

Appendix D

Apache Web Server Hardening

Solutions in this chapter:

- Understanding Common Vulnerabilities With Apache Web Server
- Patching and Securing the OS
- Hardening the Apache Application
- Monitoring the Web Server for Secure Operation

Understanding Common Vulnerabilities Within Apache Web Server

As we discussed in the previous appendix, all software systems have four general types of vulnerability. Apache is no different and can be negatively affected by any one of the following problems:

- Poor application configuration
- Unsecured Web-based code
- Inherent Apache security flaws
- Foundational OS vulnerabilities

We'll investigate these four types in detail through the remaining sections of this appendix.

Poor Application Configuration

Like the Microsoft IIS Web server, Apache has many default settings that require modification for secure operation. Nearly all configuration information for Apache Web server exists within the `httpd.conf` file and associated Include files. Because many configuration options exist within these files, it can be easy to make configuration errors that expose the application to attack.

Unsecured Web-Based Code

The second manner in which vulnerabilities are exposed is via poorly implemented code on the Apache server. Often, Web developers are far more concerned with business functionality than the security of their code. For instance, poorly written dynamic Web pages can be easy DoS targets for attackers, should coded limitations be absent from backend database queries. Simply publishing confidential or potentially harmful information without authentication can provide enemies with ammunition for attack. For these reasons, you must review and understand not only the Apache application but the information and functionality being delivered via the system.

Inherent Apache Security Flaws

Like the IIS server, vulnerabilities can exist within the Apache application code itself. There are many means by which hackers can breach or disable an Apache system, such as:

- Denial of service
- Buffer overflow attacks
- Attacks on vulnerable scripts
- URL manipulation

Occasionally, Apache security flaws are discovered and announced by Apache or by various security groups. The Apache development team is typically quick to respond and distribute patches in response to such events. For this reason, it is critical that you remain vigilant in your attention to security newsgroups and to Apache's security advisory site at http://httpd.apache.org/security_report.html.

Foundational OS Vulnerabilities

Another source of vulnerability within an Apache Web server could occur as a result of foundational security flaws in the OS on which Apache is installed. Apache can be run on just about any OS. You should be very familiar with the specific security vulnerabilities for any OS on which you run Apache. This brings us to the next section, in which we discuss the merits of patching and securing the Microsoft OS.

Patching and Securing the OS

As we discussed in the previous sections and chapters of this book, code deficiencies can exist in OSs and lead to OS and application vulnerabilities. It is therefore imperative that you fully patch newly deployed systems and remain current with all released functional and security patches. At regular intervals, thoroughly review the published vulnerabilities at your OS manufacturer's Web site.

Some popular OSs and their respective security sites are listed in Table D.1.

Table D.1 Popular Operating Systems and Their Security Sites

Operating System	Vendor Security Information Site
Sun Solaris	http://sunsolve.sun.com/security
Microsoft	www.microsoft.com/technet/security/default.msp
Mac OS	www.apple.com/support/security/
Debian Linux	www.debian.org/security/
RedHat Linux	www.redhat.com/security/
SuSe Linux	www.novell.com/linux/security/securitysupport.html
FreeBSD	www.freebsd.org/security/
NetBSD	www.netbsd.org/Security/
OpenBSD	www.openbsd.org/security.html

It might be a good idea to subscribe to your OS vendor's security mailing list to receive security-related updates and to monitor security newsgroups for 0-day exploits.

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Patching Unix, Linux, and BSD Operating Systems

Because Apache is so often run on various Unix, Linux, and BSD distributions, we include patching steps so that you can confidently deploy your Apache Web server on a well-hardened foundational OS. The steps required to patch specific Unix, Linux, and BSD OS are included in “Implementation: The Quick and Dirty Details” of Chapter 3, “UNIX DMZ Design.” Refer to these sections for more detailed information.

In general, however, each vendor provides a full suite of tools and information designed to help you remain current of their released software updates. Become familiar with each of your vendor’s OS patching methodologies and software tools. As the security administrator, you should reserve predetermined time periods for maintenance windows during episodes of low customer activity. However, the discovery of serious OS vulnerabilities could necessitate emergency downtime while patches are applied.

Configuring a Secure Operating System

Like patching, all systems used to provide services such as HTTP and HTTPS to customers should be thoroughly hardened *before* they are placed in a production environment.

Hardening includes many steps such as the following:

- Setting file permissions
- Locking down accounts
- Establishing proper OS security policies
- Configuring host-based firewalls
- Disabling vulnerable services

These are just a few examples of the general tasks required to initially secure your OS. For the detailed steps required to secure specific Unix, Linux, and BSD OS, refer to “Implementation: The Quick and Dirty Details” of Chapter 3, “UNIX DMZ Design.” For specific information about hardening Microsoft Windows OS, refer to Appendix A, “IIS Web Server Hardening.”

Now that we have a solid, secure OS, let’s move on to discuss how to properly install and securely configure the Apache Web server.

Hardening the Apache Application

The Apache Web server is a powerful application through which you can deliver critical business functionality to customers. With this power comes the possibility of misuse and attack. To ensure that your Apache server is running securely, we have compiled a series of steps to harden the Apache application. You might also want to read additional information

or review other Apache security checklist documents before deploying your Apache server. Two excellent reference guides are the *CIS Apache Benchmark* document available at the Center for Internet Security (www.cisecurity.org) and the *NIST Apache Benchmark* document available at <http://csrc.nist.gov/checklists/repository/1043.html>.

You should follow three general steps when securing the Apache Web server as follows:

- Prepare the OS for Apache Web server
- Acquire, compile, and install the Apache Web server software
- Configure the `httpd.conf` file

Within these general tasks there are many steps, which we cover in the following sections.

Prepare the OS for Apache Web Server

After you'd patched and hardened your OS, you'll need to accomplish a couple quick tasks prior to obtaining, compiling, and installing the Apache software. A critical part of installing Apache is to provide a user account and group that will run the Web server. It is important that the user and group you select be unique and unprivileged to avoid reduce exposure to attack.

WARNING

Do not run your Apache Web server as the user Nobody. Although this is often a system administrator favorite and seemingly unprivileged account for running Apache and other services, the Nobody account has historically been used for root-like operations in some OSs and should be avoided.

Choose and configure a user and group account using the following Unix OS steps. In this example, we will use `wwwusr` and `wwwgrp` as the Apache username and group, respectively.

1. As root from the command line, type **groupadd wwwgrp** to add a group.
2. Type **useradd -d /usr/local/apache/htdocs -g wwwgrp -c "Apache Account" -m wwwusr** to add the user.

The second step creates the user account but also creates a home directory for the user in `/usr/local/apache/htdocs`.

After creating the user and group accounts, you'll need to lock down the `wwwusr` user account for use with Apache. By locking the account and providing an unusable shell, this action ensures that no one can actually log into the Web server using the Apache account:

1. As **root** from the command line, type **passwd -l wwwusr** to lock the Apache account.

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2. Type **usermod -s /bin/false wwwusr** to configure an unusable shell account for the Apache account.

Now you're ready to get the Apache software and begin installation.

Acquire, Compile, and Install Apache Web Server Software

Because Apache is open-source software, you can freely download the binaries or source code and get going with your installation. Although there are many locations from which you could download the software, it is always best to obtain the Apache software directly from an approved Apache Foundation mirror listed at <http://httpd.apache.org/download.cgi>.

You'll need to decide whether to install the server using precompiled binaries or to compile the source code yourself. From a security and functionality perspective, it is usually better to obtain the source code and compile the software, since doing so permits fine-tuning of security features and business functionality. In this section, we'll discuss compiling the Apache server from source code.

To download the source code, point your browser at the URL listed previously, select a mirror, and select the latest Apache source code distribution. While you're on the Apache mirror site, also download the MD5 checksum, which should be available in the same directory as the source code. The checksum file will look identical to the source code tarball but will have an .md5 file extension. We'll use this checksum to verify the integrity of our Apache source code.

Verify Source Code Integrity

To verify the checksum, you'll need additional software called *md5sum* that might be part of your OS distribution. If it's not, you can download the software as part of GNU Textutils available at www.gnu.org/software/textutils/textutils.html. To verify the Apache checksum, perform the following steps. In this example, we'll use Apache version 2.2.3:

1. As **root** from the command line, change directories to where you downloaded the Apache source code tarball and checksum file.
2. Type **cat httpd-2.2.3.tar.gz.md5** to see the exact md5 checksum string. You should see something like **f72ffb176e2dc7b322be16508c09f63c httpd-2.2.3.tar.gz**.
3. From the same directory, type **md5sum httpd-2.2.3.tar.gz.md5** to obtain the checksum from the tarball. You should see the identical string shown in Step 2. If you do, the software you downloaded is authentic.

Compile the Source Code

After downloading and verifying the Apache source code, you'll need to do some research to understand what options you want to compile into your Web server. There are many modules, such as `mod_access` and `mod_ssl`, that can be added into your server to provide additional functionality and security. A full list of Apache Foundation-provided modules can be found at <http://httpd.apache.org/docs/2.0/mod/>. When choosing modules, be sure you select only what you need. Compiling extra, unnecessary modules will only result in a less secure, slower Web server.

WARNING

Use caution in enabling and disabling services at compile time. Before you do so, determine the dependencies of your Web server code. For instance, do you need CGI functionality on your site? Failure to understand what services you require to operate could result in loss of critical functionality. It might be prudent to test your configuration in a lab environment before disabling services on a production server.

Once you've decided which modules and configurations to use, you should accomplish one final task before building your software: Obscure the Apache version information located in the `ap_release.h` file located in the `${ApacheSrcDir}/include` directory. To do so, vi the file and alter the following lines to change the Software Vendor (Apache Software Foundation) information:

```
#define AP_SERVER_BASEVENDOR "Apache Software Foundation"
#define AP_SERVER_BASEPRODUCT "Apache"
```

In general, you'll need to perform three steps to compile and install your Apache Web server, as follows:

1. From the `${ApacheSrcDir}` directory, run **`./configure`**.
2. After configuring source, run **`./make`** to compile the software.
3. After compiling the software, run **`./make install`** to install the Apache Web server.

During the first step, you'll decide what is added to the Apache server at compile time. Table D.2 includes a list of modules you may consider adding and removing from your configuration:

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Table D.2 Modules You Can Add or Remove

Add/Remove	Module Name	Purpose
Remove	Status	Provides potentially dangerous information via server statistics Web page
Remove	Info	Provides potentially dangerous configuration information
Remove	Autoindex	Creates directory listing when index files are absent from Web directories
Remove	Include	Provides server-side include (SSI) functionality
Remove	Imap	Creates server-side index file mapping
Remove	userdir	Permits users to create personal homepages in ~user home directories
Remove	charset-lite	Enables character set translation
Remove	env	Modifies environment variables passed to CGI and SSI scripts
Remove	setenvif	Enables environment variable determination
Remove	asis	Permits documents to be sent without standard headers
Remove	cgi	Enables CGI scripts
Remove	negotiation	Permits standard HTTP1.1 content negotiation
Remove	actions	Permits CGI script execution
Remove	alias	Enables URL redirection and file system mapping
Add	mod_ssl	Provides cryptography using the Secure Sockets Layer (SSL) and Transport Layer Security (TLS) protocols
Add	mod_log_forensic	Increases granularity of logging to forensic levels
Add	mod_unique_id	Required for mod_log_forensic module

NOTE

To enable SSL for HTTPS operation in your Apache Web server, you'll need to download, compile, and install OpenSSL, which is available at www.openssl.org.

Mod_security

mod_security, a third-party Apache module available from www.modsecurity.org/, provides application firewall intrusion protection and prevention. To enable *mod_security*, you must download and compile the software into the Apache Web server. Adding *mod_security* increases the secure operation of your Apache Web server and adds functionality including, but not limited to, the following:

- HTTP protocol awareness
- Anti-evasion technique prevention such as URL encoding validation and URL decoding
- Enhanced audit logging
- Built-in *chroot* functionality
- Buffer overflow protection
- HTTPS filtering

We'll enable *mod_security* in our example because it adds so many security features to our system. Once you have downloaded the *mod_security* source from www.modsecurity.org/download/index.html, perform the following steps as root:

```
cd ${modsecuritySrcDir}/apache2
mkdir -r ${ApacheSrcDir}/modules/security
cp mod_security.c Makefile.in config.m4 \ ${ApacheSrcDir}/modules/security
cd ${ApacheSrcDir}
./buildconf
```

Now *mod_security* appears like other Apache modules. When we compile Apache, we'll enable it using the command `--enable-security`. Using the previous listed configurations, your *configure* statement would look something like the following:

```
./configure --prefix=/usr/local/apache \
--enable-so \
--enable-ssl \
--enable-security \
--enable-unique-id \
--enable-log-forensic \
--disable-info \
--disable-status \
--disable-autoindex \
--disable-imap \
--disable-include \
--disable-userdir \
--disable-auth \
```

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```
--disable-charset-lite \
--disable-env \
--disable-setenvif \
--disable-asis \
--disable-cgi \
--disable-negotiation \
--disable-actions \
--disable-alias
```

The command configures the Apache software to be installed in `/usr/local/apache` and to be built with our module options. There are many options to consider in configuring the Apache source code for compilation. To view a list of options, issue the command `./configure --help` from the `${ApacheSrcDir}` directory.

After successfully configuring the source code, proceed with Steps 2 and 3. On successful completion, you should see a message similar to the one shown in Figure D.1.

Figure D.1 Successful Completion Message

```
+-----+
| You now have successfully built and installed the |
| Apache 2.2 HTTP server. To verify that Apache actually |
| works correctly you now should first check the |
| (initially created or preserved) configuration files |
| /usr/local/apache/conf/httpd.conf |
| and then you should be able to immediately fire up |
| Apache the first time by running: |
| /usr/local/apache/bin/apachectl start |
| Thanks for using Apache. The Apache Group |
| http://www.apache.org/ |
+-----+
```

Now that we've successfully installed the Apache Web server software, let's proceed to the next step: configuring the `httpd.conf` file for secure operation.

Configure the `httpd.conf` File

The Apache Web server stores all its configuration data in the `httpd.conf` file located in the `${ApacheServerRoot}` directory, which is, in our example, `/usr/local/apache`. The `httpd.conf` file includes many directives that can be categorized into the following sections:

- Server Directives
- User Directives

- Performance/Denial of Service (DoS) Directives
- Server Software Obfuscation Directives
- Access Control Directives
- Authentication Mechanisms
- Directory Functionality Directives
- Logging Directives

Not all directives play a significant role with regard to security. In the following sections, we'll discuss the directives that impact the security of your Apache server. Furthermore, because we disabled a lot of functionality at compile time, some directives that would normally be dangerous don't need to be removed, since they weren't added into the compiled Apache binaries. There may also be other configuration files, called Include files, associated with the `httpd.conf` file. Since we have enabled `mod_security`, there is a long list of potential configurations to make in an Include file called `modsecurity.conf`, which is usually located in the `${ApacheServerRoot}/conf` directory.

In this section, we've included the Modsecurity.com-recommended `mod_security` configuration. For more information about configuring this file, refer to the `mod_security` documentation found at www.modsecurity.org/documentation/.

Recommended `modsecurity.conf` File

```
# Turn ModSecurity On
SecFilterEngine On

# Reject requests with status 403
SecFilterDefaultAction "deny,log,status:403"

# Some sane defaults
SecFilterScanPOST On
SecFilterCheckURLEncoding On
SecFilterCheckUnicodeEncoding Off

# Accept almost all byte values
SecFilterForceByteRange 1 255

# Server masking is optional
# SecServerSignature "OurServer"

SecUploadDir /tmp
SecUploadKeepFiles Off
```

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```
# Only record the interesting stuff
SecAuditEngine RelevantOnly
SecAuditLog logs/audit_log

# You normally won't need debug logging
SecFilterDebugLevel 0
SecFilterDebugLog logs/modsec_debug_log

# Only accept request encodings we know how to handle
# we exclude GET requests from this because some (automated)
# clients supply "text/html" as Content-Type
SecFilterSelective REQUEST_METHOD "!(GET|HEAD)$" chain
SecFilterSelective HTTP_Content-Type \
"!(^application/x-www-form-urlencoded$|^multipart/form-data;)"

# Do not accept GET or HEAD requests with bodies
SecFilterSelective REQUEST_METHOD "^(GET|HEAD)$" chain
SecFilterSelective HTTP_Content-Length "!"

# Require Content-Length to be provided with
# every POST request
SecFilterSelective REQUEST_METHOD "^POST$" chain
SecFilterSelective HTTP_Content-Length "!"

# Don't accept transfer encodings we know we don't handle
SecFilterSelective HTTP_Transfer-Encoding "!"
```

User Directives

There are a couple directives you must configure in the `httpd.conf` file to ensure that the Apache Web server runs using the unprivileged user account we established earlier, among other things. Inspect your `httpd.conf` file to verify that the following statements appear as shown in the following. Recall that we decided to run Apache as `wwwusr:wwwgrp`.

```
User wwwusr
Group wwwgrp
```

Also, configure the `ServerAdmin` directive with a valid alias e-mail address such as the following:

```
ServerAdmin hostmaster@oursecuredomain.com
```

This will provide a point of contact for your customers, should they experience problems with your site.

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Performance/Denial-of-Service (DoS) Directives

There are a number of performance-tuning directives in the Apache httpd.conf file. As a security professional, you should interpret these directives as DoS prevention statements, since they control resource allocation for users of the Apache server. The following directives control the performance of an Apache server:

- **Timeout** Configures the time Apache waits to receive GET requests, the time between TCP packets for POST or PUT requests, or the time between TCP ACK statements in responses. The Apache default is 300 seconds (5 minutes), but you might want to consider reducing this timer to 60 seconds to mitigate DoS attacks.
- **KeepAlive** Configures HTTP1.1-compliant persistency for all Web requests. By default, this is set to On and should remain as such to streamline Web communication.
- **KeepAliveTimeout** Determines the maximum time to wait before closing an inactive, persistent connection. Let's keep this value at the default of 15 seconds, since raising it can cause performance problems on busy servers and expose you to DoS attacks.
- **StartServers** Designates the number of child processes to start when Apache starts. Setting this value higher than the default of 5 can increase server performance, but use care not to set the value too high, because doing so could saturate system resources.
- **MinSpareServers** This setting, like the MaxSpareServers setting, allows for dynamic adjustment of Apache child processes. MinSpareServers instructs Apache to maintain the specified number of idle processes for new connections. This number should be relatively low except on very busy servers.
- **MaxSpareServers** Maintains Apache idle processes at the specified number. Like MinSpareServers, this value should be low, except for busy sites.
- **MaxClients** As its name implies, this setting determines the maximum number of concurrent requests to the Apache server. We'll leave this at the default value of 256.

Once you've finished editing this section of your httpd.conf file, you should see something similar to the following:

```
Timeout 60
KeepAlive On
KeepAliveTimeout 15
StartServers 5
MinSpareServers 10
MaxSpareServers 20
MaxClients 256
```

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Server Software Obfuscation Directives

By default, Apache informs Web users of its version number when delivering a 404 (page not found) error. Since it is good practice to limit the information you provide to would-be hackers, we'll disable this feature. Recall that we already altered the Apache server signature and that we installed *mod_security*. Both of these actions should be enough to obfuscate our server because they both alter the default behavior. If you would like to turn off server signatures completely, you can always set the `ServerSignature` directive to `Off` and the `ServerTokens` to `Prod`. This will disable Apache signatures entirely.

Access Control Directives

The Apache Web server includes mechanisms to control access to server pages and functionality. The statement syntax is part of the `<Directory>` directive and is fairly straightforward; you specify a directory structure, whether default access is permitted or denied, and the parameters that enable access to the directory if access is denied by default. There are many options for fine-grained control that you should learn by reading <http://httpd.apache.org/docs/2.0/mod/core.html#directory>.

Regardless of the access you provide to your customers, you should secure the root file system using access control before placing your server into a production environment. In your `httpd.conf` file, you should create a statement in the access control directives area as follows:

```
<Directory />  
    Order Deny, Allow  
    deny from all  
</Directory>
```

This statement will deny access to the root file system should someone intentionally or accidentally create a symlink to `/`.

Authentication Mechanisms

Apache also includes several ways in which you can authenticate customers using your Web server such as LDAP, SecureID, and basic `.htaccess`, to name a few examples. To use authentication mechanisms beyond basic `.htaccess`, you must compile additional functionality when you're building Apache. Like access control, authentication mechanisms are specified as part of the `<Directory>` directive.

The two steps to enabling basic `.htaccess` user authentication are:

1. Creating an `htpasswd` file to store user credentials.
2. Adding a `<Directory>` directive to the `httpd.conf` file to protect a directory structure.

Let's use an example to demonstrate how easy it can be to add authentication. In our example, we'll secure a directory called `/secure` and permit only customers Elise and Margot access to the files in that directory.

First, let's create an `htpasswd` file somewhere *not* in the Web server document root by issuing the following command:

```
htpasswd -c /usr/local/apache/passwdfile elise
New password: *****
Re-type new password: *****
Adding password for user elise
```

Next, we'll add Margot to the list as well. This time we don't need to use the `-c` argument, since our `htpasswd` file already exists:

```
htpasswd /usr/local/apache/passwdfile margot
New password: *****
Re-type new password: *****
Adding password for user margot
```

Now that we've established our customer accounts, we'll finish by adding a `<Directory>` directive to the `httpd.conf` file to protect the `/secure` directory as follows:

```
<Directory /usr/local/apache/htdocs/secure>
AuthType Basic
AuthName "Access for authenticated customers only"
AuthUserFile /usr/local/apache/passwdfile
Require user margot elise
</Directory>
```

Now, when anyone attempts to access the `/secure` directory, they'll be prompted for a username and password. Because we specifically require only Margot and Elise, only they will be permitted to use the directory structure, if they authenticate properly.

Let's move on to discuss a couple other security-related `<Directory>` directives.

Directory Functionality Directives

Within the `<Directory>` directive is a subdirective called *Options* that controls functionality for the directory structures specified in the `<Directory>` directive. The available options are listed in Table D.3.

Table D.3 Directory Options

Option	Functionality
All	Default setting; includes all options except MultiViews
ExecCGI	Permits CGI script execution through <code>mod_cgi</code>

Continued

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Table D.3 continued Directory Options

Option	Functionality
FollowSymLinks	Allows Apache to follow OS file system symlinks
Includes	Permits SSI through mod_include
IncludesNOEXEC	Permits SSI but denies exec and exec cgi
Indexes	Allows autoindexing using mod_autoindex if no configured index file is present
MultiViews	Permits content negotiation using mod_negotiation
SimLinkIfOwnerMatch	Allows Apache to follow OS file system symlinks but only if the link and target file have the same owner

Many of the listed options are not relevant to our installation, since we disabled Includes and CGI during compile time. Regardless, a good default <Directory> directive disabling most options is shown her:

```
<Directory "/usr/local/apache/htdocs">
Order allow,deny
Allow from all
Options -FollowSymLinks -ExecCGI -Includes -Indexes \
-MultiViews
AllowOverride None
</Directory>
```

At this point, your Apache server should be relatively secure. Let's discuss some Apache logging directives so that we can better monitor our server.

Logging Directives

There are many reasons to configure logging on your Apache server. Whether helping you see top page hits, hours of typical high volume traffic, or simply understanding who's using your system, logging plays an important part of any installation. More important, logging can provide a near-real-time and historic forensic toolkit during or after security events. In this section, we examine some logging configuration best practices.

To ensure that your logging directives are set up correctly, we'll provide an example of the Logging options in the Apache Web server. Apache has many options with which you should familiarize yourself by reading http://httpd.apache.org/docs/2.0/mod/mod_log_config.html#logformat. This will help you understand the best output data to record in logs. Also, recall that we compiled Apache with *mod_log_forensic*, which provides enhanced granularity and logging before and after each successful page request.

An example logging configuration is shown here:

```
ErrorLog /var/log/apache/error.log
LogLevel info
```



```
LogFormat "%h %l %u %t \"%r\" %>s %b \"%{Referer}i\" \"%{User-Agent}i\"
\"%{forensic-id}n\" %T %v" full
CustomLog /var/log/apache/access.log combined
ForensicLog /var/log/apache/forensic.log
```

This example provides a customized logging format that includes detailed output and places all the log files in the /var/log/apache directory.

TIP

It is good practice to archive your system and Apache log files to backup location. This prevents loss of critical forensic data due to accidental deletion or malicious activity.

Remove Default/Unneeded Apache Files

After you've installed and configured your Apache server, you'll need to do some quick cleanup of files that could represent a security threat. In general, you should not leave the source code you used to compile Apache on the file system. It's a good idea to tar the files up and move them to a secure server. Once you've done so, remove the source code from the Apache Web server.

You'll also want to remove some of the default directories and files installed by the Apache Web server. To do so, execute the following commands on your Web server. If you have added content into your document root directory, you'll want to avoid the first command:

```
rm -fr /usr/local/apache/htdocs/*
rm -fr /usr/local/apache/cgi-bin
rm -fr /usr/local/apache/icons
```

After removing files, let's ensure that our Apache files have proper ownership and permissions before starting our server.

Update Ownership/Permissions

As we discussed previously, the Apache Web server should be run as an unprivileged and unique account. In our example, we used the user wwwusr and the group wwwgrp to run our server. Let's make sure our permissions are properly set by running the following commands:

```
chown -R root:wwwgrp /usr/local/apache/bin
chmod -R 550 /usr/local/apache/bin
chown -R root:wwwgrp /usr/local/apache/conf
chmod -R 660 /usr/local/apache/conf
```

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```
chown -R root:wwwgrp /usr/local/apache/logs
chmod -R 664 /usr/local/apache/logs
chown -R root /usr/local/apache/htdocs
chmod -R 664 /usr/local/apache/htdocs
```

Monitoring the Server for Secure Operation

Even with the best defenses and secure configurations, breeches in your systems and applications could occur. Therefore, you cannot simply set up a hardened Apache Web server and walk away thinking that everything will be just fine. Robust and comprehensive monitoring is perhaps the most important part of securely operating servers and applications on the Internet.

Throughout this book, we have discussed myriad techniques to ensure your IT security. You must leverage all these secure DMZ functions in your job. With regard to Apache, there are several things to consider that will help you identify and react to potential threats.

Your primary source of data will be through Apache and OS logs. Even with small Web sites, however, sifting through this information can be a challenge. One of the first things to consider is integrating your Apache logs with other tools to help organize and identify the potential incident “needles” in your log file “haystack.” Many open-source and commercial products are available to aid you in securing your site. One such open-source tool is called Webalizer, available at www.mrunix.net/webalizer, which features graphical representation of your Apache log file contents.

SNMP polling and graphing constitute another methodology commonly employed for secure monitoring. Often, it is extremely difficult to gauge the severity or magnitude of an event without visualization of data from logs or SNMP counters. One tool you might consider using is a module called *mod_apache_snmp*, available at <http://mod-apache-snmp.sourceforge.net/>. The module can provide real-time monitoring of various metrics including, but not limited to:

- Load average
- Server uptime
- Number of errors
- Number of bytes and requests served

You might consider other commercial SNMP-based solutions, especially for enterprise-scale deployments. These tools help expedite monitoring deployment and usually include enhanced functionality to automatically alert you when important thresholds, such as Web site concurrent connections, are crossed.