports 443 and 80, those are the open ports, with all the others closed. Enter, for instance, **443** in the form's number field, as displayed in Figure 10-11.

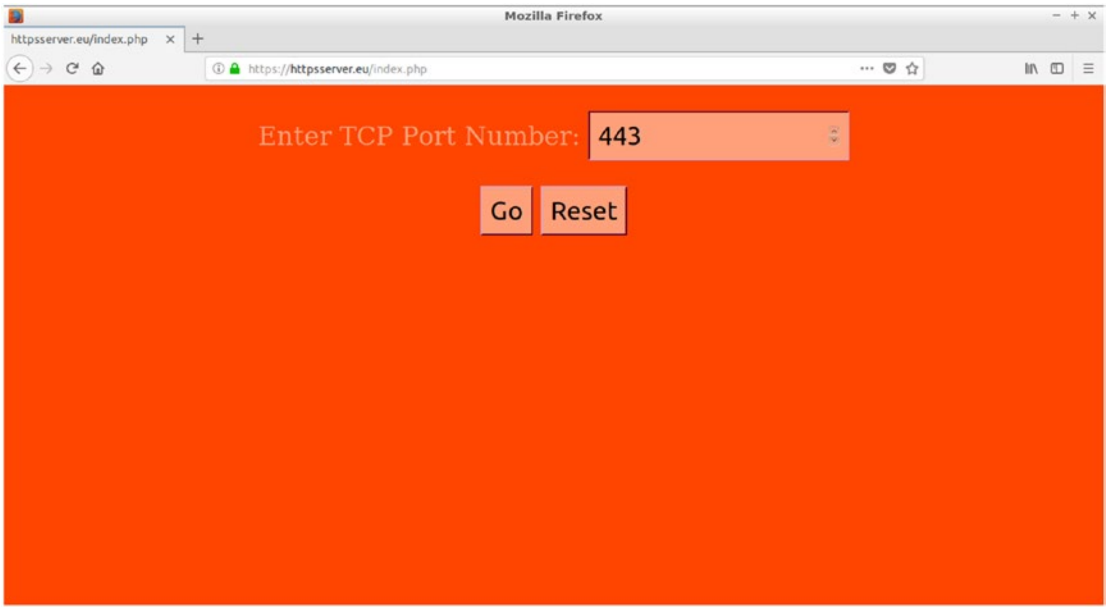
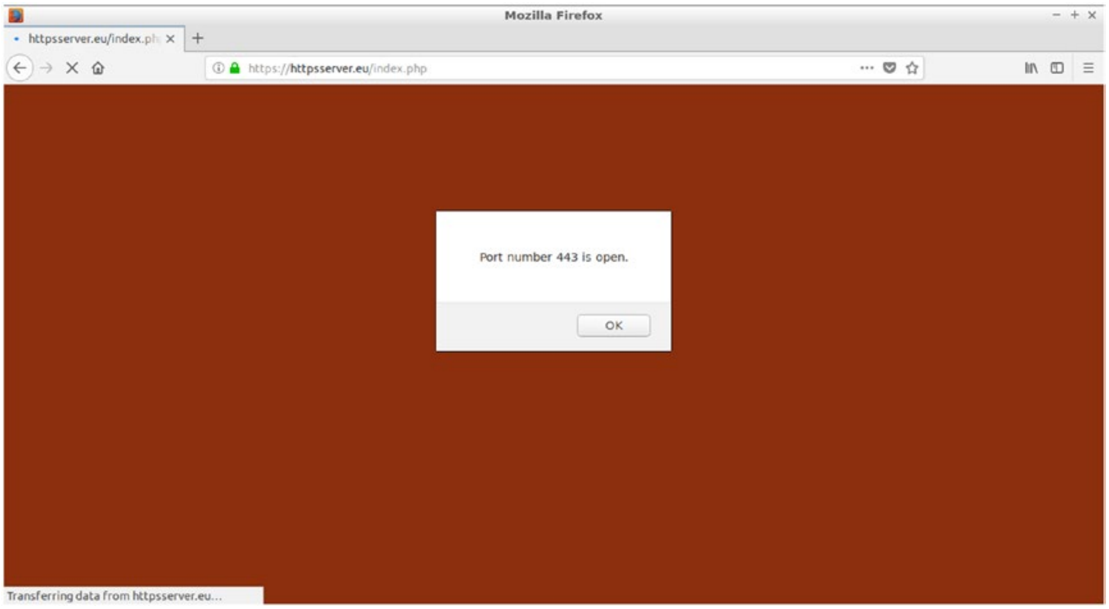


***Figure 10-11.** Testing the port number check tool for port 443*

Click the Go button. The web page shown in Figure 10-12 appears.


Mozilla Firefox
httpsserver.eu/index.ph
https://httpsserver.eu/index.php
OK
Transferring data from httpsserver.eu...

Port number 443 is open.

***Figure 10-12.** The port check output indicates an open port for port 443*

As indicated in the message, “Port number 443 is open.” Click the OK button to return to `index.php` and test another port. Enter **25** this time as the port number, as displayed in Figure 10-13.

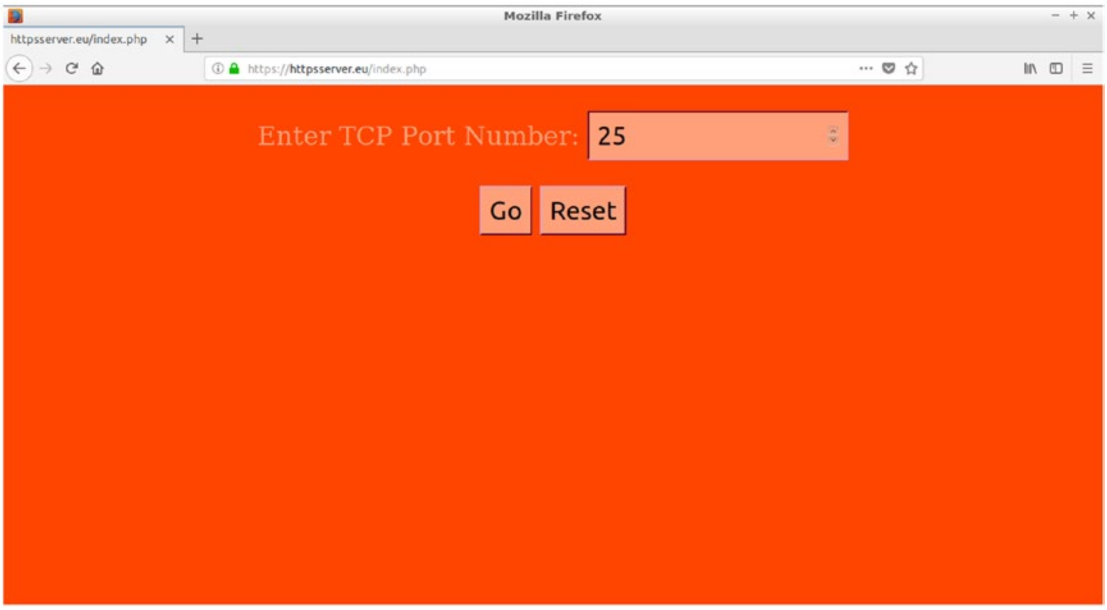
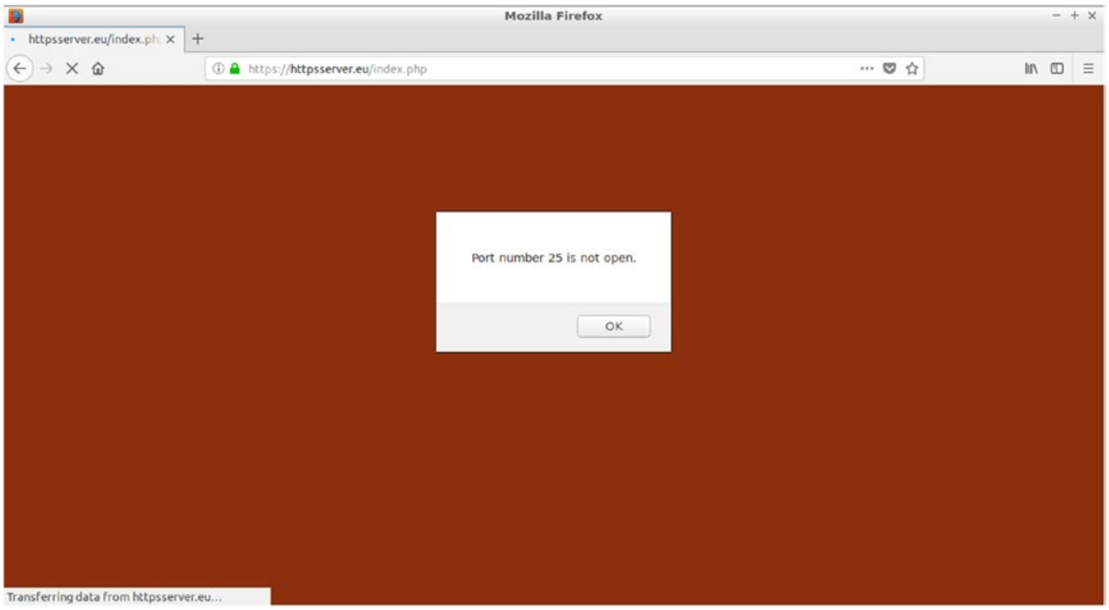


Figure 10-13. *Testing the port number check tool for port 25*

Click the Go button. The web page shown in Figure 10-14 appears.


Mozilla Firefox
httpsserver.eu/index.ph
https://httpsserver.eu/index.php
OK
Transferring data from httpsserver.eu...

Port number 25 is not open.

***Figure 10-14.** The port check output indicates a closed port for port 25*

As indicated in the message, “Port number 25 is not open.”

Next, you’ll test the online server from a computer external to your LAN to ensure it functions as expected.

Testing the Online Port Test Site Remotely

To test the port check tool remotely from a remote workstation, you cannot use online web page test services like `webpagetest.org` like in the previous chapters because this time the remote system needs to provide some form data. Instead, use an online service that allows you to interact with the remote browser such as `browserling.com`. In your browser, enter the following URL:

```
https://www.browserling.com
```

In the browser’s drop-down list, select one of your favorite browsers, for instance Chrome, as viewed in Figure 10-15.

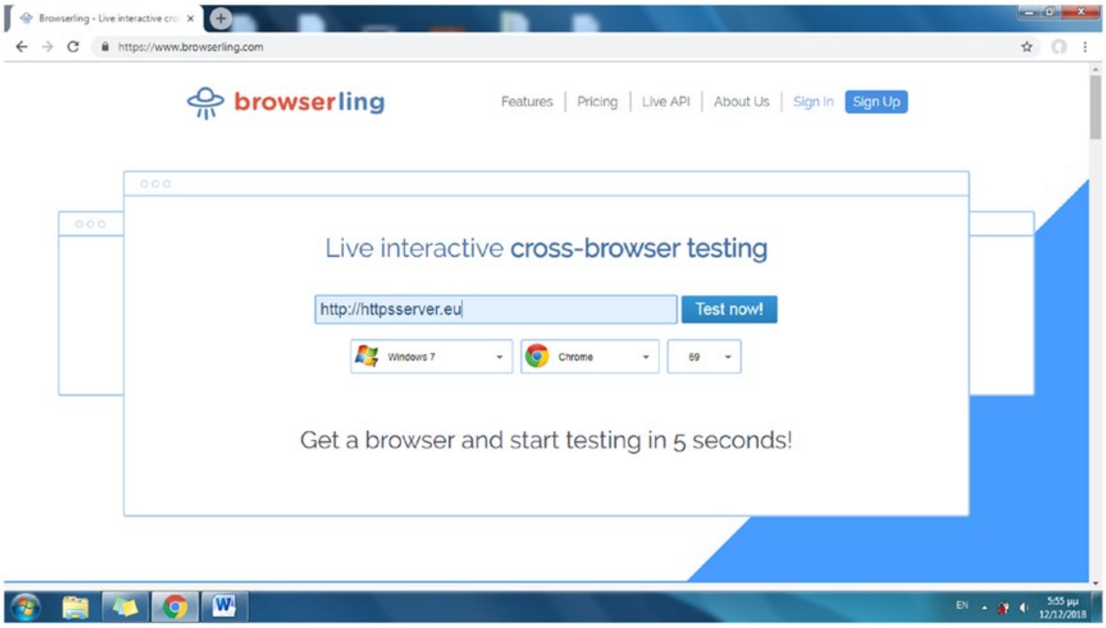

Browserling - Live interactive cro
https://www.browserling.com
browserling
Features | Pricing | Live API | About Us | Sign In
Sign Up
Live interactive cross-browser testing
http://httpsserver.eu
Test now!
Windows 7
Chrome
69
Get a browser and start testing in 5 seconds!

Figure 10-15. *The browserling.com online service home page*

In the textbox, enter the URL of your site, e.g., `httpsserver.eu`, and click the “Test now!” button. In a few seconds, the remote browser loads the web page of your site, as indicated in Figure 10-16.

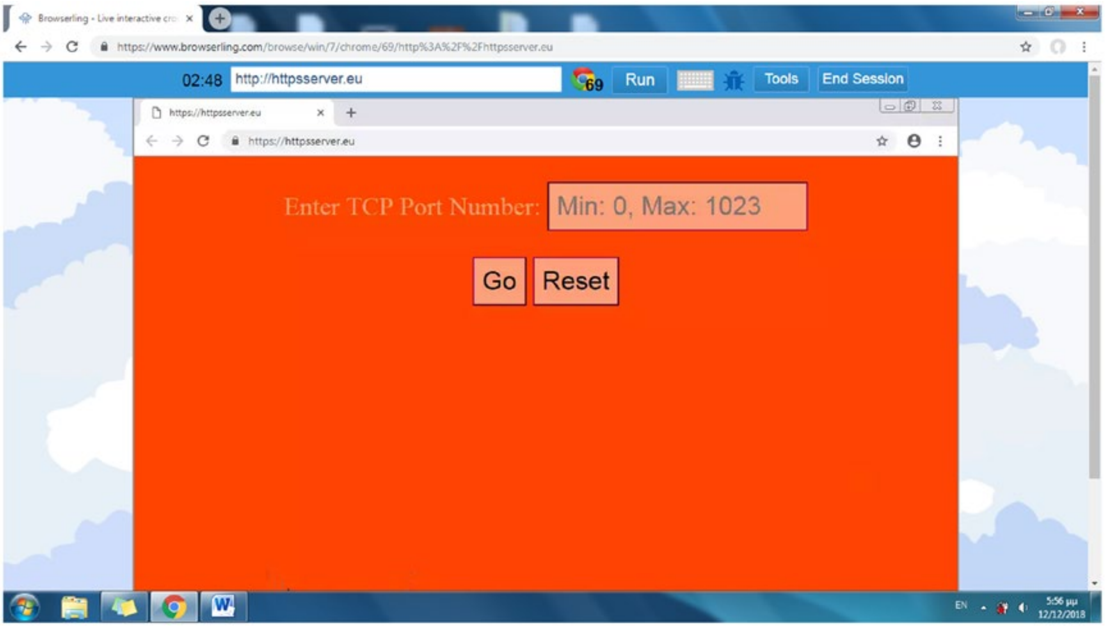
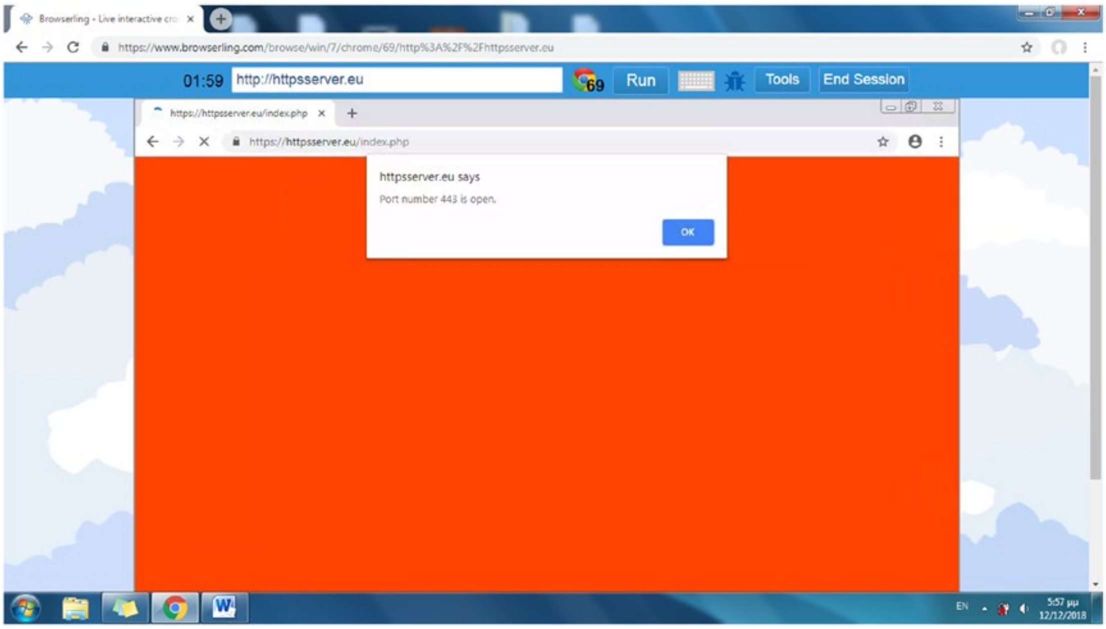


Figure 10-16. *The open port check tool site as viewed from the remote browser*

Test port 443 remotely first by using the online service's browser. Enter **443** in the number field of the form and click the Go button. Your web server will attempt to connect to the remote client on the specified port number, and accordingly a message will appear in the dialog of the evaluated PHP source code. As indicated in Figure 10-17, the connection succeeded, and a message appears to indicate that port 443 is open.



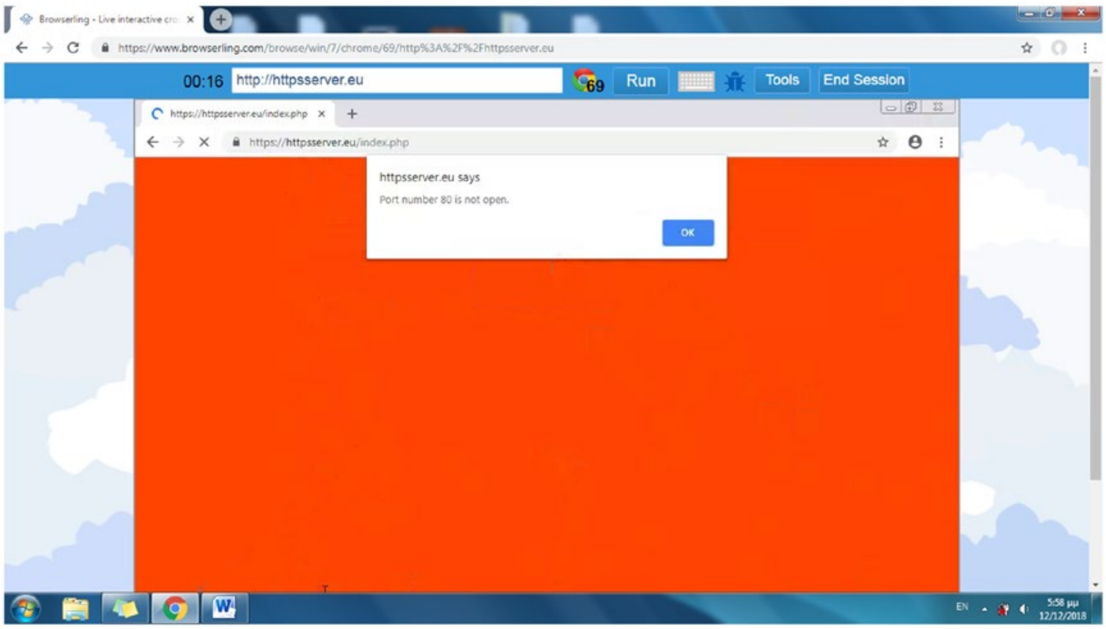
httpsserver.eu says

Port number 443 is open.

OK

Figure 10-17. *Verifying that port 443 is open on the remote system*

Test for another port, e.g., port 80. This time, as viewed in Figure 10-18, the port is closed.



httpsserver.eu says

Port number 80 is not open.

OK

Figure 10-18. *Verifying that port 80 is closed on the remote system*

A Second Version of the Open Port Check Tool Source Code

Now try the following version of `index.php`. Because it submits data to itself, it does not require a second PHP file (`ports.php`) for processing the data sent.

```
<!DOCTYPE html>
<html>
<head>
<style>
body{
background-color:orangered;
}
input[type=number]{
    width: 300px;
}
p{
text-align:center;
font-size:32px;
color:lightsalmon;
}
input{
border-color:#9F0251;
font-size:32px;
color:black;
padding:10px;
background-color:lightsalmon;
}
</style>
</head>
```

```
<body>

<?php
if (isset($_POST['s1'])) {
$host = $_SERVER['REMOTE_ADDR'];

if (isset($_POST['s1'])){

  $port = intval($_POST["port"]);
  if (isset($port)) {

  $socket = socket_create(AF_INET , SOCK_STREAM , SOL_TCP);
  $connection = socket_connect($socket , $host ,  $port);

  echo '
  <script>
  alert("Port number ';
  echo $port;
  echo ' is';

  if (!$connection){
    echo ' not';
  }

  echo ' open.");

  </script>';

  }
}
}
?>

<form method="post" action="<?php echo htmlspecialchars($_SERVER["PHP_
SELF"]); ?>">
<p>
<label for="port">Enter TCP Port Number:</label>
<input name="port" type="number" placeholder="Min: 0, Max: 1023" min="0"
max="1023" maxlength="25">
</p>
```

```
<p>
<input type="submit" name="s1" value="Go">
<input type="reset" value="Reset">
</p>
</form>
</div>

</body>
</html>
```

In this version, the form submits data to the current PHP file, indicated by the global PHP variable `$_SERVER["PHP_SELF"]`.

```
<form method="post" action="<?php echo htmlspecialchars($_SERVER["PHP_
SELF"]); ?>">
```

The source code that accepts the form values is the first PHP block. A socket connection is then issued with the user's IP address on the port to be checked. Also, a JavaScript block is created by the PHP code and is executed by the user's browser, creating a windowed message with the `alert()` method about the state of the port on the user's computer.

In this project, the web server connected to a client system with sockets. In the project in the following section, the server will connect with sockets to a server system. This time it's a server that implements another Internet service, namely, a QOTD service.

Creating an Online Service Displaying QOTD Messages

With PHP socket programming, the web server can connect to any open port number on a given computer and therefore connect to other Internet services this time as a client. Earlier in the chapter, you learned how to connect the web server through PHP sockets to the local terminal PHP server. In this project, you will connect the web server to a remote Internet service. Other than the Web, there are a large number of Internet services such as e-mail, File Transfer Protocol (FTP), Telnet, and DNS that follow the client-server model of a server that accepts a connection on a specific port number using the message formats defined by the corresponding protocol. To interface with those services from the Web, you can't rely on a client-side language like JavaScript, because a nonsystem language cannot support sockets and make a direct connection to one of these services. This can be performed, however, by the web server using PHP on behalf of the web client.

The service the web server connects to in this project will be a quote of the day (QOTD) service. This service implements a simple protocol, defined in RFC 865, to deliver daily quotes. RFC 865 recommends that the quotes should be limited to the ASCII printable characters, spaces, and newlines; their length should be less than 512 characters; and the port used for both TCP and UDP should be port 17.

Hint! You can read RFC 865 at `https://tools.ietf.org/html/rfc865`.

The user can choose one of the two available QOTD servers to receive its quote of the day. This happens through an Ajax request, which sets the values of the PHP code on the server side.

- `cygnus-x.net`
- `djxmmx.net`

To test the QOTD servers before implementing the PHP server-side sockets program, use the following Telnet command at the Linux terminal:

```
$ telnet cygnus-x.net 17
```

Telnet connects to the `cygnus-x.net` QOTD server on port 17 and prints a quote of the day. The command's output is as follows:

```
Trying 66.229.218.72...
Connected to cygnus-x.net.
Escape character is '^]'.

"Our greatest weakness lies in giving up. The most certain way to succeed
is always to try just one more time."

- Thomas Alva Edison

Connection closed by foreign host.
```

Next, you will create the source code that utilizes the Ajax technique to request the QOTD message without reloading the initial web page with the form.

The Source Code for the QOTD Project

Create a file called `index2.php` in the document root with a text editor.

```
$ sudo gedit /var/www/html/sockets/index2.php
```

Enter the following source code and save the file:

```
<!DOCTYPE html>
<html>
<head>
<title>Quote of the Day</title>
<style>
body {
background-color:lime;
}
select{
padding:20px;
font-size:32px;
color:navy;
background-color:yellow;
}
#demo{
color:deepskyblue;
padding:20px;
font-size:24px;
}
p{
text-align:center;
}
</style>
</head>
```

```
<body>
<p>
<select name="sel1" id="sel1" onchange="sendRequest()">
    <option value="-1">Select a QOTD server</option>
    <option value="1">QOTD server 1</option>
    <option value="2">QOTD server 2</option>
</select>
</p>
<script>
function sendRequest() {
if ((document.getElementById("sel1").value == 1) || (document.
getElementById("sel1").value == 2)){
  var xhr = new XMLHttpRequest();
  xhr.onreadystatechange = function() {
    if (xhr.readyState == 4 && xhr.status == 200) {
      document.getElementById("demo").innerHTML = xhr.responseText;
    }
  };
  xhr.open("POST", "qotd.php", true);
  xhr.setRequestHeader("Content-type", "application/x-www-form-urlencoded");
  var data = document.getElementById("sel1").value;
  xhr.send(`var1=${data}`);
  document.getElementById("demo").style.backgroundColor = "yellow";
} else{
  document.getElementById("demo").style.backgroundColor = "lime";
  document.getElementById("demo").innerHTML = "";
  }
}
</script>
<div>
<p id="demo"></p>
</div>
</body>
</html>
```

The source code creates the web page displayed in Figure 10-19.

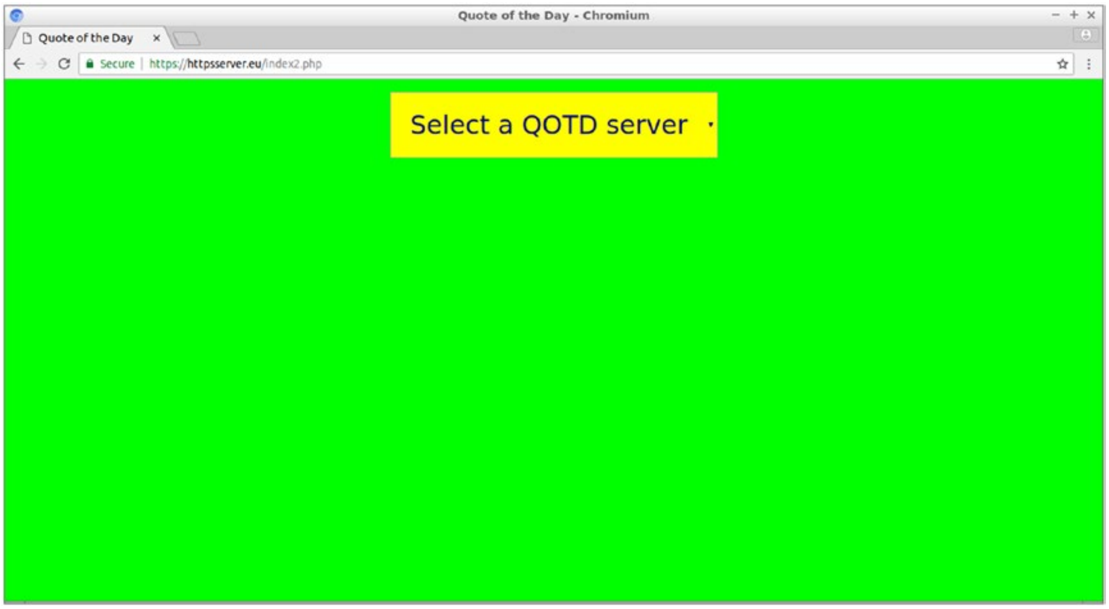

Quote of the Day - Chromium
Quote of the Day
Secure | https://httpsserver.eu/index2.php
Select a QOTD server

Figure 10-19. *The home page of the QOTD online service*

To view the page, use the following URL:

```
https://httpsserver.eu/index2.php
```

The source code creates a drop-down list with two active elements: one submitting the value 1, which for the PHP code on the web server corresponds to the domain name of the first QOTD server, `cygnus-x.net`, and the other submitting the value 2, which corresponds to the domain name of the second QOTD server, `djxmmx.net`. The list responds to the `onchange` JavaScript event, which is activated each time a new selection is made, handled by the function `sendRequest()`.

```
<select name="sel1" id="sel1" onchange="sendRequest()">
```

The function `sendRequest()` creates `xhr`, an `XMLHttpRequest` instance, that submits a `POST` request to the web server by implementing the Ajax mechanism. The data is sent behind the scenes without reloading the web page, and only the specified HTML element is updated, which for this example is a paragraph with an `id` value of `demo`.

```
    if (xhr.readyState == 4 && xhr.status == 200) {
      document.getElementById("demo").innerHTML = xhr.responseText;
```

In the second parameter of the `open()` method, belonging to the `XMLHttpRequest` instance, the `qotd.php` page was set as the destination program to receive the submitted data.

```
xhr.open("POST", "qotd.php", true);
```

The drop-down list selection is then sent as the value of variable `var1`.

```
  var data = document.getElementById("sel1").value;
  xhr.send(`var1=${data}`);
```

Notice that the function `sendRequest()` submits the data only if it is the currently selected element with value 1 or the element with value 2. There is also a third, dummy element to indicate the list functionality. It prints "Select a QOTD server" and corresponds to value -1. If this element is selected after a valid selection that prints a quote, `sendRequest()` is also called, and the `else` statement executes to clear the quote and reset its background color from yellow to lime.

Create a file called `qotd.php` using the following command at the Linux terminal:

```
$ sudo gedit /var/www/html/sockets/qotd.php
```

Enter the following source code and save the file:

```
<!DOCTYPE html>
<html>
<head>
</head>
<body>
<?php
if($_POST['var1'] == "1") {
  $host = gethostbyname("cygnus-x.net");
} elseif($_POST['var1'] == "2") {
  $host = gethostbyname("djxmmx.net");
}
  $port = 17;
  $socket = socket_create(AF_INET , SOCK_STREAM , SOL_TCP);
  $connection = socket_connect($socket , $host ,  $port);
  $result = socket_read ($socket, 512);
  socket_close($socket);
  echo $result;
?>
</body>
</html>
```

The file qotd.php is the one assigned in the index2.php source code as the server-side program to receive the data sent with the Ajax mechanism. The PHP source code block checks the value submitted with Ajax. If the value sent is 1, a connection with the QOTD server with the domain name cygnus-x.net will be created. Also, for a value of 2, a connection to the QOTD server djxmmx.net is issued. The function gethostbyname() returns the IP address corresponding to the given QOTD server FQDN, passed as the function's argument. With this IP address and port 17, the port used for the QOTD service, a TCP socket is created.

```
  $socket = socket_create(AF_INET , SOCK_STREAM , SOL_TCP);
  $connection = socket_connect($socket , $host ,  $port);
```

For the QOTD service, the client just reads the data (the quote) sent by the QOTD server, which according to RFC 865 has a maximum length of 512 bytes.

```
   $result = socket_read ($socket, 512);
```

The text read is assigned to the $result variable, whose value qotd.php is sent to index2.php with the echo command.

```
  echo $result;
```

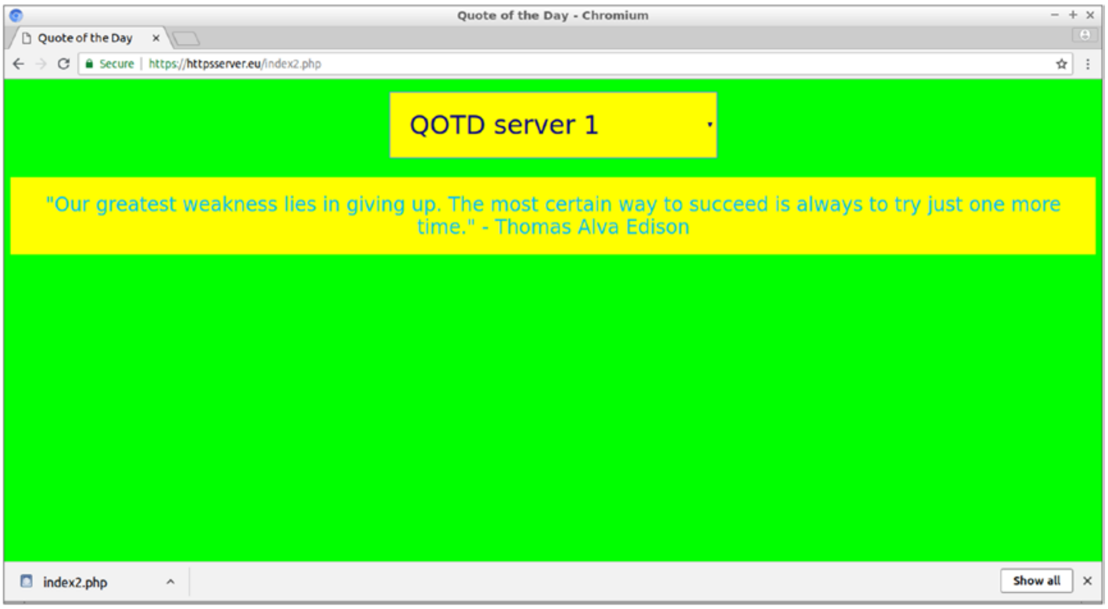
In the index2.php source code, the $result value (the quote) is received by the xhr.responseText attribute via the Ajax mechanism and is printed as the content of the paragraph demo, thus updating only a small portion of the web page.

Testing the QOTD Site

Next, you'll test the QOTD site by using the URL of the site. For example, use the following in the address bar of your browser:

```
https://httpsserver.eu/index2.php
```

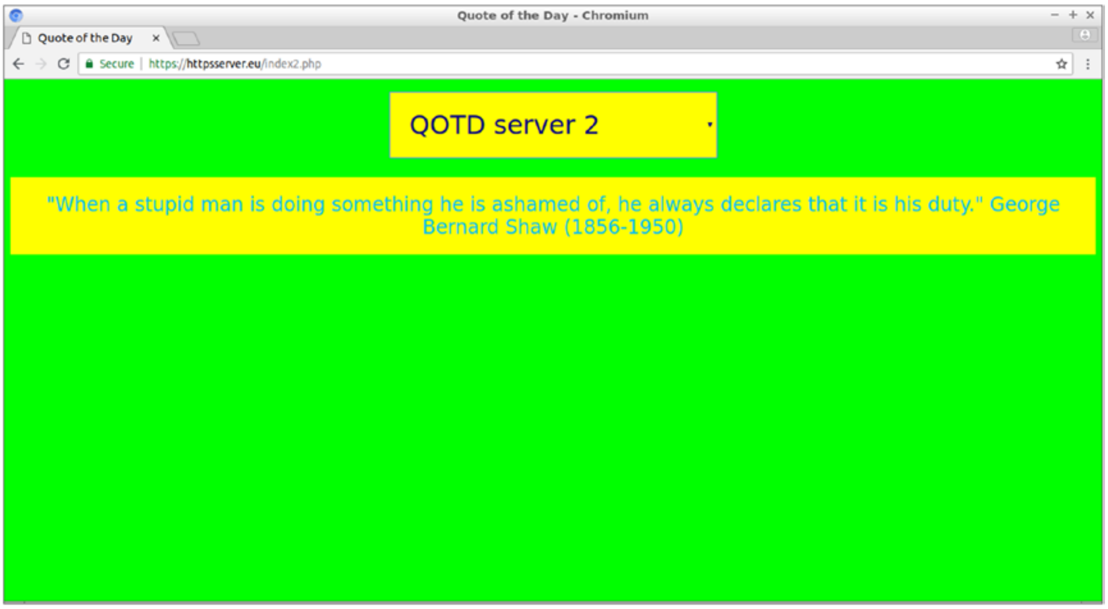
In Figure 10-20, the user has selected QOTD server 1, and the quote of the `cygnus-x.net` QOTD server is displayed in the web page.


Quote of the Day - Chromium
Quote of the Day
Secure | https://httpsserver.eu/index2.php
QOTD server 1
index2.php
Show all

"Our greatest weakness lies in giving up. The most certain way to succeed is always to try just one more time." - Thomas Alva Edison

Figure 10-20. *Displaying the quote of the first QOTD server*

In Figure 10-21, the user has selected QOTD server 2, and the quote of the `djxmmx.net` QOTD server is displayed on the web page.


Quote of the Day - Chromium
Quote of the Day
Secure | https://httpsserver.eu/index2.php
QOTD server 2

"When a stupid man is doing something he is ashamed of, he always declares that it is his duty." George Bernard Shaw (1856-1950)

Figure 10-21. *Displaying the quote of the second QOTD server*

Select next the dummy option “Select a QOTD server.” As displayed in Figure 10-22, the quote is deleted, and its background color is reset from yellow to lime.

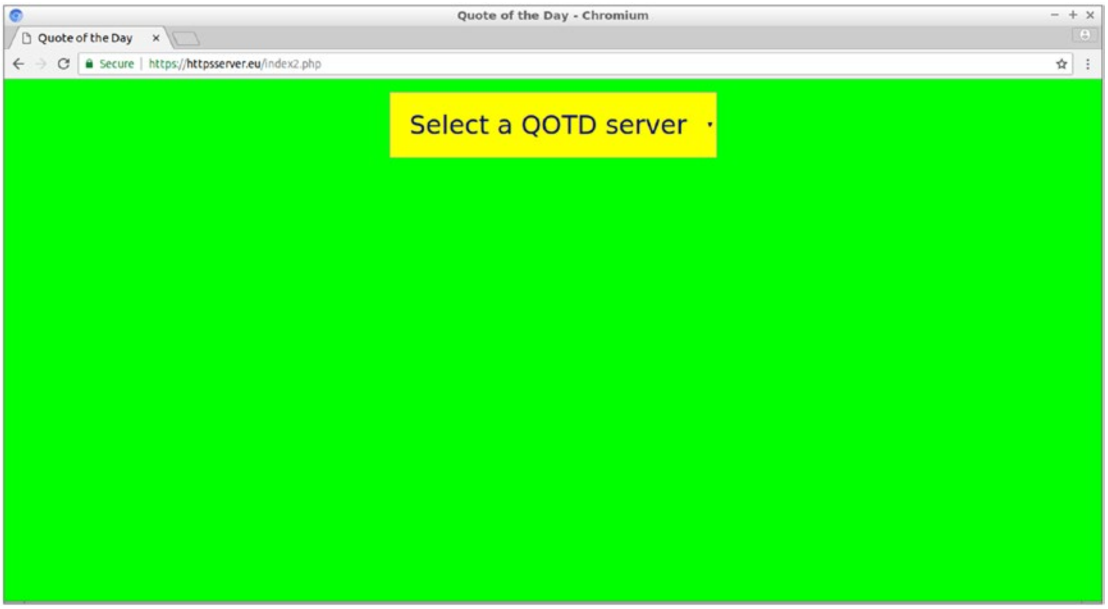

Quote of the Day - Chromium
Quote of the Day
Secure | https://httpsserver.eu/index2.php
Select a QOTD server

Figure 10-22. *By selecting the dummy option, the web page is reset to its initial state*

In the final section, you'll separate the last two sites you created by using a different fully qualified domain name for each one.

Using Different FQDNs for Your Sites

In this section, you'll implement two different fully qualified domain names for your domain, e.g., `httpsserver.eu`, with each one serving a different site. For instance, you can use `sockets.httpsserver.eu` for the site that runs the open port check tool and `qotd.httpsserver.eu` for the site that interfaces with a QOTD server.

You may at this point want to separate the files of the two sites. Use the following:

```
$ cd /var/www/html/sockets
$ sudo mkdir ports qotd
$ sudo cp index.php ports
$ sudo cp index2.php qotd.php qotd
```

In the `default-ssl.conf` Apache configuration file, add two new name-based virtual hosts, with each one serving a FQDN.

```
$ sudo gedit /etc/apache2/sites-available/default-ssl.conf
```

Add the following lines at the end of the configuration file to create the two vhosts and save the file:

```
<VirtualHost *:443>
    ServerName ports.httpsserver.eu
    DocumentRoot "/var/www/html/sockets/ports"
</VirtualHost>

<VirtualHost *:443>
    ServerName qotd.httpsserver.eu
    DocumentRoot "/var/www/html/sockets/qotd"
    DirectoryIndex index2.php
</VirtualHost>
```

Reload the configuration file to enable the new settings.

```
$ sudo service apache2 force-reload
```

Test the first vhost using the following in the address bar of your browser:

```
https://ports.httpsserver.eu
```

The web page loading is displayed, as shown in Figure 10-23.

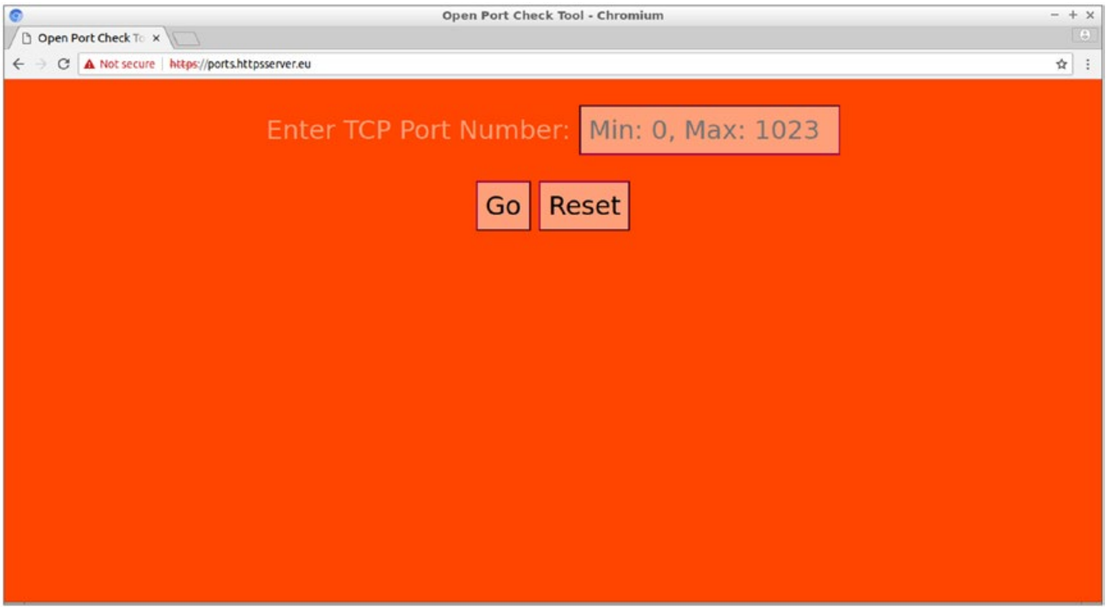


Figure 10-23. *The FQDN ports.httpsserver.eu is used for the open port check site*

Test the second vhost using the following in the address bar of your browser:

```
https://qotd.httpsserver.eu
```

The web page loads, as shown in Figure 10-24.

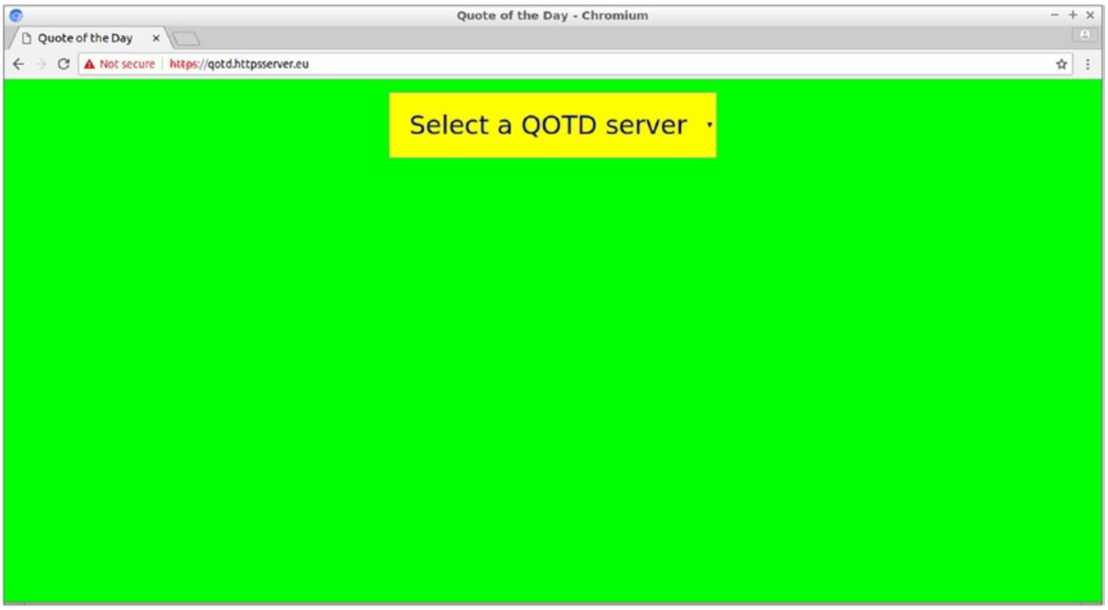


Figure 10-24. *The FQDN qotd.httpsserver.eu is used for the QOTD site*

For both sites, the browsers display the insecure site warning, while the SSL certificate verifies the domain names.

```
https://httpsserver.eu
and also the same for the hostname www:
https://www.httpsserver.eu
```

The other two hostnames for the httpsserver domain, `ports` and `qotd`, are not supported with the SSL certificate. To use one SSL certificate for any FQDN for your domain name, you have to purchase a wildcard SSL certificate, which usually costs more than a simple certificate.

Summary

In this chapter, you installed `ddclient` to update your router's public IP address to the DDNS service provider. You then used sockets programming to allow the web server to connect to a server listening to a non-HTTP port and interface with other services. Finally, you created an online open port check tool and a site that interfaces with a QOTD site.

APPENDIX

Exchanging Variables Between JavaScript and PHP

In this book, the JavaScript language is used for the client side of the HTTP client-server model, and PHP is used for the server side. In some cases, the two languages need to exchange variables, and there are a number of ways to do that. The examples in this appendix display the main ways to exchange variable values between JavaScript and PHP.

Example 1: Passing Variables from PHP to JavaScript Using the echo Command

To allow PHP to set JavaScript variables, you can simply inject PHP `echo` commands into the script in the PHP file. These commands are then evaluated on the server side and create the JavaScript code that is executed locally at the browser. The JavaScript code that appears within the PHP code has to be included in an `echo` message; otherwise, it is omitted when the PHP code is evaluated. In the following code, which shows the `test1.php` PHP file, the PHP variable `$p` holds the current IP address of the client, and it is assigned to the JavaScript variable `j`. The value of variable `j` is then printed on the web page.

```
<?php
  $p = $_SERVER['REMOTE_ADDR'];
  echo '
  <script>
```

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C. Karayiannis, *Web-Based Projects that Rock the Class*, https://doi.org/10.1007/978-1-4842-4463-0

```
  var j = "';
  echo $p;
  echo '";
  document.write(j);
  </script>';
?>
```

The previous PHP code evaluates, for the IP address 94.69.186.8, to the following code:

```
<script>

var j = "94.69.186.8";
document.write(j);
</script>
```

Example 2: Passing Variables from JavaScript to PHP Using the location Object

PHP works on the server side, in other words, at the web server. Therefore, for JavaScript to assign values to PHP variables, the values must be submitted to the web server. The following HTML file, called `index.html`, includes the JavaScript source code. The `window.location` object (or simply `location`) is used to get information about the URL of the current web page (document); it also redirects the browser to another web page. In this example, the `location.href` property sets the URL that the current page redirects to. The new page is `test2.php`, and the `p1` and `p2` values are included in the query string.

```
<!DOCTYPE html>
<html>
<head></head>
<body>
<script>
var j1 = "hello";
var j2 = "world";
location.href = "test2.php?p1=" + j1 + "&p2=" + j2;
</script>
```

```
</body>
</html>
```

The source code of `test2.php` is as follows:

```
<?php
if (isset($_GET["p1"]) && isset($_GET["p2"])) {
      $p3 = $_GET["p1"] . " " . $_GET["p2"];
      echo $p3;
}
?>
```

The request issued by JavaScript passes the values of `p1` and `p2`, which can be retrieved by PHP as `$_GET["p1"]` and `$_GET["p2"]`, respectively. The echo message printed to the web page when PHP resolves is `hello world`.

Example 3: Passing Variables from JavaScript to PHP with HTML Form Submission

In the previous example, the HTTP method `GET` is only for submitting JavaScript data to PHP. With HTML forms, you can utilize either `GET` or `POST`. Consider the following example of `index.php`, where JavaScript fills the value of a hidden element and submits it with the form.

```
<!DOCTYPE html>
<html>
<head></head>
<body>
<form id="f1" method="POST" action="test3.php">
<input type="hidden" id="p1" name="p1" value="">
</form>
<script>
var j1= "hello world";
document.getElementById('p1').value = j1;
document.getElementById("f1").submit();
</script>
</body>
</html>
```

The form is submitted from the JavaScript source code with the `submit()` method of the form object.

```
document.getElementById("f1").submit();
```

The source code of `test3.php`, the program that receives the form data, is as follows:

```
<?php
if (isset($_POST["p1"])) {
      $p2 = $_POST["p1"];
      echo $p2;
}
?>
```

The value of the JavaScript variable `j1` is submitted using the form and is assigned then from the PHP source code to the PHP variable `$p2`. The value of `$p2` is printed to the user's web page with the `echo` command.

Example 4: Passing Variables from JavaScript to PHP and Back with Ajax

Another way to pass variables from JavaScript to PHP is to use the Ajax mechanism. Ajax is not a programming language; rather, it is a technique that involves the JavaScript `XMLHttpRequest` object, which creates an asynchronous connection to the web server in the background. *Asynchronous* means that the script sends a request to the web server and continues its execution without waiting for a reply. For the asynchronous request, a callback function is set that handles the returned data from the server when it arrives. Initially Ajax was implemented with the XML language, which handled all the requests to the server.

Another way to use the Ajax method is with the DOM model. JavaScript uses the DOM to provide positions to the web page for where to place the server's reply, such as at a paragraph with a specific ID. These positions are the only parts of the web page that are updated, instead of reloading the whole page. DOM objects provide the positions of the data that will be submitted to the web server.

CSS also plays an important part in the Ajax method because the returned data can be formatted with CSS to retain the styling of the web page that submits the Ajax request.

`XMLHttpRequest()` is the constructor method that is used to create `XMLHttpRequest` instances (that is, objects) for the `XMLHttpRequest` class. The objects are used to connect to a web server, dispatching an HTTP request and receiving the reply. The `XMLHttpRequest` class defines methods (routines) and properties (variables) for the request handling. The following are the `XMLHttpRequest` class methods:

- `XMLHttpRequest()` is the constructor of the `XMLHttpRequest` object.
- `abort()` cancels the current request.
- `getAllResponseHeaders()` returns the headers of the response message.
- `getResponseHeader()` returns a specific response header.
- `open()` initializes the request by setting its attributes.
- `send()` sends the request to the web server.
- `setRequestHeader()` sets the headers of the request.

The following are the `XMLHttpRequest` class properties:

- `onreadystatechange` defines the function that will be called when the `readyState` property changes.
- `readyState` takes an integer value that corresponds to the status of the `XMLHttpRequest`, specifically:

  0: Request not initialized
  1: Server connection established
  2: Request received
  3: Processing request
  4: Request finished and response ready

- `responseText` holds the response data as a string.
- `responseXML` holds the response data as XML data.
- `status` holds the status of the request reply as an HTTP status code. Examples of HTTP status codes are the following:

  ```
  200, 301, 400, 403, 404, and 501
  ```

- `statusText` holds the corresponding text of the HTTP status code. Here are some examples:

```
OK for status code 200
Moved Permanently for status code 301
Bad Request for status code 400
Forbidden 403
Not Found for status code 404
Not Implemented for status code 501
```

The following file, `test4.html`, uses the `POST` method to submit data to the program `test4.php` with the Ajax mechanism. The JavaScript function `sendRequest()` runs when the web page is loaded.

```
window.onload = sendRequest;
```

In this example, the JavaScript variable `j1` is sent via Ajax as `value1` to the PHP source code and is received in the global variable `$_POST["value1"]`. This is echoed to the web page returned to the browser, and the message `hello world`, the initial value of `j1`, is printed to the predefined paragraph element, `p1`.

```
<!DOCTYPE html>
<html>
<head>
<script>
function sendRequest() {
  var xhr = new XMLHttpRequest();
  xhr.onreadystatechange = function() {
     if (xhr.readyState == 4 && xhr.status == 200) {
        document.getElementById("p1").innerHTML = xhr.responseText;
     }
  }
  xhr.open("POST", "test4.php", true);
  xhr.setRequestHeader("Content-type", "application/x-www-form-
  urlencoded");
  var j1 = "hello world";
  xhr.send(`value1=${j1}`);
}
window.onload = sendRequest;
</script>
</head>
```

```
<body>
<p id="p1"></p>
</body>
</html>
```

The source code for `test4.php` is as follows:

```
<?php
if (isset($_POST["value1"])) {
      $p2 = $_POST["value1"];
      echo $p2;
}
?>
```

The equivalent version for the HTTP method `GET` would be as follows:

```
<!DOCTYPE html>
<html>
<head>
<script>
function sendRequest() {
  var xhr = new XMLHttpRequest();
  xhr.onreadystatechange = function() {
     if (xhr.readyState == 4 && xhr.status == 200) {
        document.getElementById("p1").innerHTML = xhr.responseText;
     }
  }
  var j1 = "hello world";
  xhr.open("GET", `test4b.php?value1=${j1}`, true);
  xhr.send();
}
window.onload = sendRequest;
</script>
</head>
<body>
<p id="p1"></p>
</body>
</html>
```

The source code for the action file, `test4b.php`, is as follows:

```
<?php
if (isset($_GET["value1"])) {
      $p2 = $_GET["value1"];
      echo $p2;
}
?>
```

Example 5: Passing Variables from JavaScript to PHP with Cookies

Another option for exchanging variables between JavaScript and PHP is through cookies. Cookies can be set and retrieved from JavaScript and also from PHP. In addition, a cookie set with JavaScript can be retrieved by PHP and vice versa.

The following source code, used in a PHP file such as `test5.php`, uses JavaScript to set the value of the cookie `message` in the head section of the HTML source code. Then in the body section of the HTML source code, the PHP code retrieves the cookie's value and prints this message: `Cookie 'message' has value hello`.

```
<!DOCTYPE html>
<html>
<head>
<script>

function setCookie(name, value, expires, path, domain, secure){
      cookieString = name + "=" + encodeURIComponent(value) + "; ";
      if(expires){
            expires = setExpiration(expires);
            cookieString += "expires=" + expires + "; ";
      }
      if(path){
            cookieString += "path=" + path + "; ";
      }
      if(domain){
            cookieString += "domain=" + domain + "; ";
      }
      if(secure){
            cookieString += "secure; ";
      }
      document.cookie = cookieString;
}

function setExpiration(days){
    var today = new Date();
    var expires = new Date(today.getTime() + days * 24 * 60 * 60 * 1000);
    return  expires. toUTCString();
}

window.onload = setCookie("message", "hello", 1);
</script>
</head>

<body>
<?php
$c_name = "message";
if(!isset($_COOKIE[$c_name])) {
    echo "Cookie named '" . $c_name . "' is not set";
} else {
    echo "Cookie '" . $c_name . "' has value " . $_COOKIE[$c_name];
}
?>
</body>
</html>
```

In the JavaScript source code, the cookie string is formed with the required information from these properties: `name`, `value`, `expires`, `path`, `domain`, and `secure`. The function `encodeURIComponent()` is used to encode the following special characters with their UTF encoded versions:

```
, / ? : @ & = + $ #
```

For the expiration date, the current date is calculated in milliseconds via `today.getTime()`, and the days the cookie is valid, also in milliseconds, is calculated and added to the current date to form the Unix timestamp. The `toUTCString()` method converts this date to a string according to Coordinated Universal Time (UTC) standard. Here's an example:

```
Mon, 29 Oct 2018 06:35:38 GMT
```

The cookie is set when the web page is loaded with the following JavaScript command:

```
window.onload = setCookie("message", "hello", 1);
```

The PHP code retrieves the cookie in the global variable `$_COOKIE[$c_name]`, where `$c_name` is the message in the current example.

Example 6: Passing Variables from PHP to JavaScript with Cookies

The following PHP code creates a cookie named `message`, assigns the value `hello` to it, and specifies that the cookie expires in one hour (60 minutes * 60 seconds) from now. The function `time()` returns an integer containing the current time as a Unix timestamp.

```
<?php
$c_name = "message";
$c_value = "hello";
setcookie($c_name, $c_value, time()+3600);
?>
```

In the following example, which is included in a PHP file called `test6.php`, the PHP code sets the value of the cookie named `message` to `hello`, and then JavaScript retrieves this value and prints it on the web page:

```
<?php
$c_name = "message";
$c_value = "hello";
setcookie($c_name, $c_value, time()+3600);
?>
```

```
<!DOCTYPE html>
<html>
<head>
</head>
<body>
<script>
function retrieve_cookie(w){
      var c_value = "";
      var dUC = decodeURIComponent(document.cookie);
      cArray = new Array();
      cArray = dUC.split(';');
      for(i = 0; i < cArray.length; i++){
            cValues  = new Array();
            cValues  = cArray[i].split('=');
            if(cValues[0] == w){
                  c_value = decodeURIComponent(cValues[1]);
            }
      }
      return c_value;
}
var cookie_name = "message";
var val = retrieve_cookie(cookie_name);
if(val) {
  document.write('Cookie with name "' + cookie_name + '" has value ' + '"'
  + val + '"');
} else {
  document.write('Cookie with name "' + cookie_name + '" does not exist');
}
</script>
</body>
</html>
```

The function `retrieve_cookie()` returns the value for the cookie name passed as a parameter. This function splits `document.cookie`, a string containing a semicolon-separated list of all cookies of the site, and creates an array where each element includes information for a single site cookie. Consider, for instance, the case where two cookies were set with the following PHP code:

```
<?php
$c_name = "message";
$c_value = "hello";
setcookie($c_name, $c_value, time()+3600);
$c_name = "message2";
$c_value = "hello2";
setcookie($c_name, $c_value, time()+3600);
?>
```

```
The document.cookie string in this case would be as follows:
```

```
message=hello; message2=hello2
```

To print the value of `document.cookie`, use the following command in `retrieve_cookie()`:

```
document.write(document.cookie);
```

In a `for` loop in `retrieve_cookie()`, each name-value pair is split across an equal sign, and a new array is created with the first element as the name and the second element as the value. If the given name that was passed as a parameter to the function matches the first element, the second element (the value) is returned. Notice that `encodeURIComponent()` is used to ensure that `document.cookie` does not contain any commas, semicolons, or whitespace.

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