Community Experience Distilled

Mastering NGINX

An in-depth guide to configuring NGINX for any situation, including numerous examples and reference tables describing each directive

Dimitri Aivaliotis

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I would like to thank John Blackwell and Phil Margolis for reading early drafts of the manuscript. Their criticism and tips have helped me greatly and made this a better book. I would also like to thank the technical reviewers for providing constructive feedback and pointing out errors I have made along the way. Any remaining errors are of course my own.

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> I'd like to thank Dimitri for the opportunity to help review this fine book. It's a useful resource all along.

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Dedicated to my father, who has always said I can do anything I set my mind to.

Preface

NGINX is a high-performance web server designed to use very few system resources. There are many how-to's and example configurations floating around on the Web. This guide will serve to clarify the murky waters of NGINX configuration. In doing so you will learn how to tune NGINX for various situations, what some of the more obscure configuration options do, and how to design a decent configuration to match your needs.

You will no longer feel the need to copy-paste a configuration snippet because you will understand how to construct a configuration file to do exactly what you want it to do. This is a process, and there will be bumps along the way, but with the tips explained in this book you will feel comfortable writing an NGINX configuration file by hand. In case something doesn't work as expected, you will be able to debug the problem yourself or at least be capable of asking for help without feeling like you haven't given it a try yourself.

This book is written in a modular fashion. It is laid out to help you get to the information you need as quickly as possible. Each chapter is pretty much a standalone piece. Feel free to jump in anywhere you feel you need to get more in-depth about a particular topic. If you feel you have missed something major, go back and read the earlier chapters. They are constructed in a way to help you grow your configuration piece-by-piece.

What this book covers

Chapter 1, *Installing NGINX and Third-Party Modules*, teaches you how to install NGINX on your operating system of choice and how to include third-party modules in your installation.

Chapter 2, *A Configuration Guide*, explains the NGINX configuration file format. You will learn what each of the different contexts are for, how to configure global parameters, and what a location is used for.

Chapter 3, *Using the Mail Module*, explores NGINX's mail proxy module, detailing all aspects of its configuration. An example authentication service is included in the code for this chapter.

Chapter 4, *NGINX as a Reverse Proxy*, introduces the concept of a reverse proxy and describes how NGINX fills that role.

Chapter 5, *Reverse Proxy Advanced Topics*, delves deeper into using NGINX as a reverse proxy to solve scaling issues and performance problems.

Chapter 6, *The NGINX HTTP Server*, describes how to use the various modules included with NGINX to solve common web serving problems.

Chapter 7, *NGINX for the Developer*, shows how NGINX can be integrated with your application to deliver content to your users more quickly.

Chapter 8, *Troubleshooting Techniques*, investigates some common configuration problems, how to debug a problem once it arises, and makes some suggestions for performance tuning.

Appendix A, *Directive Reference*, provides a handy reference for the configuration directives used throughout the book, as well as a selection of others not previously covered.

Appendix B, *Rewrite Rule Guide*, describes how to use the NGINX rewrite module and describes a few simple steps for converting Apache-style rewrite rules into ones NGINX can process.

Appendix C, *Community*, introduces you to the online resources available to seek more information.

Appendix D, *Persisting Solaris Network Tunings*, details what is necessary to persist different network tuning changes under Solaris 10 and above.

What you need for this book

Any modern Linux PC should be sufficient to run the code samples in the book. The installation instructions are given in each chapter that uses code samples. Basically, it boils down to:

- **A build environment**: Compiler, header files, and a few more
- **NGINX**: Most recent version should be fine
- **Ruby**: Best installed from https://rvm.io
- **Perl**: Default version should be fine

Who this book is for

This book is for experienced systems administrators or systems engineers, familiar with installing and configuring servers to meet specific needs. You do not need to have experience using NGINX already.

Conventions

In this book, you will find a number of styles of text that distinguish between different kinds of information. Here are some examples of these styles, and an explanation of their meaning.

Code words in text are shown as follows: "NGINX will attempt to build a dependent library statically if you include a `--with-<library>=<path>` option to configure."

A block of code is set as follows:

```
$ export BUILD_DIR=`pwd`
$ export NGINX_INSTALLDIR=/opt/nginx
$ export VAR_DIR=/home/www/tmp
$ export LUAJIT_LIB=/opt/luajit/lib
$ export LUAJIT_INC=/opt/luajit/include/luajit-2.0
```

When we wish to draw your attention to a particular part of a code block, the relevant lines or items are set in bold:

```
$ export BUILD_DIR=`pwd`
$ export NGINX_INSTALLDIR=/opt/nginx
$ export VAR_DIR=/home/www/tmp
$ export LUAJIT_LIB=/opt/luajit/lib
$ export LUAJIT_INC=/opt/luajit/include/luajit-2.0
```

Any command-line input or output is written as follows:

```
$ mkdir $HOME/build
$ cd $HOME/build && tar xzf nginx-<version-number>.tar.gz
```

New terms and **important words** are shown in bold. Words that you see on the screen, in menus or dialog boxes for example, appear in the text like this: "clicking the **Next** button moves you to the next screen".

> ## Note
>
> Warnings or important notes appear in a box like this.

> ## Tip
>
> Tips and tricks appear like this.

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Chapter 1. Installing NGINX and Third-Party Modules

NGINX was first conceived to be an HTTP server. It was created to solve the C10K problem, described by Daniel Kegel at http://www.kegel.com/c10k.html, of designing a web server to handle 10,000 simultaneous connections. NGINX is able to do this through its event-based connection-handling mechanism, and will use the OS-appropriate event mechanism in order to achieve this goal.

Before we begin exploring how to configure NGINX, we will first install it. This chapter details how to install NGINX itself and how to get the correct modules installed and configured. NGINX is modular by design, and there is a rich community of third-party module developers who have added functionality to the core NGINX server by creating modules that can be compiled into the server and installed along with it.

In this chapter, we will cover:

- Installing NGINX using a package manager
- Installing NGINX from source
- Configuring for web or mail service
- Enabling various modules
- Finding and installing third-party modules
- Putting it all together

Installing NGINX using a package manager

Chances are that your operating system of choice already provides `nginx` as a package. Installing it is as simple as using your package manager's commands:

- Linux (deb-based)

  ```
  sudo apt-get install nginx
  ```

- Linux (rpm-based)

  ```
  sudo yum install nginx
  ```

- FreeBSD

  ```
  sudo pkg_install -r nginx
  ```

Note

The `sudo` command is representative of what you need to execute on your operating system to achieve superuser ('root') privileges. If your operating system supports **RBAC** (**Role-based access control**), then you would use a different command, such as 'pfexec' to achieve the same goal.

These commands will install NGINX into standard locations, specific to your operating system. This is the preferred installation method if you need to use your operating system's packages.

The NGINX core team also provides binaries of the stable version, available from http://nginx.org/en/download.html. Users of distributions without an `nginx` package (such as CentOS), can use the following instructions to install pre-tested, pre-compiled binaries.

CentOS

Add the NGINX repository to your yum configuration by creating the following file:

```
sudo vi /etc/yum.repos.d/nginx.repo
[nginx]
name=nginx repo
baseurl=http://nginx.org/packages/centos/6/$basearch/
gpgcheck=0
enabled=1
```

Then install `nginx` by executing the following command:

```
sudo yum install nginx
```

Alternative instructions for installing an `nginx-release` package are available at the preceding URL.

Debian

Install the NGINX signing key by downloading it from http://nginx.org/keys/nginx_signing.key and adding it to the apt keyring:

```
sudo apt-key add nginx_signing.key
```

Append the `nginx.org` repository to the end of `/etc/apt/sources.list`:

```
vi /etc/apt/sources.list
deb http://nginx.org/packages/debian/ squeeze nginx
deb-src http://nginx.org/packages/debian/ squeeze nginx
```

Then install `nginx` by executing the following command:

```
sudo apt-get update
sudo apt-get install nginx
```

If your operating system does not include `nginx` in its list of available packages, the version there is too old for what you would like to do, the packages at nginx.org don't serve your needs, or you would like to use the "development" release of NGINX, then compiling NGINX from source is the only other option.

Installing NGINX from source

NGINX downloads are available for two separate branches of NGINX code—stable and development. The development branch is the one in which active development is taking place. Here is where new features will be found and integrated before finding their way into the stable branch. When a "development" version is released, it has undergone the same QA and a similar set of functional tests as the stable branch, so either branch may be used on production systems. The major difference between the two branches lies in the support of third-party modules. The internal API may change in the development release, whereas it stays the same on the stable branch, so backward compatibility for third-party modules is only available for stable releases.

Preparing a build environment

In order to compile NGINX from source, certain requirements need to be met on your system. Besides a compiler, you also need the OpenSSL and **PCRE** (**Perl Compatible Regular Expressions**) libraries and development headers, if you want to enable the SSL support and be able to use the `rewrite` module, respectively. Depending on your system, these requirements may already be met in the default installation. If not, you will need to either locate the appropriate package and install it, or download the source, unpack it, and point NGINX's configure script to this location.

NGINX will attempt to build a dependent library statically if you include a `-with-<library>=<path>` option to configure. You might want this if you would like to ensure that NGINX is not dependent on any other part of the system and/or would like to squeeze that extra bit of performance out of your `nginx` binary. If you are using features of external libraries that are only available from a certain version onwards (for example, the Next Protocol Negotiation TLS extension available from OpenSSL Version 1.0.1), then you would have to specify the path to the unpacked sources of that particular version.

There are other, optional, packages that you may provide support for if you like. These include MD5 and SHA-1 hashing algorithm support, zlib compression, and libatomic library support. The hashing algorithms are used in many places in NGINX, for example, to compute the hash of a URI to determine a cache key. The zlib compression library is used for delivering gzipped content. If the `atomic_ops` library is available, NGINX will use its atomic memory update operations to implement high-performance memory-locking code.

Compiling from source

NGINX may be downloaded from http://nginx.org/en/download.html. Here you will find the source of either branch in the `.tar.gz` or `.zip` format. Unpack the archive into a temporary directory as follows:

```
$ mkdir $HOME/build
$ cd $HOME/build && tar xzf nginx-<version-number>.tar.gz
```

Configure it using the following command:

```
$ cd $HOME/build/nginx-<version-number> && ./configure
```

And compile it as follows:

```
$ make && sudo make install
```

When compiling your own `nginx` binary, you are much more free to include only what you need. Can you already say under which user NGINX should run? Do you want to specify the default logfile locations so that they don't need to be explicitly set in the configuration? The following table of configure options will help you design your own binary. These are options that are valid for NGINX independent of which module is activated.

Table: Common configure options

Option	Explanation
`--prefix=<path>`	The root of the installation. All other installation paths are relative to this one.
`--sbin-path=<path>`	The path to the `nginx` binary. If not specified, this will be relative to the prefix.
`--conf-path=<path>`	The path to where `nginx` will look for its configuration file, if not specified on the command line.
`--error-log-path=<path>`	This is where `nginx` will write its error logfile, unless configured otherwise.
`--pid-path=<path>`	This is where nginx will write the pid file of the master process, usually

	under /var/run.
--lock-path=<path>	The path to the shared memory mutex lock file.
--user=<user>	The user under which the worker processes should run.
--group=<group>	The group under which the worker processes should run.
--with-file-aio.	Enables asynchronous I/O for FreeBSD 4.3+ and Linux 2.6.22+
--with-debug	This option will enable debug logging. Not recommended for production systems.

You are also able to compile with optimizations that you may not get in a packaged installation. This is where the following options can be especially useful:

Table: Configure options for optimization

Option	**Explanation**
--with-cc=<path>	If you would like to set a C compiler that is not in your default PATH.
--with-cpp=<path>	This is the corresponding path to the C preprocessor.
--with-cc-opt=<options>	Here is where the path to the necessary include files may be indicated (-I<path>), as well as optimizations (-O4) and specifying a 64-bit build.
--with-ld-opt=<options>	The options to the linker include library path (-L<path>) and run path (-R<path>).

`--with-cpu-opt=<cpu>`	A build specific to a particular CPU family may be specified with this option.

Configuring for web or mail service

NGINX is unique among high-performing web servers in that it was also designed to be a mail proxy server. Depending on your goals in building NGINX, you can configure it for web acceleration, a web server, a mail proxy, or all of them. It may be beneficial to have one package that you can install on any server in your infrastructure and be able to set NGINX's role through configuration, or it may serve your needs better to have a slimmed-down binary to use in high-performance environments where every extra KB counts.

Configure options for a mail proxy

The following table specifies configuration options that are unique to the mail module:

Table: Mail configure options

Option	Explanation
`--with-mail`	This will enable the `mail` module, which is not activated by default.
`--with-mail_ssl_module`	In order to proxy any kind of `mail` transaction that uses SSL/TLS, this module will need to be activated.
`--without-mail_pop3_module`	When enabling the `mail` module, the POP3 module may be disabled separately.
`--without-mail_imap_module`	When enabling the `mail` module, the IMAP module may be disabled separately.
`--without-mail_smtp_module`	When enabling the `mail` module, the SMTP module may be disabled separately.
`--without-http`	This option will completely disable the `http` module; use it if you know you only want to compile in `mail` support.

For a typical mail proxy, I would recommend configuring NGINX as follows:

```
$ ./configure --with-mail --with-mail_ssl_module --with-
openssl=${BUILD_DIR}/openssl-1.0.1c
```

SSL/TLS is needed nowadays on almost every mail installation and not having it enabled on a mail proxy robs users of expected functionality. I've recommended compiling OpenSSL statically so that there are no dependencies on the operating system's OpenSSL library. The `BUILD_DIR` variable referenced in the preceding command would of course have to be set beforehand.

Configure the options to specify paths

The following table shows what configuration options are available to the `http` module, from activating the Perl module to specifying the location of temporary directories:

Table: HTTP configure options

Option	Explanation
`--without-http-cache`	When using the upstream module, NGINX can be configured to cache the contents locally. This option disables that cache.
`--with-http_perl_module`	NGINX configuration can be extended by using Perl code. This option activates that module. (Use of this module, however, degrades performance.)
`--with-perl_modules_path=<path>`	This option specifies the path to additional Perl modules needed for using the embedded Perl interpreter. It may also be specified as a configuration option.
`--with-perl=<path>`	The path to Perl (Version 5.6.1 and higher), if not found on the default path.
`--http-log-path=<path>`	The default path to the HTTP access log.

`--http-client-body-temp-path=<path>`	When receiving the request from the client, this is the directory used as a temporary location for the body of that request. If the WebDAV module is enabled, it is recommended to set this path to be on the same filesystem as the final destination.
`--http-proxy-temp-path=<path>`	When proxying, this is the directory used as a location to store temporary files.
`--http-fastcgi-temp-path=<path>`	The location for FastCGI temporary files.
`--http-uwsgi-temp-path=<path>`	The location for uWSGI temporary files.
`--http-scgi-temp-path=<path>`	The location for SCGI temporary files.

Enabling various modules

Besides the `http` and `mail` modules, there are a number of other modules included in the NGINX distribution. These modules are not activated per default, but may be enabled by setting the appropriate configuration option `--with-<module-name>_module`.

Table: HTTP module configure options

Option	Explanation
`--with-http_ssl_module`	If you need to encrypt web traffic, you will need this option to be able to use URLs beginning with `https`. (Requires the OpenSSL library.)
`--with-http_realip_module`	If your NGINX will be behind a L7 load balancer or other device that passes the client's IP address in an HTTP header, you will need to enable this module. For use in situations where multiple clients appear to come from one IP address.
`--with-http_addition_module`	This module works as an output filter, enabling you to add content of a different location before or after that of the location itself.
`--with-http_xslt_module`	This module will handle transformations of XML responses, based on one or more XSLT stylesheets. (Requires the libxml2 and libxslt libraries.)
`--with-http_image_filter_module`	This module is able to act as a filter on images, processing them before handing them over to the client. (Requires the libgd library.)
`--with-http_geoip_module`	With this module, you are able to set various variables to use in configuration blocks to make decisions based on the geographic location found for a client's IP address. (Requires

	the MaxMind GeoIP library and the corresponding precompiled database files.)
`--with-http_sub_module`	This module implements a substitution filter, replacing one string in the response with another.
`--with-http_dav_module`	Enabling this module will activate the configuration directives for using WebDAV. Note that this module should only be enabled on a need-to-use basis, as it could present security problems if configured incorrectly.
`--with-http_flv_module`	If you need to be able to stream Flash video files, this module will provide for pseudo-streaming.
`--with-http_mp4_module`	This module supports pseudo-streaming for H.264/AAC files.
`--with-http_gzip_static_module`	Use this module if you would like to support sending pre-compressed versions of static files when the resource is called without the `.gz` ending.
`--with-http_gunzip_module`	This module will decompress pre-compressed content for clients that do not support gzip encoding.
`--with-http_random_index_module`	If you would like to serve an index file chosen at random from the files in a directory, then this module needs to be enabled.
`--with-http_secure_link_module`	This module provides a mechanism to hash a link to a URL, so that only those with the proper password would be able to calculate the link.
`--with-http_stub_status_module`	Enabling this module will help you gather statistics from NGINX itself. The output can be graphed using RRDtool or something similar.

As you can see, these are all modules that build upon the `http` module, providing extra functionality. Enabling the modules at compile time should not affect runtime performance at all. Using the modules later in the configuration is where performance may be impacted.

I would therefore recommend the following `configure` options for a web accelerator/proxy:

```
$ ./configure --with-http_ssl_module --with-http_realip_module --
with-http_geoip_module --with-http_stub_status_module --with-
openssl=${BUILD_DIR}/openssl-1.0.1c
```

And the following for a web server:

```
$ ./configure --with-http_stub_status_module
```

The difference lies in where NGINX will be faced with clients. The web acceleration role would take care of terminating SSL requests as well as dealing with proxied clients and making decisions based on where a client came from. The web server role would need only provide default file serving capability.

I would recommend always enabling the `stub_status` module, as it provides a means of gathering metrics on how your NGINX is performing.

Disabling unused modules

There are also a number of `http` modules that are normally activated, but may be disabled by setting the appropriate configuration option `--without-<module-name>_module`. If you have no use for these modules in your configuration, you can safely disable them.

Table: Disable configure options

Option	Explanation
`--without-http_charset_module`	The charset module is responsible for setting the `Content-Type` response header, as well as converting from one charset to another.
`--without-http_gzip_module`	The `gzip` module works as an output filter, compressing content as it's delivered to the client.

--without-http_ssi_module	This module is a filter that processes Server Side Includes. If the Perl module is enabled, an additional SSI command (perl) is available.
--without-http_userid_module	The userid module enables NGINX to set cookies that can be used for client identification. The variables $uid_set and $uid_got can then be logged for user tracking.
--without-http_access_module	The access module controls access to a location based on IP address.
--without-http_auth_basic_module	This module limits access via HTTP Basic Authentication.
--without-http_autoindex_module	The autoindex module enables NGINX to generate a directory listing for directories that have no index file.
--without-http_geo_module	This module enables you to set up configuration variables based on a client's IP address and then take action on the value of those variables.
--without-http_map_module	The map module enables you to map one variable to another.
--without-http_split_clients_module	This module creates variables that can be used for A/B testing.
--without-http_referer_module	This module enables NGINX to block requests based on the Referer HTTP header.
--without-http_rewrite_module	The rewrite module allows you to change URIs based on various conditions.

--without-http_proxy_module	The proxy module allows NGINX to pass requests on to another server or group of servers.
--without-http_fastcgi_module	The FastCGI module enables NGINX to pass requests to a FastCGI server.
--without-http_uwsgi_module	This module enables NGINX to pass requests to a uWSGI server.
--without-http_scgi_module	The SCGI module enables NGINX to pass requests to an SCGI server.
--without-http_memcached_module	This module enables NGINX to interact with a memcached server, placing responses to queries into a variable.
--without-http_limit_conn_module	This module enables NGINX to set connection limits based on certain keys, usually an IP address.
--without-http_limit_req_module	With this module, NGINX can limit the request rate per key.
--without-http_empty_gif_module	The empty GIF module produces a 1 x 1-pixel in-memory transparent GIF.
--without-http_browser_module	The browser module allows for configurations based on the User-Agent HTTP request header. Variables are set based on the version found in this header.
--without-http_upstream_ip_hash_module	This module defines a set of servers that may be used in conjunction with the various proxy modules.

Finding and installing third-party modules

As with many open source projects, there is an active developer community surrounding NGINX. Thanks to NGINX's modular nature, this community is able to develop and publish modules to provide additional functionality. They cover a wide range of applications, so it pays to take a look at what is available before embarking on developing your own module.

The procedure for installing a third-party module is fairly straightforward:

1. Locate the module you would like to use (either search on https://github.com or see http://wiki.nginx.org/3rdPartyModules).
2. Download the module.
3. Unpack the source.
4. Read the README file, if included. See if there are any dependencies that you will need to install.
5. Configure NGINX to use the module as follows. `/configure -add-module=<path>`.

This procedure will give you an `nginx` binary with the additional functionality of that module.

Keep in mind that many third-party modules are of an experimental nature. Test using a module first before rolling it out on production systems. And remember that the development releases of NGINX may have API changes that can cause problems with third-party modules.

Special mention should be made here of the `ngx_lua` third-party module. The `ngx_lua` module serves to enable Lua instead of Perl as a configuration time embedded scripting language. The great advantage this module has over the `perl` module is its non-blocking nature and tight integration with other third-party modules. The installation instructions are fully described at http://wiki.nginx.org/HttpLuaModule#Installation. We will be using this module as an example of installing a third-party module in the next section.

Putting it all together

Now that you have gotten a glimpse at what all the various configuration options are for, you can design a binary that precisely fits your needs. The following example specifies the prefix, user, group, certain paths, disables some modules, enables some others, and includes a couple of third-party modules:

```
$ export BUILD_DIR=`pwd`
$ export NGINX_INSTALLDIR=/opt/nginx
$ export VAR_DIR=/home/www/tmp
$ export LUAJIT_LIB=/opt/luajit/lib
$ export LUAJIT_INC=/opt/luajit/include/luajit-2.0

$ ./configure \
        --prefix=${NGINX_INSTALLDIR} \
        --user=www \
        --group=www \
        --http-client-body-temp-path=${VAR_DIR}/client_body_temp \
        --http-proxy-temp-path=${VAR_DIR}/proxy_temp \
        --http-fastcgi-temp-path=${VAR_DIR}/fastcgi_temp \
        --without-http_uwsgi_module \
        --without-http_scgi_module \
        --without-http_browser_module \
        --with-openssl=${BUILD_DIR}/../openssl-1.0.1c \
        --with-pcre=${BUILD_DIR}/../pcre-8.32 \
        --with-http_ssl_module \
        --with-http_realip_module \
        --with-http_sub_module \
        --with-http_flv_module \
        --with-http_gzip_static_module \
        --with-http_gunzip_module \
        --with-http_secure_link_module \
        --with-http_stub_status_module \
        --add-module=${BUILD_DIR}/ngx_devel_kit-0.2.17 \
        --add-module=${BUILD_DIR}/ngx_lua-0.7.9
```

Following a lot of output showing what `configure` was able to find on your system, a summary is printed out as follows:

```
Configuration summary
  + using PCRE library: /home/builder/build/pcre-8.32
  + using OpenSSL library: /home/builder/build/openssl-1.0.1c
  + md5: using OpenSSL library
  + sha1: using OpenSSL library
  + using system zlib library

  nginx path prefix: "/opt/nginx"
  nginx binary file: "/opt/nginx/sbin/nginx"
  nginx configuration prefix: "/opt/nginx/conf"
  nginx configuration file: "/opt/nginx/conf/nginx.conf"
  nginx pid file: "/opt/nginx/logs/nginx.pid"
  nginx error log file: "/opt/nginx/logs/error.log"
  nginx http access log file: "/opt/nginx/logs/access.log"
  nginx http client request body temporary files:
"/home/www/tmp/client_body_temp"
  nginx http proxy temporary files: "/home/www/tmp/proxy_temp"
  nginx http fastcgi temporary files: "/home/www/tmp/fastcgi_temp"
```

As you can see, `configure` found all the items we were looking for, and acknowledged our preferences for certain paths. Now, you can build your `nginx` and install it, as mentioned at the beginning of the chapter.

Summary

This chapter has introduced you to the various modules available for NGINX. By compiling your own binary, you are able to tailor what functionality your `nginx` will provide. Building and installing software will not be new to you, so not a lot of time was spent on creating a build environment or making sure that all dependencies were present. An NGINX installation should be one that fits your needs, so feel free to enable or disable modules as you see fit.

Next up we will present an overview of basic NGINX configuration, to get a feel for how to configure NGINX in general.

Chapter 2. A Configuration Guide

The NGINX configuration file follows a very logical format. Learning this format and how to use each section is one of the building blocks that will help you to create a configuration file by hand. This chapter will help you reach that goal by explaining the following topics:

- Basic configuration format
- NGINX global configuration parameters
- Using `include` files
- The HTTP server section
- The virtual server section
- Locations – where, when, and how
- The mail server section
- Full sample configuration

The basic configuration format

The basic NGINX configuration file is set up in a number of sections. Each section is delineated in the following way:

```
<section> {

    <directive> <parameters>;

}
```

It is important to note that each directive line ends with a semicolon (`;`). This marks the end-of-line. The curly braces (`{}`) actually denote a new configuration context, but we will read these as "sections" for the most part.

NGINX global configuration parameters

The global section is used to configure the parameters that affect the entire server, and is an exception to the format shown in the preceding section. The global section may include configuration directives, such as `user` and `worker_processes`, as well as sections, such as events. There are no open and closing braces (`{}`) surrounding the global section.

The most important configuration directives in the global context are shown in the following table. These will be the ones that you will be dealing with for the most part.

Table: Global configuration directives

Directive	Explanation
`user`	The user and group under which the worker processes run is configured using this parameter. If the group is omitted, a group name equal to that of the user is used.
`worker_processes`	This is the number of worker processes that will be started. These will handle all connections made by the clients. Choosing the right number depends on the server environment, the disk subsystem, and the network infrastructure. A good rule of thumb is to set this equal to the number of processor cores for CPU-bound loads and to multiply this number by `1.5` to `2` for I/O bound loads.
`error_log`	`error_log` is where all errors are written. If no other `error_log` is given in a separate context, this log file will be used for all errors, globally. A second parameter to this directive indicates the level at which (`debug`, `info`, `notice`, `warn`, `error`, `crit`, `alert`, and `emerg`) errors are written to the log. Note that debug-level errors are only available if the --with-debug configuration switch is given at compilation time.
`pid`	This is the file where the process ID of the main process is written, overwriting the compiled-in default.

`use`	The `use` directive indicates which connection processing method should be used. This will overwrite the compiled-in default, and must be contained in an `events` context, if used. It will not normally need to be overridden, except when the compiled-in default is found to produce errors over time.
`worker_connections`	This directive configures the maximum number of simultaneous connections that a worker process may have open. This includes, but is not limited to, client connections and connections to upstream servers. This is especially important on reverse proxy servers – some additional tuning may be required at the operating system level in order to reach this number of simultaneous connections.

Here is a short example using each of these directives:

```
# we want nginx to run as user 'www'
user www;

# the load is CPU-bound and we have 12 cores
worker_processes  12;

# explicitly specifying the path to the mandatory error log
error_log  /var/log/nginx/error.log;

# also explicitly specifying the path to the pid file
pid        /var/run/nginx.pid;

# sets up a new configuration context for the 'events' module
events {

    # we're on a Solaris-based system and have determined that
nginx
    # will stop responding to new requests over time with the
default
    # connection-processing mechanism, so we switch to the second-
best
    use /dev/poll;
    # the product of this number and the number of worker_processes
    # indicates how many simultaneous connections per IP:port pair
are
    # accepted
    worker_connections  2048;

}
```

This section would be placed at the top of the `nginx.conf` configuration file.

Using include files

Include files can be used anywhere in your configuration file, to help it be more readable and to enable you to re-use parts of your configuration. To use them, make sure that the files themselves contain the syntactically correct NGINX configuration directives and blocks; then specify a path to those files:

```
include /opt/local/etc/nginx/mime.types;
```

A wildcard may appear in the path to match multiple files:

```
include /opt/local/etc/nginx/vhost/*.conf;
```

If the full path is not given, NGINX will search relative to its main configuration file.

A configuration file can be easily tested by calling NGINX as follows:

```
nginx -t -c <path-to-nginx.conf>
```

This will test the configuration including all the files separated out into include files, for syntax errors.

The HTTP server section

The HTTP server section, or HTTP configuration context, is available unless you have built NGINX without the HTTP module (`--without-http`). This section controls all the aspects of working with the HTTP module, and will probably be the one that you will use the most.

The configuration directives found in this section deal with handling HTTP connections. As such, there are quite a number of directives defined by this module We will divide these directives up by type, to be able to talk about them more easily.

Client directives

This set of directives deals with the aspects of the client connection itself, as well as with different types of clients.

Table: HTTP client directives

Directive	**Explanation**
`chunked_transfer_encoding`	Allows disabling the standard HTTP/1.1 chunked transfer encoding in responses to clients.
`client_body_buffer_size`	Used to set a buffer size for the client request body larger than the default two memory pages, in order to prevent temporary files from being written to the disk.
`client_body_in_file_only`	Used for debugging or further processing of the client request body. This directive can be set to `on` to force save the client request body to a file.
`client_body_in_single_buffer`	This directive forces NGINX to save the entire client request body in a single buffer, to reduce copy operations.
`client_body_temp_path`	Defines a directory path for saving the client request

	body.
client_body_timeout	Specifies the length of time between successive read operations of the client body.
client_header_buffer_size	Used for specifying a buffer size for the client request header, when this needs to be larger than the default 1 KB.
client_header_timeout	This timeout is the length of time for reading the entire client header.
client_max_body_size	Defines the largest allowable client request body, before a 413 (Request Entity Too Large) error is returned to the browser.
keepalive_disable	Disables the keep-alive requests for certain browser types.
keepalive_requests	Defines how many requests may be made over one keep-alive connection before it is closed.
keepalive_timeout	Specifies how long a keep-alive connection will stay open. A second parameter may be given, to set a "Keep-Alive" header in the response.
large_client_header_buffers	Defines the maximum number and size of a large client request header.
msie_padding	Enables the disabling of adding comments to responses with a status greater than 400 for MSIE clients, in order to pad the response size to 512 bytes.
msie_refresh	Enables the sending of a refresh instead of a redirect for

	MSIE clients.

File I/O directives

These directives control how NGINX delivers static files and/or how it manages file descriptors.

Table: HTTP file I/O directives

Directive	Explanation
`aio`	Enables the use of asynchronous file I/O. It is available on all the modern versions of FreeBSD and distributions of Linux. On FreeBSD, `aio` may be used to preload data for `sendfile`. Under Linux, `directio` is required, which automatically disables `sendfile`.
`directio`	Enables the operating system specific flag or function for serving files larger than the given parameter. It's required when using `aio` on Linux.
`directio_alignment`	Sets the alignment for `directio`. The default of `512` is usually enough, although it's recommended to increase this to 4 K when using XFS on Linux.
`open_file_cache`	Configures a cache that can store open file descriptors, directory lookups, and file lookup errors.
`open_file_cache_errors`	Enables the caching of file lookup errors by `open_file_cache`.
`open_file_cache_min_uses`	Configures the minimum number of uses for a file within the inactive parameter to `open_file_cache` for the file descriptor to remain open in the cache.

open_file_cache_valid	Specifies the time interval between validity checks for items in open_file_cache.
postpone_output	Specifies the minimum size of data for NGINX to send to the client. If possible, no data will be sent until this value is reached.
read_ahead	If possible, the kernel will preread files up to the size parameter. It's supported on current FreeBSD and Linux (the size parameter is ignored on Linux).
sendfile	Enables using sendfile(2) to directly copy the data from one file descriptor to another.
sendfile_max_chunk	Sets the maximum size of data to copy in one sendfile(2) call, to prevent a worker from seizing.

Hash directives

The set of hash directives controls how large a range of static memory NGINX allocates to certain variables. NGINX will calculate the minimum size needed on startup and reconfiguration. You will most likely only need to adjust one of the *_hash_max_size parameters by setting the appropriate directive when NGINX emits a warning to that effect. The *_hash_bucket_size variables are set by default to a multiple of the processor's cache line size to minimize lookups needed to retrieve the entry, and therefore should not normally be changed. See http://nginx.org/en/docs/hash.html for additional details.

Table: HTTP hash directives

Directive	**Explanation**
server_names_hash_bucket_size	It specifies the bucket size used to hold the server_name hash tables.

server_names_hash_max_size	It specifies the maximum size of the server_name hash tables.
types_hash_bucket_size	It specifies the bucket size used to hold the types hash tables.
types_hash_max_size	It specifies the maximum size of the types hash tables.
variables_hash_bucket_size	It specifies the bucket size used to hold the remaining variables.
variables_hash_max_size	It specifies the maximum size of the hash that holds the remaining variables.

Socket directives

These directives describe how NGINX can set various options on the TCP sockets it creates.

Table: HTTP socket directives

Directive	Explanation
lingering_close	It specifies how a client connection will be kept open for more data.
lingering_time	In connection with the lingering_close directive, this directive will specify how long a client connection will be kept open for processing more data.
	Also in conjunction with lingering_close, this directive

lingering_timeout	indicates how long NGINX will wait for additional data before closing the client connection.
reset_timedout_connection	With this directive enabled, connections that have been timed out will immediately be reset, freeing all associated memory. The default is to leave the socket in the FIN_WAIT1 state, which will always be the case for keep-alive connections.
send_lowat	If non-zero, NGINX will try to minimize the number of send operations on client sockets. It is ignored on Linux, Solaris, and Windows.
send_timeout	Sets a timeout between two successive write operations for a client receiving a response.
tcp_nodelay	Enables or disables the TCP_NODELAY option for keep-alive connections.
tcp_nopush	Relevant only when sendfile is used. It enables NGINX to attempt to send response headers in one packet, as well as sending a file in full packets.

Sample configuration

The following is an example of an HTTP configuration section:

```
http {
    include       /opt/local/etc/nginx/mime.types;
    default_type  application/octet-stream;
    sendfile on;
    tcp_nopush on;
    tcp_nodelay on;
    keepalive_timeout  65;
    server_names_hash_max_size 1024;
}
```

This context block would go after any global configuration directives in the `nginx.conf` file.

The virtual server section

Any context beginning with the keyword `server` is considered a "virtual server" section. It describes a logical separation of a set of resources that will be delivered under a different `server_name` directive. These virtual servers respond to HTTP requests, and so are contained within the `http` section.

A virtual server is defined by a combination of the `listen` and `server_name` directives. `listen` defines an IP address/port combination or path to a UNIX-domain socket:

```
listen address[:port];
listen port;
listen unix:path;
```

The `listen` directive uniquely identifies a socket binding under NGINX. There are also a number of optional parameters that `listen` can take:

Table: listen parameters

Parameter	Explanation	Comment
`default_server`	Defines `this address:port` combination as being the default for the requests bound here.	
`setfib`	Sets the corresponding FIB for the listening socket.	Only supported on FreeBSD. Not for UNIX-domain sockets.
`backlog`	Sets the backlog parameter in the `listen()` call.	Defaults to `-1` on FreeBSD and `511` on all other platforms.
`rcvbuf`	Sets the `SO_RCVBUF` parameter on the listening socket.	
`sndbuf`	Sets the `SO_SNDBUF` parameter on the listening socket.	

accept_filter	Sets the name of the accept filter to either dataready or httpready.	Only supported on FreeBSD.
deferred	Sets the TCP_DEFER_ACCEPT option to use a deferred accept() call.	Only supported on Linux.
bind	Make a separate bind() call for this address:port pair.	A separate bind() call will be made implicitly if any of the other socket-specific parameters are used.
ipv6only	Sets the value of the IPV6_V6ONLY parameter.	Can only be set on a fresh start. Not for UNIX-domain sockets.
ssl	Indicates that only HTTPS connections will be made on this port.	Allows for a more compact configuration.
so_keepalive	Configures the TCP keepalive for the listening socket.	

The server_name directive is fairly straightforward, but can be used to solve a number of configuration problems. Its default value is "", which means that a server section without a server_name directive will match a request that has no Host header field set. This can be used, for example, to drop requests that lack this header:

```
server {
    listen 80;
    return 444;
}
```

The non-standard HTTP code, 444, used in this example will cause NGINX to immediately close the connection.

Besides a normal string, NGINX will accept a wildcard as a parameter to the `server_name` directive:

- The wildcard can replace the subdomain part: `*.example.com`
- The wildcard can replace the top-level-domain part: `www.example.*`
- A special form will match the subdomain or the domain itself: `.example.com` (matches `*.example.com` as well as `example.com`)

A regular expression can also be used as a parameter to `server_name` by prepending the name with a tilde (`~`):

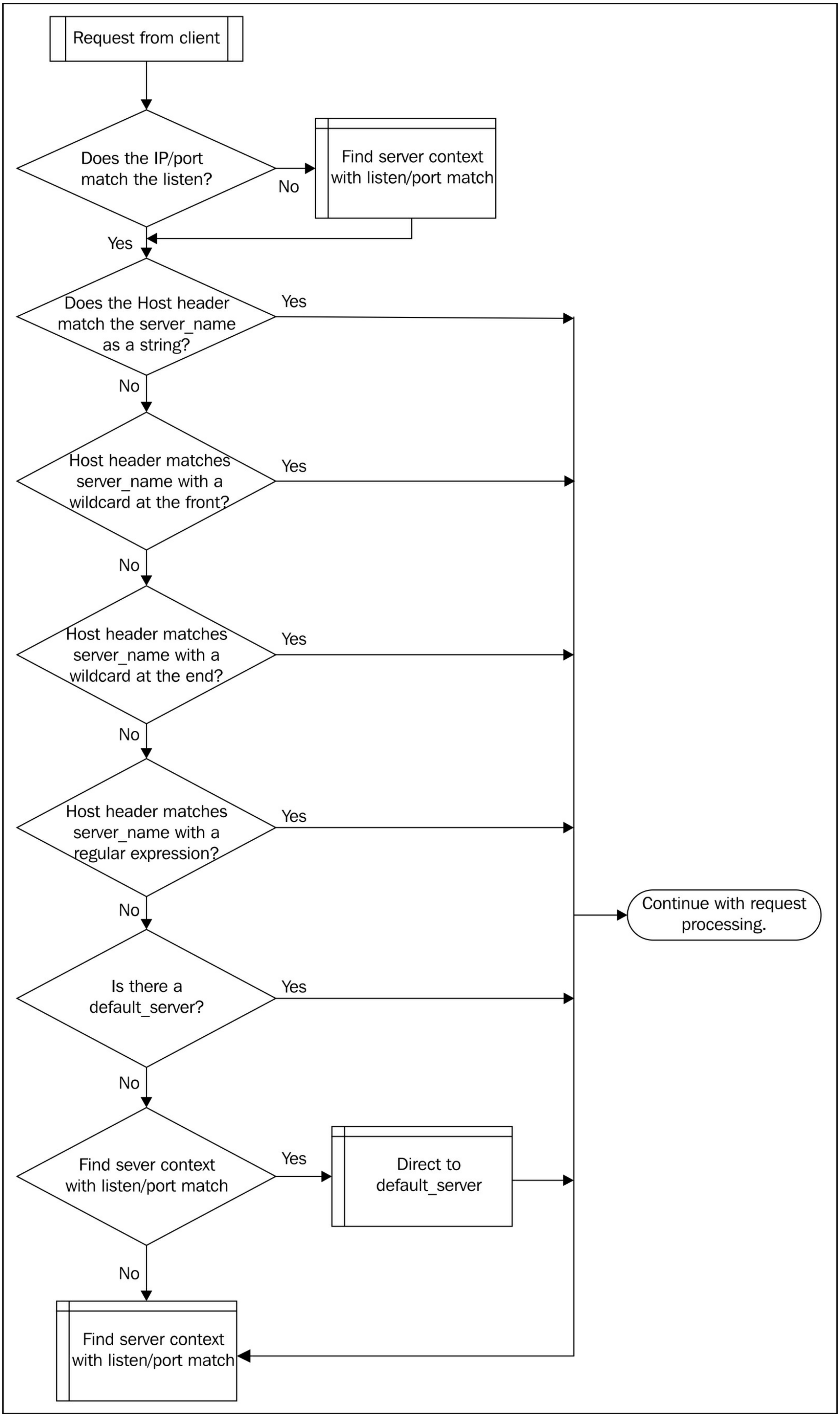
```
server_name ~^www\.example\.com$;
server_name ~^www(\d+).example\.(com)$;
```

The latter form is an example using captures, which can later be referenced (as `$1`, `$2`, and so on) in further configuration directives.

NGINX uses the following logic when determining which virtual server should serve a specific request:

1. Match the IP address and port to the `listen` directive.
2. Match the `Host` header field against the `server_name` directive as a string.
3. Match the `Host` header field against the `server_name` directive with a wildcard at the beginning of the string.
4. Match the `Host` header field against the `server_name` directive with a wildcard at the end of the string.
5. Match the `Host` header field against the `server_name` directive as a regular expression.
6. If all the `Host` headers match `fail`, then direct to the `listen` directive marked as `default_server`.
7. If all the `Host` headers match `fail` and there is no `default_server`, direct to the first server with a `listen` directive that satisfies step 1.

This logic is expressed in the following flowchart:


Request from client
Does the IP/port match the listen?
No
Find server context with listen/port match
Yes
Does the Host header match the server_name as a string?
Yes
No
Host header matches server_name with a wildcard at the front?
Yes
No
Host header matches server_name with a wildcard at the end?
Yes
No
Host header matches server_name with a regular expression?
Yes
No
Continue with request processing.
Is there a default_server?
Yes
No
Find sever context with listen/port match
Yes
Direct to default_server
No
Find server context with listen/port match

`default_server` can be used to handle requests that would otherwise go unhandled. It is therefore recommended to always set `default_server` explicitly, so that these unhandled requests will be handled in a defined manner.

Besides this usage, `default_server` may also be helpful in configuring a number of virtual servers with the same `listen` directive. Any directives set here will be the same for all matching server blocks.

Locations – where, when, and how

The `location` directive may be used within a virtual server section and indicates a URI that comes either from the client or from an internal redirect. Locations may be nested with a few exceptions. They are used for processing requests with as specific a configuration as possible.

A location is defined as follows:

```
location [modifier] uri {...}
```

Or for a named location:

```
location @name {…}
```

A named location is only reachable from an internal redirect. It preserves the URI as it was before entering the location block. It may only be defined at the server context level.

The modifiers affect processing of a location in the following way:

Table: Location modifiers

Modifier	Handling
`=`	Use exact match and terminate search.
`~`	Case-sensitive regular expression matching.
`~*`	Case-insensitive regular expression matching.
`^~`	Stops processing before regular expressions are checked for a match of this location's string, if it's the most specific match. Note that this is not a regular expression match – its purpose is to preempt regular expression matching.

When a request comes in, the URI is checked against the most specific location as follows:

- Locations without a regular expression are searched for the most-specific match, independent of the order in which they are defined.
- Regular expressions are matched in the order in which they are found in the configuration file. The regular expression search is terminated on the first match. The most-specific location match is then used for request processing.

The comparison match described here is against decoded URIs; for example, a `"%20"` in a URI will match against a `" "` (space) specified in a location.

A named location may only be used by internally redirected requests.

The following directives are found only within a location:

Table: Location-only directives

Directive	Explanation
`alias`	Defines another name for the location, as found on the filesystem. If the location is specified with a regular expression, `alias` should reference captures defined in that regular expression. `alias` replaces the part of the URI matched by the location, such that the rest of the URI not matched will be searched for in that filesystem location. Using the `alias` directive is fragile when moving bits of the configuration around, so using the `root` directive is preferred, unless the URI needs to be modified in order to find the file.
`internal`	Specifies a location that can only be used for internal requests (redirects defined in other directives, rewrite requests, error pages, and so on.)
`limit_except`	Limits a location to the specified HTTP verb(s) (`GET` also includes `HEAD`).

Additionally, a number of directives found in the `http` section may also be specified in a location. See Appendix A, *Directive Reference*, for a complete list.

The `try_files` directive deserves a special mention here. It may also be used in a server context, but will most often be found in a location. `try_files` will do just that—try files in the order given as parameters; the first match wins. It is often used to match potential files from a variable, then pass processing to a named location, as shown in the following example:

```
location / {

    try_files $uri $uri/ @mongrel;

}
location @mongrel {
    proxy_pass http://appserver;

}
```

Here, an implicit directory index is tried if the given URI is not found as a file, then processing is passed on to `appserver` via a proxy. We will explore how best to use `location`, `try_files`, and `proxy_pass` to solve specific problems throughout the rest of the book.

Locations may be nested except when:

- The prefix is "`=`"
- The location is a named location

Best practice dictates that regular expression locations be nested inside string-based locations. An example of this is as follows:

```
# first, we enter through the root
location / {

    # then we find a most-specific substring
    # note that this is not a regular expression
    location ^~ /css {

        # here is the regular expression that then gets matched
        location ~* /css/.*\.css$ {

        }

    }

}
```

The mail server section

The mail server section, or mail configuration context, is available only if you've built NGINX with the mail module (`--with-mail`). This section controls all aspects of working with the mail module.

The mail module allows for configuration directives that affect all aspects of proxying mail connections, as well as for specifying them per server. The server context also accepts the `listen` and `server_name` directives that we saw under the `http` server section.

NGINX can proxy the IMAP, POP3, and SMTP protocols. The following table lists the directives that are available to this module:

Table: Mail module directives

Directive	Explanation
`auth_http`	Specifies the server used for authenticating the POP3/IMAP user. The functionality of this server will be discussed in detail in Chapter 3.
`imap_capabilities`	Indicates which IMAP4 capabilities are supported by the backend server.
`pop3_capabilities`	Indicates which POP3 capabilities are supported by the backend server.
`protocol`	Indicates which protocol is supported by this virtual server context.
`proxy`	This directive will simply enable or disable mail proxying.
`proxy_buffer`	This directive allows setting the size of the buffer used for the proxy connection beyond the default of one page.

proxy_pass_error_message	Useful in situations where the backend authentication process emits a useful error message to the client.
proxy_timeout	If a timeout beyond the default of 24 hours is required, this directive can be used.
xclient	The SMTP protocol allows checking based on IP/HELO/LOGIN parameters, which are passed via the XCLIENT command. This directive enables NGINX to communicate this information.

If NGINX was compiled with SSL support (--with-mail_ssl_module), the following directives will be available in addition to the previous ones:

Table: Mail SSL directives

Directive	**Explanation**
ssl	Indicates if this context should support SSL transactions.
ssl_certificate	It specifies the path to the PEM-encoded SSL certificate(s) for this virtual server.
ssl_certificate_key	It specifies the path to the PEM-encoded SSL secret key for this virtual server.
ssl_ciphers	It specifies the ciphers that should be supported in this virtual server context (OpenSSL format).
ssl_prefer_server_ciphers	Indicates that SSLv3 and TLSv1 server ciphers are preferred over the client's ciphers.

ssl_protocols	Indicates which SSL protocols should be enabled.
ssl_session_cache	Specifies an SSL cache, and whether or not it should be shared among all worker processes.
ssl_session_timeout	How long the client can use the same SSL parameters, provided they are stored in the cache.

Full sample configuration

What follows is a sample configuration file including the different sections discussed in this chapter. Please note that this should not be copy-pasted and used as is. It will most likely not fit your needs. It is shown here only to give an idea of the structure of a complete configuration file.

```
user www;

worker_processes 12;

error_log /var/log/nginx/error.log;

pid /var/run/nginx.pid;

events {

    use /dev/poll;

    worker_connections  2048;

}
http {

    include        /opt/local/etc/nginx/mime.types;

    default_type  application/octet-stream;

    sendfile on;

    tcp_nopush on;

    tcp_nodelay on;

    keepalive_timeout  65;

    server_names_hash_max_size 1024;

    server {

        listen 80;

        return 444;

    }

    server {

        listen 80;

        server_name www.example.com;

        location / {
```

```
            try_files $uri $uri/ @mongrel;
        }
        location @mongrel {
            proxy_pass http://127.0.0.1:8080;
        }
    }
}
```

Summary

In this chapter, we have seen how the NGINX configuration file is built. Its modular nature is a reflection, in part, of the modularity of NGINX itself. A global configuration block is responsible for all aspects that affect the running of NGINX as a whole. There is a separate configuration section for each protocol that NGINX is responsible for handling. We may further define how each request is to be handled by specifying servers within those protocol configuration contexts (either `http` or `mail`), so that requests are routed to a specific IP address/port. Within the `http` context, locations are then used to match the URI of the request. These locations may be nested or otherwise ordered to ensure that requests get routed to the right areas of the filesystem or application server.

What we did not cover in this chapter are the configuration options provided by the various modules that may be compiled into your `nginx` binary. These additional directives will be touched upon throughout the book, as that particular module is used to solve a problem. Also absent was an explanation of the variables that NGINX makes available for its configuration. These too will be discussed later in this book. This chapter's focus was on the basics of configuring NGINX.

In the next chapter, we will explore configuring NGINX's mail module, to enable mail proxying.

Chapter 3. Using the Mail Module

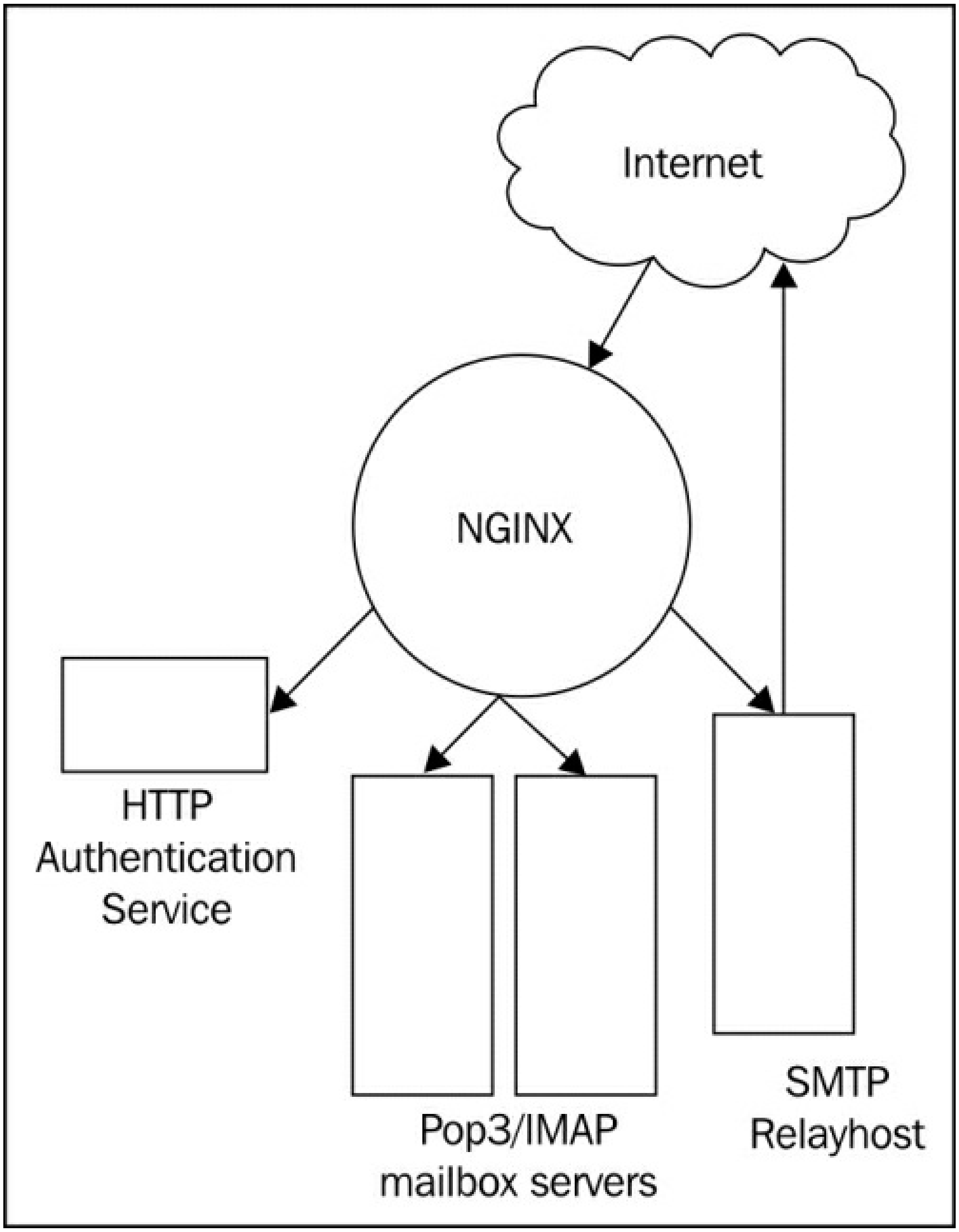
NGINX was designed to not only serve web traffic, but also to provide a means of proxying mail services. In this chapter you will learn how to configure NGINX as a mail proxy for POP3, IMAP, and SMTP services. We will examine running NGINX as a mail proxy server in the following sections:

- Basic proxy service
- Authentication service
- Combining with memcached
- Interpreting log files
- Operating system limits

Basic proxy service

The NGINX mail proxy module was originally developed for FastMail. They had a need to provide a single IMAP endpoint for their users, while hosting the actual mail account on one of a number of upstream mail servers. Typical proxying programs of the time used the classic Unix forking model, which meant that a new process was forked for each connection. IMAP has very long-lived connections, which means that these processes would stay around for a very long time. This would then lead to very sluggish proxy servers, as they would have to manage these processes for the lifetime of each connection. NGINX's event-based process model was a better fit for this type of service. As a mail proxy, NGINX is able to direct traffic to any number of mailbox servers where the actual mail account is hosted. This provides the ability to communicate one endpoint to customers, while scaling the number of mailbox servers up with the number of users. Both commercial and open-source mail solutions, such as Atmail and Zimbra, are built around this model.

The following diagram will help visualize how this works:



An incoming request will be handled on a per-protocol basis. The mail proxy module may be configured differently for POP3, IMAP, or SMTP. For each protocol, NGINX queries an authentication service with the username and password. If the authentication is successful, the connection is proxied to the mail server indicated in the response from the authentication service. If the authentication was unsuccessful, the client connection is terminated. The authentication service thus determines which clients can use POP3 / IMAP / SMTP services and which mail server they may use. As any number of mail servers may be handled in this way, NGINX can provide a proxy service for all of them through one central gateway.

A proxy acts on behalf of someone or something else. In this case, NGINX is acting on behalf of the mail client, terminating the connection and opening a new one to the upstream server. This means that there is no direct communication between the mail client and the actual mailbox server or SMTP relay host.

Note

If there are any mail rules based on information contained in the client connection, these rules will not work, unless the mail software is able to support an extension, such as XCLIENT for SMTP.

This is an important point in designing an architecture that contains a proxy server—the proxy host will need to be able to support more connections than a typical upstream server. Not as much processing power or memory as a mailbox server would be needed, but the number of persistent connections needs to be taken into account.

POP3 service

The **Post Office Protocol** is an Internet standard protocol used to retrieve mail messages from a mailbox server. The current incarnation of the protocol is Version 3, thus **POP3** . Mail clients will typically retrieve all new messages on a mailbox server in one session, then close the connection. After closing, the mailbox server will delete all messages that have been marked as retrieved.

In order for NGINX to act as a POP3 proxy, some basic directives need to be configured:

```
mail {
  auth_http  localhost:9000/auth;

  server {
    listen  110;
    protocol  pop3;
    proxy  on;
  }
}
```

This configuration snippet enables the mail module and configures it for POP3 service, querying an authentication service running on port 9000 on the same machine. NGINX will listen on port 110 on all local IP addresses, providing a POP3 proxy service. You will notice that we do not configure the actual mail servers here—it is the job of the authentication service to tell NGINX which server a particular client should be connected to.

If your mail server only supports certain capabilities (or you only want to advertise certain capabilities), NGINX is flexible enough to announce these:

```
mail {
  pop3_capabilities    TOP USER;
}
```

Capabilities are a way of advertising support for optional commands. For POP3, the client can request the supported capabilities before or after authentication, so it is important to configure these correctly in NGINX.

You may also specify which authentication methods are supported:

```
mail {
  pop3_auth    apop cram-md5;
}
```

If the APOP authentication method is supported, the authentication service needs to provide NGINX with the user's password in clear text, so that it can generate the MD5 digest.

IMAP service

The **Internet Message Access Protocol** is also an Internet-standard protocol used to retrieve mail messages from a mailbox server. It provides quite a bit of extended functionality over the earlier POP protocol. Typical usage leaves all messages on the server, so that multiple mail clients can access the same mailbox. This also means that there may be many more, persistent connections to an upstream mailbox server from clients using IMAP than those using POP3.

To proxy IMAP connections, a configuration similar to the POP3 NGINX snippet used before can be used:

```
mail {
  auth_http  localhost:9000/auth;

  imap_capabilities    IMAP4rev1 UIDPLUS QUOTA;
  imap_auth    login cram-md5;

  server {
    listen 143;
    protocol imap;
    proxy on;
  }
}
```

Note that we did not need to specify the `protocol`, as `imap` is the default value. It is included here for clarity.

The `imap_capabilities` and `imap_auth` directives function similarly to their POP3 counterparts.

SMTP service

The **Simple Mail Transport Protocol** is the Internet-standard protocol for transferring mail messages from one server to another or from a client to a server. Although authentication was not at first conceived for this protocol, SMTP-AUTH is supported as an extension.

As you have seen, the logic of configuring the `mail` module is fairly straightforward. This holds for SMTP proxying as well:

```
mail {
  auth_http  localhost:9000/auth;

  smtp_capabilities  PIPELINING 8BITMIME DSN;
  smtp_auth    login cram-md5;

  server {
    listen 25;
    protocol smtp;
    proxy on;
  }
}
```

Our proxy server will only advertise the `smtp_capabilities` that we set, otherwise it will only list which authentication mechanisms it accepts, because the list of extensions is sent to the client when it sends the `HELO`/`EHLO` command. This may be useful when proxying to multiple SMTP servers, each having different capabilities. You could configure NGINX to list only the capabilities that all of these servers have in common. It is important to set these to only the extensions that the SMTP server itself supports.

Due to SMTP-AUTH being an extension to SMTP, and not necessarily supported in every configuration, NGINX is capable of proxying an SMTP connection that does no authentication whatsoever. In this case, only the `HELO`, `MAIL FROM`, and `RCPT TO` parts of the protocol are available to the authentication service for determining which upstream should be chosen for a given client connection. For this setup, ensure that the `smtp_auth` directive is set to `none`.

Using SSL/TLS

If your organization requires mail traffic to be encrypted, or if you yourself want more security in your mail transfers, you can enable NGINX to use TLS to provide POP3 over SSL, IMAP over SSL, or SMTP over SSL. To enable TLS support, either set the `starttls` directive to `on` for STLS/STARTTLS support or set the `ssl` directive to `on` for pure SSL/TLS support and configure the appropriate `ssl_*` directives for your site:

```
mail {
  # allow STLS for POP3 and STARTTLS for IMAP and SMTP
  starttls    on;
  # prefer the server's list of ciphers, so that we may determine
security
  ssl_prefer_server_ciphers  on;
  # use only these protocols
     ssl_protocols    TLSv1 SSLv3;
  # use only high encryption cipher suites, excluding those
  #   using anonymous DH and MD5, sorted by strength
     ssl_ciphers    HIGH:!ADH:!MD5:@STRENGTH;
  # use a shared SSL session cache, so that all workers can
  #   use the same cache
  ssl_session_cache    shared:MAIL:10m;
  # certificate and key for this host
  ssl_certificate      /usr/local/etc/nginx/mail.example.com.crt;
  ssl_certificate_key  /usr/local/etc/nginx/mail.example.com.key;
}
```

See https://www.fastmail.fm/help/technology_ssl_vs_tls_starttls.html for a description of the differences between a pure SSL/TLS connection and upgrading a plain connection to an encrypted one with SSL/TLS.

Tip

Using OpenSSL to generate an SSL certificate

If you have never generated an SSL certificate before, the following steps will help you create one:

Create a certificate request:

```
$ openssl req -newkey rsa:2048 -nodes -out mail.example.com.csr
-keyout mail.example.com.key
```

Tip

This should generate the following output:

```
Generating a 2048 bit RSA private key
..................................................................
.......................................................+++
....................+++
writing new private key to 'mail.example.com.key'
-----
You are about to be asked to enter information that will be
incorporated
into your certificate request.
What you are about to enter is what is called a Distinguished
Name or a DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter '.', the field will be left blank.
-----
Country Name (2 letter code) [AU]:CH
State or Province Name (full name) [Some-State]:Zurich
Locality Name (eg, city) []:ZH
Organization Name (eg, company) [Internet Widgits Pty
Ltd]:Example Company
Organizational Unit Name (eg, section) []:
Common Name (e.g. server FQDN or YOUR name) []:mail.example.com
Email Address []:
Please enter the following 'extra' attributes
to be sent with your certificate request
A challenge password []:
An optional company name []:
```

You can get this Certificate Signing Request (mail.example.com.csr) signed by a Certificate Authority such as Verisign or GoDaddy, or you can sign it yourself:

```
$ openssl x509 -req -days 365 -in mail.example.com.csr -signkey
mail.example.com.key -out mail.example.com.crt
```

You will see the following response:

```
Signature ok
subject=/C=CH/ST=Zurich/L=ZH/O=Example
Company/CN=mail.example.com
Getting Private key
```

Tip

The signed certificate is shown in the following screenshot.

Please note, though, that a self-signed certificate will generate an error in a client that connects to your server. If you are deploying this certificate on a production server, make sure that you get it signed by a recognized authority.

```
-----BEGIN CERTIFICATE-----
MIIDPDCCAiQCCQDdPKFcY1X35jANBgkqhkiG9w0BAQUFADBgMQswCQYDVQQGEwJD
SDEPMA0GA1UECAwGWnVyaWNoMQswCQYDVQQHDAJaSDEYMBYGA1UECgwPRXhhbXBs
ZSBDb21wYW55MRkwFwYDVQQDDBBtYWlsLmV4YW1wbGUuY29tMB4XDTEyMDgzMTE0
MjczMloXDTEzMDgzMTE0MjczMlowYDELMAkGA1UEBhMCQ0gxDzANBgNVBAgMBlp1
cmljaDELMAkGA1UEBwwCWkgxGDAWBgNVBAoMD0V4YW1wbGUgQ29tcGFueTEZMBcG
A1UEAwwQbWFpbC5leGFtcGxlLmNvbTCCASIwDQYJKoZIhvcNAQEBBQADggEPADCC
AQoCggEBAN8WUGzQIKR+iuTxtLPko/zSR+DbjDYqbMo4PdNvEN46nTFMkktvOsIk
1kfk9l2jzVcmUUSZayLp3woDgxRpkpQ5eRpB7yeifsZwPJlXfVPTgfXtQkktfPVn
uz0Mf7Ogd2Xt8uI6n0At0DAr8+CxebIpRwIwZBXPrWwFFjQvy4/qD7EXs33+x5U8
9CMxkGo2FPqCSYE39jN3JtIZ9YibnZh01NALHRvnqyw3mdzR34Omu5WNFjl/NElp
MOyFL7+5wzI4ktgmAo+Mic6JnXC0bSjrL1xZjWfn/5TQiYQVzUit4jd1CswWtCHw
tv67TRQ3edgvssvzfZlm7QfBbdYGjkUCAwEAATANBgkqhkiG9w0BAQUFAAOCAQEA
TDfdngMRk2w/1KCGbxrg9bVmfKXUSIfpWyt0hGO2EtLx83TZajqwtOKhmPh9Q/lc
GZdF1PGscdJ2Bc0eJBUGyt6mevEi2Dg4h727yVvnacnViQvzyLxQgmeC5rDEj4EC
yDzzi4n0I/rddjPeQ0+cMFHz26scsKYoRemzp0yHT8JhK8AF2iOioLzwaMqxC+ll
U7lkinHdTaG6nT4WpH05HtSBno8Xco/ujY6xIrShiPOnaOd/B4TRCmB96KYhyMdd
Ayr0ZgLqsskKeAlnmuSJA/7zbp1LwHarvUVFpzKed73554lfJ5kpy0ciHrIfyj/2
dM/tjsDVjpE2B/meYBx8Kg==
-----END CERTIFICATE-----
```


Complete mail example

Mail services are often combined on one gateway. The following configuration will enable NGINX to service POP3, IMAP, and SMTP traffic (as well as their encrypted variants) from one authentication service, while offering clients the option to use STLS/STARTTLS on unencrypted ports:

```
events {
    worker_connections 1024;
}

mail {
     server_name  mail.example.com;
     auth_http  localhost:9000/auth;

     proxy on;


     ssl_prefer_server_ciphers on;
     ssl_protocols    TLSv1 SSLv3;
     ssl_ciphers      HIGH:!ADH:!MD5:@STRENGTH;
     ssl_session_cache   shared:MAIL:10m;
     ssl_certificate   /usr/local/etc/nginx/mail.example.com.crt;
     ssl_certificate_key
/usr/local/etc/nginx/mail.example.com.key;

     pop3_capabilities   TOP USER;
     imap_capabilities   IMAP4rev1 UIDPLUS QUOTA;
     smtp_capabilities   PIPELINING 8BITMIME DSN;

     pop3_auth    apop cram-md5;
     imap_auth    login cram-md5;
     smtp_auth    login cram-md5;
```

```
        server {
           listen 25;
           protocol smtp;
           timeout 120000;
           }
        server {
           listen 465;
           protocol smtp;
           ssl on;
           }
        server {
           listen 587;
           protocol smtp;
           starttls on;
           }
        server {
           listen 110;
           protocol pop3;
           starttls on;
           }
        server {
           listen 995;
           protocol pop3;
           ssl on;
           }
        server {
           listen 143;
           protocol imap;
           starttls on;
           }
        server {
           listen 993;
           protocol imap;
           ssl on;
           }
}
```

As you can see, we declared the name of this server at the top of the `mail` context. This is because we want each of our mail services to be addressed as `mail.example.com`. Even if the actual hostname of the machine on which NGINX runs is different, and each mail server has its own hostname, we want this proxy to be a single point of reference for our users. This hostname will in turn be used wherever NGINX needs to present its own name, for example, in the initial SMTP server greeting.

The `timeout` directive was used in the `smtp server` context in order to double its default value because we knew this particular upstream SMTP relay host inserted an artificial delay in order to dissuade spammers from trying to send mail via this server.

Authentication service

We have mentioned the authentication service quite a few times in the previous section, but what exactly is the authentication service and what does it do? When a user makes a POP3, IMAP, or SMTP request to NGINX, authenticating the connection is one of the first steps. NGINX does not perform this authentication itself, but rather makes a query to an authentication service that will fulfill the request. NGINX then uses the response from the authentication service to make the connection to the upstream mail server.

This authentication service may be written in any language. It need only conform to the authentication protocol required by NGINX. The protocol is similar to HTTP, so it will be fairly easy for us to write our own authentication service.

NGINX will send the following headers in its request to the authentication service:

- Host
- Auth-Method
- Auth-User
- Auth-Pass
- Auth-Salt
- Auth-Protocol
- Auth-Login-Attempt
- Client-IP
- Client-Host
- Auth-SMTP-Helo
- Auth-SMTP-From
- Auth-SMTP-To

The meaning of each of these headers should be fairly self-explanatory, and not each header will be present in every request. We will go over these as we write our authentication service.

We choose Ruby as the language for this authentication service implementation. If you do not currently have Ruby installed, don't worry about doing so now. Ruby as a language is very clear to read, so just try to follow along with the commented code below. Adapting it to your environment and running it is outside the scope of this book. This example will give you a good starting point in writing your own authentication service.

> **Note**
>
> A good resource to help you get Ruby installed easily is located at https://rvm.io.

Let us first examine the request part of the HTTP request/response dialogue.

We first collect the values we need from the headers NGINX sends:

```
        # the authentication mechanism
        meth = @env['HTTP_AUTH_METHOD']
        # the username (login)
        user = @env['HTTP_AUTH_USER']
        # the password, either in the clear or encrypted, depending
    on the
        #  authentication mechanism used
        pass = @env['HTTP_AUTH_PASS']
        # need the salt to encrypt the cleartext password, used for
    some
        #  authentication mechanisms, not in our example
        salt = @env['HTTP_AUTH_SALT']
        # this is the protocol being proxied
        proto = @env['HTTP_AUTH_PROTOCOL']
        # the number of attempts needs to be an integer
        attempt = @env['HTTP_AUTH_LOGIN_ATTEMPT'].to_i
        # not used in our implementation, but these are here for
    reference
        client = @env['HTTP_CLIENT_IP']
        host = @env['HTTP_CLIENT_HOST']
```

Tip

What are all these @'s about?

The `@` symbol is used in Ruby to denote a class variable. We'll use them in our example to make it easier to pass around variables. In the preceding snippet, we are referencing the environment `(@env)` as passed into the Rack request. Besides all the HTTP headers that we need, the environment contains additional information relating to how the service is being run.

Now that we know how to handle each of the headers NGINX may send, we need to do something with them and send NGINX a response. The following headers are expected in the response from the authentication service:

- `Auth-Status`: In this header, anything but `OK` is an error
- `Auth-Server`: This is the IP address to which the connection is proxied
- `Auth-Port`: This is the port to which the connection is proxied
- `Auth-User`: This is the user that will be used to authenticate with the mail server
- `Auth-Pass`: The plaintext password used for APOP
- `Auth-Wait`: How many seconds to wait before another authentication attempt is made
- `Auth-Error-Code`: An alternative error code to return to the client

The three headers used most often are `Auth-Status`, `Auth-Server`, and `Auth-Port`. The presence of these in a response is typically all that is needed for a successful authentication session.

As we will see in the following snippet, additional headers may be used, depending on the situation. The response itself consists of simply emitting the relevant headers with the appropriate values substituted in.

We first check if there have been too many tries:

```
        # fail if more than the maximum login attempts are tried
        if attempt > @max_attempts
          @res["Auth-Status"] = "Maximum login attempts exceeded"
          return
        end
```

Then we return the appropriate headers and set with the values obtained from our authentication mechanism:

```
          @res["Auth-Status"] = "OK"
          @res["Auth-Server"] = @mailhost
          # return the correct port for this protocol
          @res["Auth-Port"] = MailAuth::Port[proto]
          # if we're using APOP, we need to return the password in
  cleartext
          if meth == 'apop' && proto == 'pop3'
            @res["Auth-User"] = user
            @res["Auth-Pass"] = pass
          end
```

If the authentication check has failed, we need to tell NGINX.

```
          # if authentication was unsuccessful, we return an
  appropriate response
          @res["Auth-Status"] = "Invalid login or password"
          # and set the wait time in seconds before the client may
  make
          # another authentication attempt
          @res["Auth-Wait"] = "3"
          # we can also set the error code to be returned to the SMTP
  client
          @res["Auth-Error-Code"] = "535 5.7.8"
```

Not every header is required in the response, but as we can see, some are dependent on the status of the authentication query and/or any error condition that may exist.

Note

One interesting use of the `Auth-User` header is to return a different username than the one given in the request. This can prove useful, for example, when migrating from an older upstream mail server that accepted a username without the domain to a newer upstream mail server that requires the username to have a domain. NGINX will then use this username when connecting to the upstream server.

The authentication database may take any form, from a flat text file, to an LDAP directory, to a relational database. It does not have to necessarily be the same store that your mail service uses to access this information, but should be in sync with that store to prevent any errors due to stale data.

Our example authentication database is a simple hash for this example:

```
@auths = { "test:1234" => '127.0.1.1' }
```

The mechanism used to verify a user is a simple hash lookup:

```
      # this simply returns the value looked-up by the 'user:pass'
key
      if @auths.key?("#{user}:#{pass}")
        @mailhost = @auths["#{user}:#{pass}"]
        return true
      #  if there is no such key, the method returns false
      else
        return false
      end
```

Tying these three parts together, we have the complete authentication service:

```
#!/usr/bin/env rackup

# This is a basic HTTP server, conforming to the authentication
protocol
#  required by NGINX's mail module.
#
require 'logger'
require 'rack'

module MailAuth

  # setup a protocol-to-port mapping
  Port = {
    'smtp' => '25',
    'pop3' => '110',
    'imap' => '143'
  }

  class Handler

    def initialize
      # setup logging, as a mail service
      @log = Logger.new("| logger -p mail.info")
      # replacing the normal timestamp by the service name and pid
      @log.datetime_format = "nginx_mail_proxy_auth pid: "
      # the "Auth-Server" header must be an IP address
      @mailhost = '127.0.0.1'
      # set a maximum number of login attempts
      @max_attempts = 3
      # our authentication 'database' will just be a fixed hash
for# this example
      # it should be replaced by a method to connect to LDAP or a #
database
      @auths = { "test:1234" => '127.0.1.1' }
    end
```

After the preceding setup and module initialization, we tell Rack which requests we would like to have handled and define a `get` method to respond to requests from NGINX.

```
    def call(env)
      # our headers are contained in the environment
      @env = env
      # set up the request and response objects
      @req = Rack::Request.new(env)
      @res = Rack::Response.new
      # pass control to the method named after the HTTP verb
      #  with which we're called
      self.send(@req.request_method.downcase)
      # come back here to finish the response when done
      @res.finish
    end

    def get
      # the authentication mechanism
      meth = @env['HTTP_AUTH_METHOD']
      # the username (login)
```

```
      user = @env['HTTP_AUTH_USER']
      # the password, either in the clear or encrypted, depending
on
      # the authentication mechanism used
      pass = @env['HTTP_AUTH_PASS']
      # need the salt to encrypt the cleartext password, used for
some
      #  authentication mechanisms, not in our example
      salt = @env['HTTP_AUTH_SALT']
      # this is the protocol being proxied
      proto = @env['HTTP_AUTH_PROTOCOL']
      # the number of attempts needs to be an integer
      attempt = @env['HTTP_AUTH_LOGIN_ATTEMPT'].to_i
      # not used in our implementation, but these are here
forreference
      client = @env['HTTP_CLIENT_IP']
      host = @env['HTTP_CLIENT_HOST']

      # fail if more than the maximum login attempts are tried
      if attempt > @max_attempts
        @res["Auth-Status"] = "Maximum login attempts exceeded"
        return
      end

      # for the special case where no authentication is done
      #  on smtp transactions, the following is in nginx.conf:
      #     smtp_auth   none;
      # may want to setup a lookup table to steer certain senders
      #  to particular SMTP servers
      if meth == 'none' && proto == 'smtp'
        helo = @env['HTTP_AUTH_SMTP_HELO']
        # want to get just the address from these two here
        from = @env['HTTP_AUTH_SMTP_FROM'].split(/: /)[1]
        to = @env['HTTP_AUTH_SMTP_TO'].split(/: /)[1]
        @res["Auth-Status"] = "OK"
        @res["Auth-Server"] = @mailhost
        # return the correct port for this protocol
        @res["Auth-Port"] = MailAuth::Port[proto]
        @log.info("a mail from #{from} on #{helo} for #{to}")
      # try to authenticate using the headers provided
      elsif auth(user, pass)
        @res["Auth-Status"] = "OK"
        @res["Auth-Server"] = @mailhost
        # return the correct port for this protocol
        @res["Auth-Port"] = MailAuth::Port[proto]
        # if we're using APOP, we need to return the password in
cleartext
        if meth == 'apop' && proto == 'pop3'
          @res["Auth-User"] = user
          @res["Auth-Pass"] = pass
        end
        @log.info("+ #{user} from #{client}")
      # the authentication attempt has failed
      else
        # if authentication was unsuccessful, we return an
appropriate response
        @res["Auth-Status"] = "Invalid login or password"
        # and set the wait time in seconds before the client may
```

```
make
        # another authentication attempt
        @res["Auth-Wait"] = "3"
        # we can also set the error code to be returned to the
SMTPclient
        @res["Auth-Error-Code"] = "535 5.7.8"
        @log.info("! #{user} from #{client}")
      end

    end
```

The next section is declared `private` so that only this class may use the methods declared afterwards. The `auth` method is the workhorse of the authentication service, checking the username and password for validity. The `method_missing` method is there to handle invalid methods, responding with a `Not Found` error message:

```
    private

    # our authentication method, adapt to fit your environment
    def auth(user, pass)
      # this simply returns the value looked-up by the 'user:pass'
key
      if @auths.key?("#{user}:#{pass}")
        @mailhost = @auths["#{user}:#{pass}"]
        return @mailhost
      #  if there is no such key, the method returns false
      else
        return false
      end
    end

    # just in case some other process tries to access the service
    #  and sends something other than a GET
    def method_missing(env)
      @res.status = 404
    end

  end # class MailAuthHandler
end # module MailAuth
```

This last section sets up the server to run and routes the `/auth` URI to the proper handler:

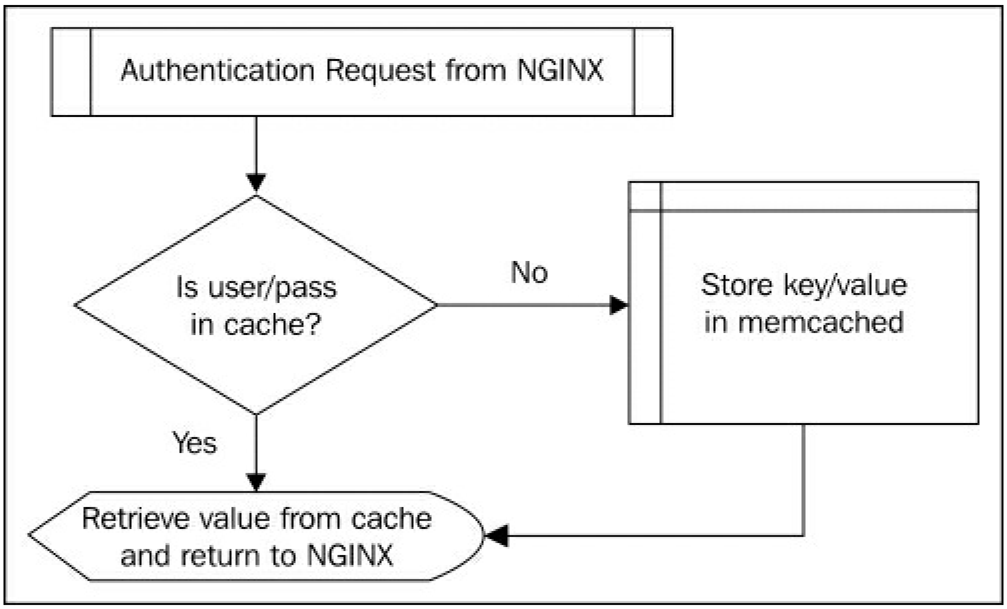
```
# setup Rack middleware
use Rack::ShowStatus
# map the /auth URI to our authentication handler
map "/auth" do
  run MailAuth::Handler.new
end
```

This listing may be saved as a file, `nginx_mail_proxy_auth.ru`, and called with a `-p <port>` parameter to tell it on which port it should run. For more options and more information about the Rack web server interface, visit http://rack.github.com.

Combining with memcached

Depending on the frequency of clients accessing the mail services on your proxy and how many resources are available to the authentication service, you may want to introduce a caching layer into the setup. To this end, we will integrate `memcached` as an in-memory store for authentication information.

NGINX can look up a key in `memcached`, but only in the context of a location in the `http` module. Therefore, we will have to implement our own caching layer outside of NGINX.



As the flowchart shows, we will first check whether or not this username/password combination is already in the cache. If not, we will query our authentication store for the information and place the key/value pair into the cache. If it is, we can retrieve this information directly from the cache.

Note

Zimbra has created a `memcache` module for NGINX that takes care of this directly within the context of NGINX. To date, though, this code has not been integrated into the official NGINX sources.

The following code will extend our original authentication service by implementing a caching layer (admittedly, a little overkill for our implementation, but this is to provide a basis for working with a networked authentication database):

```
# gem install memcached (depends on libsasl2 and gettext libraries)
require 'memcached'

# set this to the IP address/port where you have memcached running
@cache = Memcached.new("localhost:11211")

def get_cache_value(user, pass)
  resp = ''
  begin
    # first, let's see if our key is already in the cache
    resp = @cache.get("#{user}:#{pass}")
  rescue Memcached::NotFound
    # it's not in the cache, so let's call the auth method
    resp = auth(user, pass)
    # and now store the response in the cache, keyed on 'user:pass'
    @cache.set("#{user}:#{pass}",resp)
  end
  # explicitly returning the response to the caller
  return resp
end
```

In order to use this code, you will of course have to install and run `memcached`. There should be a pre-built package for your operating system:

- Linux (deb-based)

  ```
  sudo apt-get install memcached
  ```

- Linux (rpm-based)

  ```
  sudo yum install memcached
  ```

- FreeBSD

  ```
  sudo pkg_add -r memcached
  ```

Memcached is configured simply by passing parameters to the binary when running it. There is no configuration file that is read directly, although your operating system and/or packaging manager may provide a file that is parsed to make passing these parameters easier.

The most important parameters for `memcached` are as follows:

- `-l`: This parameter specifies the address(es) on which `memcached` will listen (default is all). It is important to note that for the greatest security, `memcached` shouldn't listen on an address that is reachable from the Internet because there is no authentication.
- `-m`: This parameter specifies the amount of RAM to use for the cache (in megabytes).
- `-c`: This parameter specifies the maximum number of simultaneous connections (default is 1024).

- `-p`: This parameter specifies the port on which `memcached` will listen (default is 11211).

Setting these to reasonable values will be all you need to do to get `memcached` up and running.

Now, by substituting the `elsif auth(user, pass)` with `elsif get_cache_value(user, pass)` in our `nginx_mail_proxy_auth.ru` service, you should have an authentication service running with a caching layer, to help serve as many requests as quickly as possible.

Interpreting log files

Log files provide some of the best clues as to what is going on when a system doesn't act as expected. Depending on the verbosity level configured and whether or not NGINX was compiled with debugging support (`--enable-debug`), the log files will help you understand what is going on in a particular session.

Each line in the error log corresponds to a particular log level, configured using the `error_log` directive. The different levels are `debug`, `info`, `notice`, `warn`, `error`, `crit`, `alert`, and `emerg`, in order of increasing severity. Configuring a particular level will include messages for all of the more severe levels above it. The default log level is `error`.

In the context of the `mail` module, we would typically want to configure a log level of `info`, so that we can get as much information about a particular session as possible without having to configure debug logging. Debug logging in this case would be useful only for following function entry points, or seeing what password was used for a particular connection.

Note

Since mail is extremely dependent upon a correctly-functioning DNS, many errors can be traced back to invalid DNS entries or expired cache information. If you believe you may have a case that could be explained by a name resolution error, you can get NGINX to tell you what IP address a particular hostname is resolved to by configuring debug logging. Unfortunately, this requires a recompile if your `nginx` binary was not initially compiled with debugging support.

A typical proxy connection is logged as in the following example of a POP3 session.

First, the client establishes a connection to the proxy:

```
<timestamp> [info] <worker pid>#0: *<connection id> client <ip
address> connected to 0.0.0.0:110
```

Then, once the client has completed a successful login, a statement listing all relevant connection information is logged:

```
<timestamp> [info] <worker pid>#0: *<connection id> client logged
in, client: <ip address>, server: 0.0.0.0:110, login: "<username>",
upstream: <upstream ip>:<upstream port>, [<client ip>:<client
port>-<local ip>:110] <=> [<local ip:<high port>-<upstream ip>:
<upstream port>]
```

You will notice that the section before the double arrows `<=>` relates to the client-to-proxy side of the connection, whereas the section after the double arrows describes the proxy-to-upstream part of the connection. This information is again repeated once the session is terminated:

```
<timestamp> [info] <worker pid>#0: *<connection id> proxied session
done, client: <ip address>, server: 0.0.0.0:110, login: "
<username>", upstream: <upstream ip>:<upstream port>, [<client ip>:
<client port>-<local ip>:110] <=> [<local ip:<high port>-<upstream
ip>:<upstream port>]
```

In this way, we see which ports are in use on all sides of the connection, to help debug any potential problems or to perhaps correlate the log entry with what may appear in a firewall log.

Other log entries at the `info` level pertain to timeouts or invalid commands/responses sent by either the client or upstream.

Entries at the `warn` log level are typically configuration errors:

```
<timestamp> [warn] <worker pid>#0: *<connection id> "starttls"
directive conflicts with "ssl on"
```

Many errors that are reported at the `error` log level are indicative of problems with the authentication service. You will notice the text `while in http auth state` in the following entries. This shows where in the connection state the error has occurred:

```
<timestamp> [error] <worker pid>#0: *<connection id> auth http
server 127.0.0.1:9000 timed out while in http auth state, client:
<client ip>, server: 0.0.0.0:25
<timestamp> [error] <worker pid>#0: *<connection id> auth http
server 127.0.0.1:9000 sent invalid response while in http auth
state, client: <client ip>, server: 0.0.0.0:25
```

If the authentication query is not successfully answered for any reason, the connection is terminated. NGINX doesn't know to which upstream the client should be proxied, and thereby closes the connection with an `Internal server error` with the protocol-specific response code.

Depending on whether or not the username is present, the information will appear in the log file. Here's an entry from an authenticated SMTP connection:

```
<timestamp> [error] <worker pid>#0: *<connection id> auth http
server 127.0.0.1:9000 did not send server or port while in http
auth state, client: <client ip>, server: 0.0.0.0:25, login: "
<login>"
```

Note the previous two entries are missing in the `login` information.

An `alert` log level event will indicate that NGINX was not able to set a parameter as expected, but will otherwise operate normally.

Any log entry at the `emerg` level, however, will prevent NGINX from starting: either the situation has to be corrected or the configuration must be changed. If NGINX is already running, it will not restart any worker process until the change has been made:

```
<timestamp> [error] <worker pid>#0: *<connection id> no "http_auth"
is defined for server in /opt/nginx/conf/nginx.conf:32
```

Here we need to define an authentication service using the `http_auth` directive.

Operating system limits

You may run into a situation in which NGINX does not perform as you expect. Either connections are being dropped or warning messages are printed in the log file. This is when it is important to know what limits your operating system may place on NGINX and how to tune them to get the best performance out of your server.

The area in which a mail proxy is most likely to run into problems is a connection limit. To understand what this means, you first have to know how NGINX handles client connections. The NGINX master process starts a number of workers, each of which runs as a separate process. Each process is able to handle a fixed number of connections, set by the `worker_connections` directive. For each proxied connection, NGINX opens a new connection to the mail server. Each of these connections requires a file descriptor and per mail server IP/port combination, a new TCP port from the ephemeral port range (see the following explanation).

Depending on your operating system, the maximum number of open file descriptors is tunable in a resource file or by sending a signal to a resource-management daemon. You can see what the current value is set to by entering the following command at the prompt:

```
ulimit -n
```

If by your calculations, this limit is too low, or you see a message in your error log that `worker_connections exceed open file resource limit`, you'll know that you need to increase this value. First tune the maximum number of open file descriptors at the operating system level, either for just the user that NGINX runs as or globally. Then, set the `worker_rlimit_nofile` directive to the new value in the main context of the `nginx.conf` file. Sending `nginx` a configuration reload signal (HUP) will then be enough to raise this limit without restarting the main process.

If you observe a connection limit due to exhaustion of available TCP ports, you will need to increase the ephemeral port range. This is the range of TCP ports which your operating system maintains for outgoing connections. It can default to as few as 5000, but is typically set to a range of 16384 ports. A good description of how to increase this range for various operating systems is provided at http://www.ncftp.com/ncftpd/doc/misc/ephemeral_ports.html.

Summary

In this chapter, we have seen how NGINX can be configured to proxy POP3, IMAP, and SMTP connections. Each protocol may be configured separately, announcing support for various capabilities in the upstream server. Encrypting mail traffic is possible by using TLS and providing the server with an appropriate SSL certificate.

The authentication service is fundamental to the functioning of the `mail` module, as no proxying can be done without it. We have detailed an example of such an authentication service, outlining the requirements of both what is expected in the request and how the response should be formed. With this as a foundation, you should be able to write an authentication service that fits your environment.

Understanding how to interpret log files is one of the most useful skills a system administrator can develop. NGINX gives fairly detailed log entries, although some may be a bit cryptic. Knowing where to place the various entries within the context of a single connection and seeing the state NGINX is in at that time is helpful to deciphering the entry.

NGINX, like any other piece of software, runs within the context of an operating system. It is therefore extremely useful to know how to increase any limits the OS may place on NGINX. If it is not possible to increase the limits any further, then an architectural solution must be found by either multiplying the number of servers on which NGINX runs, or using some other technique to reduce the number of connections a single instance must handle.

In the next chapter, we see how to configure NGINX to proxy HTTP connections.

Chapter 4. NGINX as a Reverse Proxy

A **reverse proxy** is a web server that terminates connections with clients and makes new ones to upstream servers on their behalf. An **upstream server** is defined as a server that NGINX makes a connection with in order to fulfill the client's request. These upstream servers can take various forms, and NGINX can be configured differently to handle each of them.

NGINX configuration, which you have been learning about in detail, can be difficult to understand at times. There are different directives that may be used to fulfill similar configuration needs. Some of these options should not really be used, as they can lead to unexpected results.

At times, an upstream server may not be able to fulfill a request. NGINX has the capability to deliver an error message to the client, either directly from this upstream server, from its local disk, or as a redirect to a page on a completely different server.

Due to the nature of a reverse proxy, the upstream server doesn't obtain information directly from the client. Some of this information, such as the client's real IP address, is important for debugging purposes, as well as tracking requests. This information may be passed to the upstream server in the form of headers.

We will cover these topics, as well as an overview of some proxy module directives, in the following sections:

- Introduction to reverse proxying
- Types of upstream servers
- Converting an "if"-fy configuration to a more modern interpretation
- Using error documents to handle upstream problems
- Determining the client's real IP address

Introduction to reverse proxying

NGINX can serve as a reverse proxy by terminating requests from clients and opening new ones to its upstream servers. On the way, the request can be split up according to its URI, client parameters, or some other logic, in order to best respond to the request from the client. Any part of the request's original URL can be transformed on its way through the reverse proxy.

The most important directive when proxying to an upstream server is the `proxy_pass` directive. This directive takes one parameter—the URL to which the request should be transferred. Using `proxy_pass` with a URI part will replace the `request_uri` with this part.

For example, `/uri` in the following example will be transformed to `/newuri` when the request is passed on to the upstream:

```
location /uri {

  proxy_pass http://localhost:8080/newuri;
}
```

There are two exceptions to this rule, however. First, if the location is defined with a regular expression, no transformation of the URI occurs. In this example, the URI `/local` will be passed directly to the upstream, and not be transformed to `/foreign` as intended:

```
location ~ ^/local {

  proxy_pass http://localhost:8080/foreign;
}
```

The second exception is that if within the location a rewrite rule changes the URI, and then NGINX uses this URI to process the request, no transformation occurs. In this example, the URI passed to the upstream will be `/index.php?page=<match>`, with `<match>` being whatever was captured in the parentheses, and not `/index`, as indicated by the URI part of the `proxy_pass` directive:

```
location / {

  rewrite /(.*)$ /index.php?page=$1 break;

  proxy_pass http://localhost:8080/index;
}
```

Tip

The `break` flag to the rewrite directive is used here to immediately stop all processing of rewrite module directives.

In both of these cases, the URI part of the `proxy_pass` directive is not relevant, so the configuration would be complete without it:

```
location ~ ^/local {

  proxy_pass http://localhost:8080;
}

location / {

  rewrite /(.*)$ /index.php?page=$1 break;

  proxy_pass http://localhost:8080;
}
```

The proxy module

The following table summarizes some of the commonly used directives in the proxy module:

Table: Proxy module directives

Directive	Explanation
`proxy_connect_timeout`	The maximum amount of time NGINX will wait for its connection to be accepted when making a request to an upstream server.
`proxy_cookie_domain`	Replaces the domain attribute of the `Set-Cookie` header from the upstream server; the domain to be replaced can either be a string or a regular expression, or reference a variable.
`proxy_cookie_path`	Replaces the `path` attribute of the `Set-Cookie` header from the upstream server; the path to be replaced can either be a string or a regular expression, or reference a variable.
`proxy_headers_hash_bucket_size`	The maximum size of header names.
`proxy_headers_hash_max_size`	The total size of headers received from the upstream server.

proxy_hide_header	A list of header fields that should not be passed on to the client.
proxy_http_version	The HTTP protocol version used to communicate with upstream servers (use 1.1 for keepalive connections).
proxy_ignore_client_abort	If set to on, NGINX will not abort the connection to an upstream server if the client aborts the connection.
proxy_ignore_headers	Sets which headers can be disregarded when processing the response from the upstream server.
proxy_intercept_errors	If enabled, NGINX will display a configured error_page error instead of the response directly from the upstream server.
proxy_max_temp_file_size	The maximum size of the overflow file, written when the response doesn't fit into memory buffers.
proxy_pass	Specifies the upstream server to which the request is passed, in the form of a URL.
proxy_pass_header	Overrides the disabled headers set in proxy_hide_header, allowing them to be sent to the client.
proxy_pass_request_body	Prevents sending the body of the request to the upstream server if set to off.
proxy_pass_request_headers	Prevents sending the headers of the request to the upstream server if set to off.

proxy_read_timeout	Specifies the length of time that needs to elapse between two successive read operations from an upstream server, before the connection is closed. Should be set to a higher value if the upstream server processes requests slowly.
proxy_redirect	Rewrites the Location and Refresh headers received from the upstream servers; useful for working around assumptions made by an application framework.
proxy_send_timeout	The length of time that needs to elapse between two successive write operations to an upstream server, before the connection is closed.
proxy_set_body	The body of a request sent to an upstream server may be altered by setting this directive.
proxy_set_header	Rewrites the contents of headers sent to an upstream server; may also be used to not send certain headers by setting its value to the empty string.
proxy_temp_file_write_size	Limits the amount of data buffered to a temporary file at one time, so that NGINX will not block too long on a single request.
proxy_temp_path	A directory where temporary files may be buffered as they are proxied from the upstream server, optionally multi-level deep.

The following listing brings many of these directives together in a file that can be included in the configuration within the same location as the proxy_pass directive.

Contents of proxy.conf:

```
proxy_redirect  off;

proxy_set_header Host      $host;

proxy_set_header X-Real-IP    $remote_addr;

proxy_set_header X-Forwarded-For  $proxy_add_x_forwarded_for;

client_max_body_size   10m;

client_body_buffer_size  128k;
proxy_connect_timeout   30;

proxy_send_timeout     15;

proxy_read_timeout     15;

proxy_send_lowat     12000;

proxy_buffer_size      4k;

proxy_buffers       4 32k;

proxy_busy_buffers_size   64k;

proxy_temp_file_write_size    64k;
```

We are setting a number of common directives to values that we think would be useful for reverse-proxying scenarios:

- The `proxy_redirect` directive has been set to `off` because there is no need to rewrite the `Location` header in most situations.
- The `Host` header is set so the upstream server can map the request to a virtual server or otherwise make use of the host portion of the URL the user entered.
- The `X-Real-IP` and `X-Forwarded-For` headers serve similar purposes—to relay the information about the connecting client's IP address to the upstream server.
    - The `$remote_addr` variable used in the `X-Real-IP` header is the IP address of the client as NGINX perceives it.
    - The `$proxy_add_x_forwarded_for` variable contains the contents of the `X-Forwarded-For` header field from the client's request, followed by the `$remote_addr` variable.
- The `client_max_body_size` directive, while not strictly a proxy module directive, is mentioned here because of its relevance to proxy configurations. If this value is set too low, uploaded files will not make it to the upstream server. When setting this directive, keep in mind that files uploaded via a web form will usually have a larger file size than that shown in the filesystem.
- The `proxy_connect_timeout` directive indicates how long NGINX will wait when establishing initial contact with the upstream server.

- The `proxy_read_timeout` and `proxy_send_timeout` directives define how long NGINX will wait between successive operations with the upstream server.
- The `proxy_send_lowat` directive is only effective on FreeBSD systems and specifies the number of bytes the socket send buffer should hold before passing the data on to the protocol.
- The `proxy_buffer_size`, `proxy_buffers`, and `proxy_busy_buffers_size` directives will be discussed in detail in the next chapter. Suffice it to say that these buffers control how quickly NGINX appears to respond to user requests.
- The `proxy_temp_file_write_size` directive controls how long a worker process blocks while spooling data: the higher the value, the longer the process blocks.

These directives are included in a file as follows, and may be used multiple times in the same configuration:

```
location / {

  include proxy.conf;

  proxy_pass http://localhost:8080;
}
```

If one of these directives should have a different value than what's in the include file, then override it in that particular location.

```
location /uploads {

  include proxy.conf;

  client_max_body_size    500m;

  proxy_connect_timeout   75;

  proxy_send_timeout     90;

  proxy_read_timeout     90;

  proxy_pass http://localhost:8080;
}
```

> ### Tip
>
> The order is important here. If there is more than one occurrence of a directive in a configuration file (or include), NGINX will take the value of the directive defined last.

Legacy servers with cookies

You may find yourself in a situation where you will need to place multiple legacy applications behind one common endpoint. The legacy applications were written for a case where they were the only servers talking directly with the client. They set cookies from their own domain, and assumed that they would always be reachable via the `/` URI. In placing a new endpoint in front of these servers, these assumptions no longer hold true. The following configuration will rewrite the cookie domain and path to match that of the new application endpoint:

```
server {

  server_name app.example.com;

  location /legacy1 {

    proxy_cookie_domain legacy1.example.com app.example.com;

    proxy_cookie_path $uri /legacy1$uri;

    proxy_redirect default;

    proxy_pass http://legacy1.example.com/;
  }
```

Tip

The value of the `$uri` variable already includes the beginning slash (`/`), so it is not necessary to duplicate it here.

```
 location /legacy2 {

    proxy_cookie_domain legacy2.example.org app.example.com;

    proxy_cookie_path $uri /legacy2$uri;

    proxy_redirect default;

    proxy_pass http://legacy2.example.org/;

  }

  location / {

    proxy_pass http://localhost:8080;

  }
}
```

The upstream module

Closely paired with the `proxy` module is the `upstream` module. The `upstream` directive starts a new context, in which a group of upstream servers is defined. These servers may be given different weights (the higher the weight, the greater the number of connections NGINX will pass to that particular upstream server), may be of different types (TCP versus UNIX domain), and may even be marked as `down` for maintenance reasons.

The following table summarizes the directives valid within the upstream context:

Table: Upstream module directives

Directive	Explanation
`ip_hash`	Ensures the distribution of connecting clients evenly over all servers by hashing the IP address, keying on its class-C network.
`keepalive`	The number of connections to upstream servers that are cached per worker process. When used with HTTP connections, `proxy_http_version` should be set to `1.1` and `proxy_set_header` to `Connection ""`.
`least_conn`	Activates the load-balancing algorithm where the server with the least number of active connections is chosen for the next new connection.
`server`	Defines an address (domain name or IP address with an optional TCP port, or path to a UNIX-domain socket) and optional parameters for an upstream server. The parameters are: • `weight`: It sets the preference for one server over another • `max_fails`: It is the maximum number of unsuccessful communication attempts to a server within `fail_timeout` before the server is marked as `down` • `fail_timeout`: It is the length of time a server has to respond to a request and the length of time a server will be marked as down • `backup`: It will only receive requests once the other servers are down • `down`: It marks a server as not able to process requests

Keepalive connections

The keepalive directive deserves special mention. NGINX will keep this number of connections per worker open to an upstream server. This connection cache is useful in situations where NGINX has to constantly maintain a certain number of open connections to an upstream server. If the upstream server speaks HTTP, NGINX can use the HTTP/1.1 Persistent Connections mechanism for maintaining these open connections.

```
upstream apache {

  server 127.0.0.1:8080;

  keepalive 32;

}

location / {

  proxy_http_version 1.1;

  proxy_set_header  Connection "";

  proxy_pass http://apache;

}
```

Here, we've indicated that we'd like to hold open 32 connections to Apache running on port 8080 of the localhost. NGINX need only negotiate the TCP handshake for the initial 32 connections per worker, and will then keep these connections open by not sending a Connection header with the close token. With proxy_http_version, we specify that we'd like to speak HTTP/1.1 with the upstream server. We also clear the contents of the Connection header with proxy_set_header, so that we are not proxying the client connection properties directly.

If more than 32 connections are needed, NGINX will, of course, open them to satisfy requests. After this peak has passed, NGINX will close the least recently used connections, to bring the number back down to 32, as we indicated in the keepalive directive.

This mechanism can also be used to proxy non-HTTP connections, as well. In the following example, we show that NGINX maintains 64 connections to two instances of memcached:

```
upstream memcaches {

  server 10.0.100.10:11211;

  server 10.0.100.20:11211;

  keepalive 64;

}
```

If we were to switch load-balancing algorithms from the default round-robin to either `ip_hash` or `least_conn`, we would need to specify this before using the `keepalive` directive:

```
upstream apaches {
  least_conn;
  server 10.0.200.10:80;
  server 10.0.200.20:80;
  keepalive 32;
}
```

Load-balancing algorithms

The `upstream` module can select which upstream server to connect to in the next step by using one of three load-balancing algorithms—round-robin, IP hash, or least connections. The **round-robin** algorithm is selected by default, and doesn't need a configuration directive to activate it. This algorithm selects the next server, based on which server was selected previously, which server is next in the configuration block, and what weight each server carries. The round-robin algorithm tries to ensure a fair distribution of traffic, based on a concept of who's turn it is next.

The **IP hash** algorithm, activated by the `ip_hash` directive, instead takes the view that certain IP addresses should always be mapped to the same upstream server. NGINX does this by using the first three octets of an IPv4 address or the entire IPv6 address, as a hashing key. The same pool of IP addresses are therefore always mapped to the same upstream server. So, this mechanism isn't designed to ensure a fair distribution, but rather a consistent mapping between the client and upstream server.

The third load-balancing algorithm supported by the default upstream module**, least connections** , is activated by the `least_conn` directive. This algorithm is designed to distribute the load evenly among upstream servers, by selecting the one with the fewest number of active connections. If the upstream servers do not all have the same processing power, this can be indicated using the `weight` parameter to the `server` directive. The algorithm will take into account the differently-weighted servers when calculating the number of least connections.

Types of upstream servers

An upstream server is a server to which NGINX proxies a connection. This can be on a different physical or virtual machine, but doesn't have to be. The upstream server may be a daemon listening on a UNIX domain socket for connections on the local machine or could be one of many on a different machine listening over TCP. It may be an Apache server, with multiple modules to handle different kinds of requests, or a Rack middleware server, providing an HTTP interface to Ruby applications. NGINX can be configured to proxy to each of them.

Single upstream server

The Apache web server is used in common hosting scenarios to serve static files as well as multiple types of interpreted files. The extensive documentation and how-to's (found online) help users to get up-and-running quickly with their favorite CMS. Unfortunately, the typical Apache configuration, due to resource limits, is not able to handle many simultaneous requests. NGINX, though, is designed to handle this kind of traffic and performs very well with little resource consumption. Since most CMSs come pre-configured for Apache, integrating the use of `.htaccess` files for extended configuration, the easiest way to take advantage of NGINX's strengths is for NGINX to simply proxy connections to an Apache instance:

```
server {

 location / {

    proxy_pass http://localhost:8080;

  }

}
```

This is the most basic proxy configuration possible. NGINX will terminate all client connections, and then proxy all requests to the local host on TCP port 8080. We assume here that Apache has been configured to listen on `localhost:8080`.

A configuration such as this is typically extended so that NGINX will serve any static files directly, and then proxy the remaining requests to Apache:

```
server {

  location / {

    try_files $uri @apache;

  }

  location @apache {

    proxy_pass http://127.0.0.1:8080;

  }

}
```

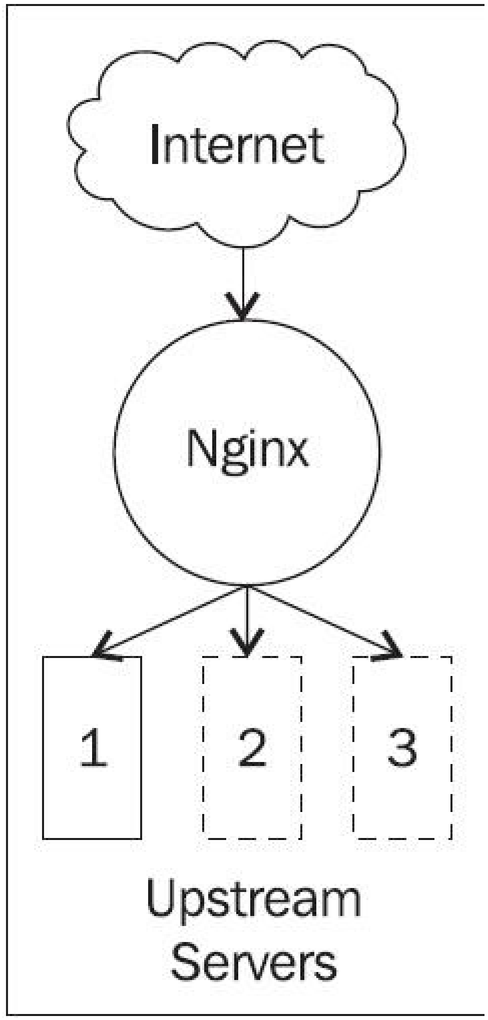
The `try_files` directive (included in the `http` core module) does just what its name implies—it tries files, in order, until it finds a match. So, in the preceding example, NGINX will deliver any files it finds in its root that match the URI given by the client. If it doesn't find any files, it will proxy the request to Apache for further processing. We use a named location here to proxy the request after an unsuccessful try to locate the file locally.

Multiple upstream servers

It is also possible to configure NGINX to pass the request to more than one upstream server. This is done by declaring an upstream context, defining multiple servers, and referencing the upstream in a `proxy_pass` directive:

```
upstream app {

  server 127.0.0.1:9000;

  server 127.0.0.1:9001;

  server 127.0.0.1:9002;

}
server {

  location / {

    proxy_pass http://app;

  }

}
```

Using this configuration, NGINX will pass consecutive requests in a round-robin fashion to the three upstream servers. This is useful when an application can handle only one request at a time, and you'd like NGINX to handle the client communication so that none of the application servers get overloaded. The configuration is illustrated in the following diagram:



Other load-balancing algorithms are available, as detailed in the *Load-balancing algorithms* section earlier in this chapter. Which one should be used in a particular configuration depends on the situation.

If a client should always get the same upstream server, to effect a poor-man's session-stickiness, the `ip_hash` directive should be used. When the distribution of requests leads to widely varying response times per request, the `least_conn` algorithm should be selected. The default round-robin algorithm is good for a general case where no special consideration of either the client or upstream server is required.

Non-HTTP upstream servers

So far, we've focused on communicating with upstream servers over HTTP. For this, we use the `proxy_pass` directive. As hinted at earlier in this chapter, in the *Keepalive connections* section, NGINX can proxy requests to a number of different kinds of upstream servers. Each has its corresponding *`_pass` directive.

Memcached upstream servers

The memcached NGINX module (enabled by default) is responsible for communicating with a memcached daemon. As such, there is no direct communication between the client and the memcached daemon; that is, NGINX does not act as a reverse-proxy in this sense. The memcached module enables NGINX to speak the memcached protocol, so that a key lookup can be done before a request is passed to an application server:

```
upstream memcaches {

  server 10.0.100.10:11211;

  server 10.0.100.20:11211;

}

server {

  location / {

    set $memcached_key "$uri?$args";

    memcached_pass memcaches;

    error_page 404 = @appserver;

  }
  location @appserver {

    proxy_pass http://127.0.0.1:8080;

  }

}
```

The memcached_pass directive uses the $memcached_key variable to make the key lookup. If there is no corresponding value (error_page 404), we pass the request on to localhost, where there is presumably a server running that will handle this request and insert a key/value pair into the memcached instance.

FastCGI upstream servers

Using a FastCGI server is a popular way to run PHP applications behind an NGINX server. The fastcgi module is compiled in by default, and is activated with the fastcgi_pass directive. This enables NGINX to speak the FastCGI protocol with one or more upstream servers. We define a set of FastCGI upstream servers as follows:

```
upstream fastcgis {

  server 10.0.200.10:9000;

  server 10.0.200.20:9000;

  server 10.0.200.30:9000;
}
```

And pass connections to them from the root location:

```
location / {

  fastcgi_pass fastcgis;
}
```

This is a very minimalist configuration to illustrate the basics of using FastCGI. The `fastcgi` module contains a number of directives and configuration possibilities, which we will discuss in Chapter 6, *The NGINX HTTP Server*.

SCGI upstream servers

NGINX can also speak the SCGI protocol by using its built-in `scgi` module. The principle is the same as for the `fastcgi` module. NGINX communicates with an upstream server indicated with the `scgi_pass` directive.

uWSGI upstream servers

The `uWSGI` protocol has been very popular with Python developers. NGINX provides support for connecting to a Python-based upstream server through its `uwsgi` module. The configuration is similar to the `fastcgi` module, using the `uwsgi_pass` directive instead to indicate an upstream server. An example configuration will be shown in Chapter 6, *The NGINX HTTP Server*.

Converting an "if"-fy configuration to a more modern interpretation

Using the `if` directive within a location is really only considered valid for certain cases. It may be used in combination with a return and with a rewrite with a `last` or `break` flag, but should generally be avoided in other situations. This is due in part to the fact that it can produce some very unexpected results. Consider the following example:

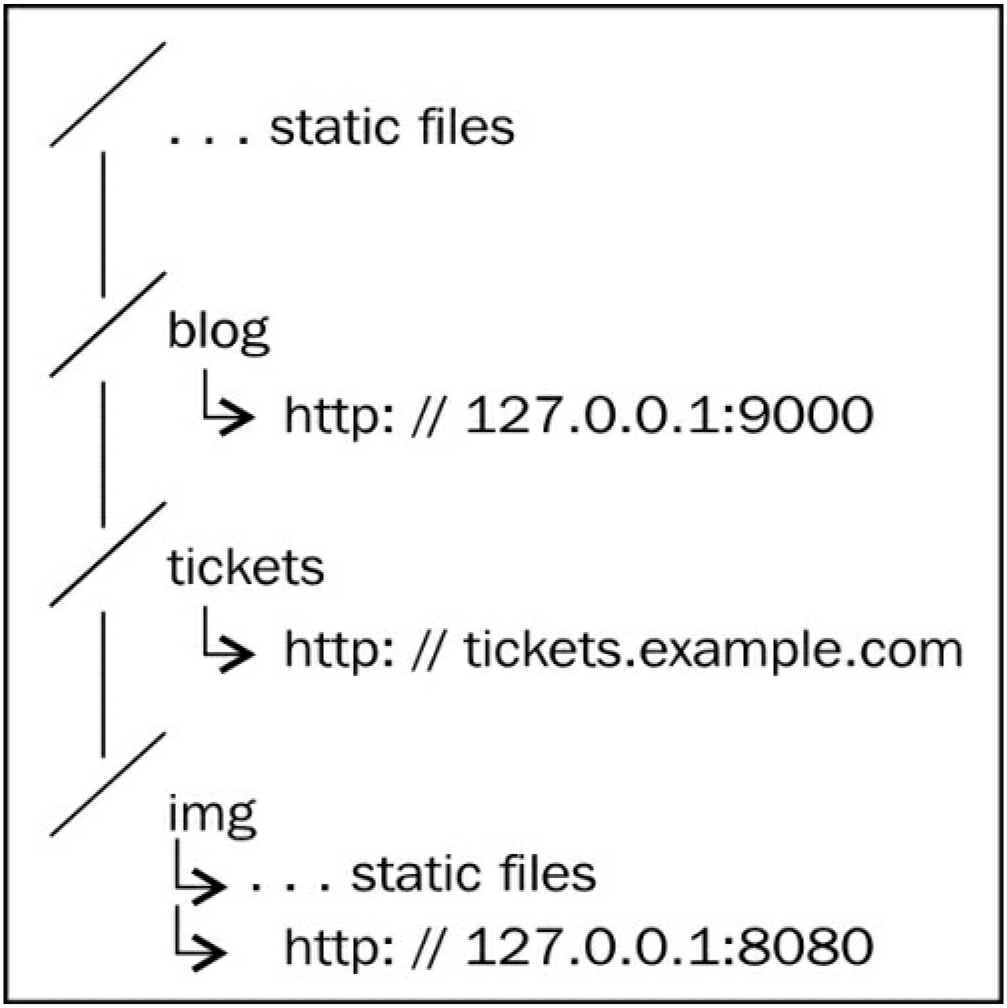
```
location / {

 try_files /img /static @imageserver;

 if ($request_uri ~ "/blog") {

  proxy_pass http://127.0.0.1:9000;

  break;

 }

 if ($request_uri ~ "/tickets") {

  proxy_pass http://tickets.example.com;

  break;
 }

}

location @imageserver {

  proxy_pass http://127.0.0.1:8080;
}
```

Here, we're trying to determine which upstream to pass the request to, based on the value of the `$request_uri` variable. This seems like a very reasonable configuration at first glance, because it works for our simple test cases. But the images will neither be served from the `/img` filesystem location, the `/static` filesystem location, nor from the `@imageserver` named location. `try_files` simply doesn't work when an `if` directive is present in the same location. `if` creates an implicit location with its own content handler; in this case, the `proxy` module. So the outer content handler, where `try_files` is registered, won't ever get invoked. There is a way to write this configuration differently to make it do what we want.

Let's think about our request as NGINX processes it. After having found a matching IP and port, it first selects a virtual host (server) based on the `Host` header. Then, it scans all locations under this server, looking for a matching URI. So, we see that the better way to configure a selector based on the URI is in fact by defining multiple locations, as shown in the following example:

```
location /blog {

  proxy_pass http://127.0.0.1:9000;

}

location /tickets {

  proxy_pass http://tickets.example.com;

}

location /img {

  try_files /static @imageserver;

}

location / {

  root /static;

}

location @imageserver {
  proxy_pass http://127.0.0.1:8080;
}
```

This configuration can be illustrated by the following diagram:



Another example of an `"if"-fy` configuration is the following:

```
server {

  server_name marketing.example.com communication.example.com
marketing.example.org communication.example.org
marketing.example.net communication.example.net;

  if ($host ~*
(marketing\.example\.com|marketing\.example\.org|marketing\.example
\.net)) {

   rewrite ^/$ http://www.example.com/marketing/application.do
redirect;

  }

  if ($host ~*
(communication\.example\.com|communication\.example\.org|communicat
ion\.example\.net)) {

    rewrite ^/$ http://www.example.com/comms/index.cgi redirect;

  }

  if ($host ~* (www\.example\.org|www\.example\.net)) {

    rewrite ^/(.*)$ http://www.example.com/$1 redirect;

  }

}
```

Here, we have a number of `if` directives matching the Host header (or, if not present, `server_name`). After each `if`, the URI is rewritten to lead directly to the correct application component. Besides being terribly inefficient due to the processing required to match each regular expression for every URI, it breaks our "no ifs within a location" rule.

This type of configuration is better rewritten as a series of separate server contexts, in which the URL is rewritten to the application component:

```
server {

  server_name marketing.example.com marketing.example.org
marketing.example.net;

  rewrite ^ http://www.example.com/marketing/application.do
permanent;

}

server {

  server_name communication.example.com communication.example.org
communication.example.net;

  rewrite ^ http://www.example.com/comms/index.cgi permanent;

}

server {

  server_name www.example.org www.example.net;

  rewrite ^ http://www.example.com$request_uri permanent;
}
```

In each block, we have placed only those `server_name` that are relevant to the respective rewrite, so that no `if` is needed. In each `rewrite` rule, we have replaced the `redirect` flag with the `permanent` flag to indicate that this is a full URL that the browser should remember and automatically use the next time the domain is requested. In the last rewrite rule, we have also replaced the match (`^/(.*)$`) with a readily-available variable, `$request_uri`, which contains the same information but saves the trouble of matching the regular expression and saving the capture variable.

Using error documents to handle upstream problems

There are situations in which the upstream server cannot respond to a request. In these cases, NGINX can be configured to supply a document from its local disk:

```
server {

  error_page 500 502 503 504 /50x.html;

  location = /50x.html {

    root share/examples/nginx/html;

  }

}
```

Or from an external site:

```
server {

  error_page 500 http://www.example.com/maintenance.html;

}
```

When proxying to a set of upstream servers, you may want to define an extra upstream as being a "fallback" server, to handle requests when the others cannot. This is useful in scenarios when the fallback server is able to deliver a customized response based on the requested URI:

```
upstream app {
  server 127.0.0.1:9000;
  server 127.0.0.1:9001;
  server 127.0.0.1:9002;
}
server {
  location / {
    error_page 500 502 503 504 = @fallback;
    proxy_pass http://app;
  }
  location @fallback {
    proxy_pass http://127.0.0.1:8080;
  }
}
```

Tip

The "`=`" notation shown in the preceding `error_page` line is used to indicate that we want to return the status code resulting from the last parameter; in this case, the `@fallback` location.

These examples cover cases in which the error code was 500 or greater. NGINX can also supply an `error_page` for error codes 400 or greater, when the `proxy_intercept_errors` directive is set to `on`, as in the following example:

```
server {
  proxy_intercept_errors on;
  error_page 400 403 404 /40x.html;
  location = /40x.html {
    root share/examples/nginx/html;
  }
}
```

Note

When HTTP error code 401 is configured to be served from an `error_page`, the authentication will not complete. You may want to do this in situations when the authentication backend is offline, for maintenance or other reasons, but you should otherwise avoid them.

Determining the client's real IP address

When using a proxy server, the clients don't have a direct connection to the upstream servers. The upstream servers, therefore, aren't able to get information directly from those clients. Any information, such as the client's IP address, would need to be passed via headers. NGINX provides this with the `proxy_set_header` directive:

```
proxy_set_header X-Real-IP $remote_addr;
proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;
```

The client's IP address will then be available in both the `X-Real-IP` and `X-Forwarded-For` headers. The second form takes a client request header into account. If present, the IP address of the request will be added to the `X-Forwarded-For` header from the client, separated by a comma. Depending on your upstream server configuration, you will need one or the other of these. Configuring Apache, for example, to use the `X-Forwarded-For` header for the client's IP address in its logs is done using the `%{<header-name>}i` formatting option.

The following example shows how to change the default 'combined' Apache log format:

```
LogFormat "%{X-Forwarded-For}i %l %u %t \"%r\" %>s %b \"%
{Referer}i\" \"%{User-Agent}i\"" combined
```

If your upstream server, on the other hand, requires a non-standard header such as `Client-IP`, then this can easily be configured with the following:

```
proxy_set_header Client-IP $remote_addr;
```

Other information, such as the `Host` header, can be passed to the upstream servers in the same manner:

```
proxy_set_header Host $host;
```

Summary

We have seen how NGINX can be used as a reverse proxy. Its efficient connection-handling model is ideal for interfacing directly with clients. After having terminated requests, NGINX can then open new ones to upstream servers, taking into account the strengths and weaknesses of each upstream server. Using `if` inside a location is only considered valid under certain situations. By thinking about how NGINX actually handles a request, we can develop a configuration that is more suited to what we want to achieve. If NGINX cannot reach an upstream server for any reason, it can serve another page instead. As NGINX terminates the clients' requests, the upstream servers can obtain information about the client only via headers passed in NGINX's proxied request. These concepts will help you design an ideal NGINX configuration to match your needs.

Coming up in the next chapter, we will explore more advanced reverse-proxy techniques.

Chapter 5. Reverse Proxy Advanced Topics

As we saw in the previous chapter, a reverse proxy makes connections to upstream servers on behalf of clients. These upstream servers therefore have no direct connection to the client. This is for several different reasons, such as security, scalability, and performance.

A reverse proxy server aids security because if an attacker were to try to get onto the upstream server directly, he would have to first find a way to get onto the reverse proxy. Connections to the client can be encrypted by running them over HTTPS. These SSL connections may be terminated on the reverse proxy, when the upstream server cannot or should not provide this functionality itself. NGINX can act as an SSL terminator as well as provide additional access lists and restrictions based on various client attributes.

Scalability can be achieved by utilizing a reverse proxy to make parallel connections to multiple upstream servers, enabling them to act as if they were one. If the application requires more processing power, additional upstream servers can be added to the pool served by a single reverse proxy.

Performance of an application may be enhanced through the use of a reverse proxy in several ways. The reverse proxy can cache and compress content before delivering it out to the client. NGINX as a reverse proxy can handle more concurrent client connections than a typical application server. Certain architectures configure NGINX to serve static content from a local disk cache, passing only dynamic requests to the upstream server to handle. Clients can keep their connections to NGINX alive, while NGINX terminates the ones to the upstream servers immediately, thus freeing resources on those upstream servers.

We will discuss these topics, as well as the remaining proxy module directives, in the following sections:

- Security through separation
- Isolating application components for scalability
- Reverse proxy performance tuning

Security through separation

We can achieve a measure of security by separating out the point to which clients connect to an application. This is one of the main reasons for using a reverse proxy in an architecture. The client connects directly only to the machine running the reverse proxy. This machine should therefore be secured well enough that an attacker cannot find a point of entry.

Security is such a large topic that we will touch only briefly on the main points to observe:

- Set up a firewall in front of the reverse proxy that only allows public access to port 80 (and 443, if HTTPS connections should also be made)
- Ensure that NGINX is running as an unprivileged user (typically `www`, `webservd`, or `www-data`, depending on the operating system)
- Encrypt traffic where you can to prevent eavesdropping

We will spend some time on this last point in the next section.

Encrypting traffic with SSL

NGINX is often used to terminate SSL connections, either because the upstream server is not capable of using SSL or to offload the processing requirements of SSL connections. This requires that your `nginx` binary was compiled with SSL support (`--with_http_ssl_module`) and that you install an SSL certificate and key.

> ## Note
>
> For details about how to generate your own SSL certificate, please see the *Using OpenSSL to generate an SSL certificate* tip in Chapter 3, *Using the Mail Module*.

The following is an example configuration for enabling HTTPS connections to `www.example.com`:

```
server {

   listen              443 default ssl;

   server_name www.example.com;


    ssl_prefer_server_ciphers  on;

    ssl_protocols    TLSv1 SSLv3;

    ssl_ciphers      RC4:HIGH:!aNULL:!MD5:@STRENGTH;

    ssl_session_cache    shared:WEB:10m;

    ssl_certificate
/usr/local/etc/nginx/www.example.com.crt;

    ssl_certificate_key /usr/local/etc/nginx/www.example.com.key;

    location / {

        proxy_set_header X-FORWARDED-PROTO https;

        proxy_pass http://upstream;

    }

}
```

In the preceding example, we first activate the `ssl` module by using the `ssl` parameter to the `listen` directive. Then, we specify that we wish the server's ciphers to be chosen over the client's list, as we can configure the server to use the ciphers that have proven to be most secure. This prevents clients from negotiating a cipher that has been deprecated. The `ssl_session_cache` directive is set to `shared` so that all worker processes can benefit from the expensive SSL negotiation that has already been done once per client. Multiple virtual servers can use the same `ssl_session_cache` directive if they are all configured with the same name, or if this directive is specified in the `http` context. The second and third parts of the value are the name of the cache and its size, respectively. Then it is just a matter of specifying the certificate and key for this host. Note that the permissions of this key file should be set such that only the master process may read it. We set the header `X-FORWARDED-PROTO` to the value `https` so that the application running on the upstream server can recognize the fact that the original request used HTTPS.

Tip

SSL ciphers

The preceding ciphers were chosen based on NGINX's default, which excludes those that offer no authentication (`aNULL`) as well as those using MD5. The RC4 is placed at the beginning so that ciphers not susceptible to the BEAST attack described in CVE-2011-3389 are preferred. The `@STRENGTH` string at the end is present to sort the list of ciphers in order of the encryption algorithm key length.

We have just encrypted the traffic passing between the client and the reverse proxy. It is also possible to encrypt the traffic between the reverse proxy and the upstream server:

```
server {
    …

    proxy_pass https://upstream;

}
```

This is usually only reserved for those architectures in which even the internal network over which such a connection flows is considered insecure.

Authenticating clients using SSL

Some applications use information from the SSL certificate the client presents, but this information is not directly available in a reverse proxy architecture. To pass this information along to the application, you can instruct NGINX to set an additional header:

```
location /ssl {

    proxy_set_header ssl_client_cert $ssl_client_cert;

    proxy_pass http://upstream;

}
```

The `$ssl_client_cert` variable contains the client's SSL certificate, in PEM format. We pass this on to the upstream server in a header of the same name. The application itself is then responsible for using this information in whatever way is appropriate.

Instead of passing the whole client certificate to the upstream server, NGINX can do some work ahead of time to see if the client is even valid. A valid client SSL certificate is one which has been signed by a recognized Certificate Authority, has a validity date in the future, and has not been revoked:

```
server {
    …
    ssl_client_certificate /usr/local/etc/nginx/ClientCertCAs.pem;

    ssl_crl /usr/local/etc/nginx/ClientCertCRLs.crl;

    ssl_verify_client on;

    ssl_verify_depth 3;

    error_page 495 = @noverify;

    error_page 496 = @nocert;

    location @noverify {

        proxy_pass http://insecure?status=notverified;

    }

    location @nocert {

        proxy_pass http://insecure?status=nocert;

    }

    location / {

        if ($ssl_client_verify = FAILED) {

            return 495;

        }

        proxy_pass http://secured;

    }

}
```

The preceding configuration is constructed out of the following parts to achieve the objective of having NGINX validate client SSL certificates before passing the request on to the upstream server:

- The argument to the `ssl_client_certificate` directive specifies the path to the PEM-encoded list of root CA certificates that will be considered valid signers of client certificates.
- The `ssl_crl` argument indicates the path to a certificate revocation list, issued by the Certificate Authority responsible for signing client certificates. This CRL needs to be downloaded separately and periodically refreshed.
- The `ssl_verify_client` directive states that we want NGINX to check the validity of SSL certificates presented by clients.

- The `ssl_verify_depth` directive is responsible for how many signers will be checked before declaring the certificate invalid. SSL certificates may be signed by one or more intermediate CAs. Either an intermediate CA certificate or the root CA that signed it needs to be in our `ssl_client_certificate` path for NGINX to consider the client certificate valid.
- If some sort of error occurred during client certificate validation, NGINX will return the non-standard error code 495. We have defined an `error_page` that matches this code and redirects the request to a named location, to be handled by a separate proxied server. We also include a check for the value of `$ssl_client_verify` within the `proxy_pass` location, so that an invalid certificate will also return this code.
- If a certificate is not valid, NGINX will return the non-standard error code 496, which we capture as well with an `error_page` directive. The `error_page` directive that we define points to a named location, which proxies the request to a separate error handler.

Only when the client has presented a valid SSL certificate will NGINX pass the request on to the upstream server, `secured`. By doing so, we have ensured that only authenticated users actually get to place requests to the upstream server. This is an important security feature of a reverse proxy.

> ## Note
>
> NGINX from Version 1.3.7 provides the capability to use OCSP responders to verify client SSL certificates. See the `ssl_stapling*` and `ssl_trusted_certificate` directives in Appendix A, *Directive Reference*, for a description of how to activate this functionality.

If the application still needs some information present in the certificate, for example, to authorize a user, NGINX can deliver this information in a header:

```
location / {

    proxy_set_header X-HTTP-AUTH $ssl_client_s_dn;

    proxy_pass http://secured;

}
```

Now, our application running on the upstream server `secured` can use the value of the `X-HTTP-AUTH` header to authorize the client for access to different areas. The variable `$ssl_client_s_dn` contains the subject `DN` of the client certificate. The application can use this information to match the user against a database or make a look up in a directory.

Blocking traffic based on originating IP address

As client connections terminate on the reverse proxy, it is possible to limit clients based on IP address. This is useful in cases of abuse where a number of invalid connections originate from a certain set of IP addresses. As in Perl, there is more than one way to do it. We will discuss the `GeoIP` module here as a possible solution.

Your `nginx` binary will need to have been compiled with the `GeoIP` module activated (`--with-http_geoip_module`) and the MaxMind GeoIP library installed on your system. Specify the location of the precompiled database file with the `geoip_country` directive in the `http` context. This provides the most efficient way to block/allow IP addresses by country code:

```
geoip_country /usr/local/etc/geo/GeoIP.dat;
```

If a client's connection comes from an IP address listed in this database, the value of the `$geoip_country_code` variable will be set to the ISO two-letter code for the originating country.

We will use the data provided by the `GeoIP` module together with the closely-named `geo` module, as well. The `geo` module provides a very basic interface for setting variables based on the IP address of a client connection. It sets up a named context within which the first parameter is the IP address to match and the second is the value that match should obtain. By combining these two modules, we can block IP addresses based on the country of origin, while allowing access from a set of specific IP addresses.

In our scenario, we are providing a service to Swiss banks. We want the public parts of the site to be indexed by Google, but are for now still restricting access to Swiss IPs. We also want a local watchdog service to be able to access the site to ensure it is still responding properly. We define a variable `$exclusions`, which will have the value `0` by default. If any of our criteria are matched, the value will be set to `1`, which we will use to control access to the site:

```
http {

    # the path to the GeoIP database

    geoip_country /usr/local/etc/geo/GeoIP.dat;

    # we define the variable $exclusions and list all IP addresses
# allowed
    #   access by setting the value to "1"

    geo $exclusions {

        default 0;
        127.0.0.1 1;
        216.239.32.0/19 1;
```

```
        64.233.160.0/19 1;
        66.249.80.0/20  1;
        72.14.192.0/18  1;
        209.85.128.0/17 1;
        66.102.0.0/20   1;
        74.125.0.0/16   1;
        64.18.0.0/20    1;
        207.126.144.0/20 1;
        173.194.0.0/16 1;

    }

    server {

        # the country code we want to allow is "CH", for
Switzerland
        if ($geoip_country_code = "CH") {

            set $exclusions 1;

        }
        location / {

            # any IP's not from Switzerland or in our list above #
receive the
            # default value of "0" and are given the Forbidden
HTTP# code
            if ($exclusions = "0" ) {

                return 403;

            }

            # anybody else has made it this far and is allowed
access# to the
            # upstream server
            proxy_pass http://upstream;

        }

    }

}
```

This is just one way of solving the problem of blocking access to a site based on the client's IP address. Other solutions involve saving the IP address of the client in a key-value store, updating a counter for each request, and blocking access if there have been too many requests within a certain time period.

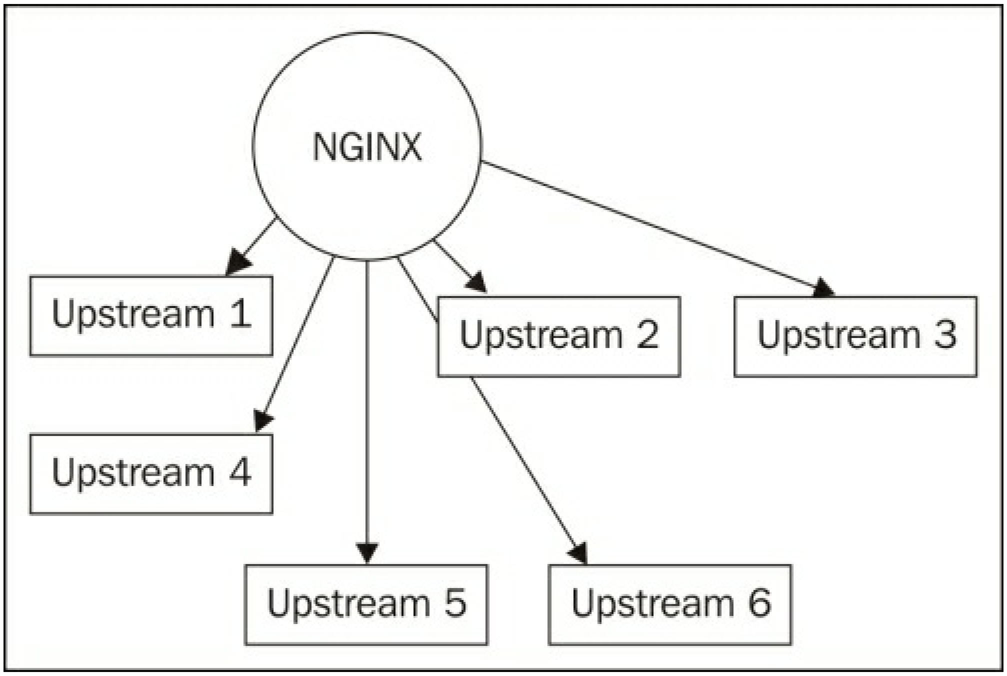
Isolating application components for scalability

Scaling applications can be described by moving in two dimensions, up and out. Scaling up refers to adding more resources to a machine, growing its pool of available resources to meet client demand. Scaling out means adding more machines to a pool of available responders, so that no one machine gets tied up handling the majority of clients. Whether these machines are virtualized instances running in the cloud or physical machines sitting in a datacenter, it is often more cost-effective to scale out rather than up. This is where NGINX fits in handily as a reverse proxy.

Due to its very low resource usage, NGINX acts ideally as the broker in a client-application relationship. NGINX handles the connection to the client, able to process multiple requests simultaneously. Depending on the configuration, NGINX will either deliver a file from its local cache or pass the request on to an upstream server for further processing. The upstream server can be any type of server that speaks the HTTP protocol. More client connections can be handled than if an upstream server were to respond directly:

```
upstream app {

    server 10.0.40.10;

    server 10.0.40.20;

    server 10.0.40.30;

}
```

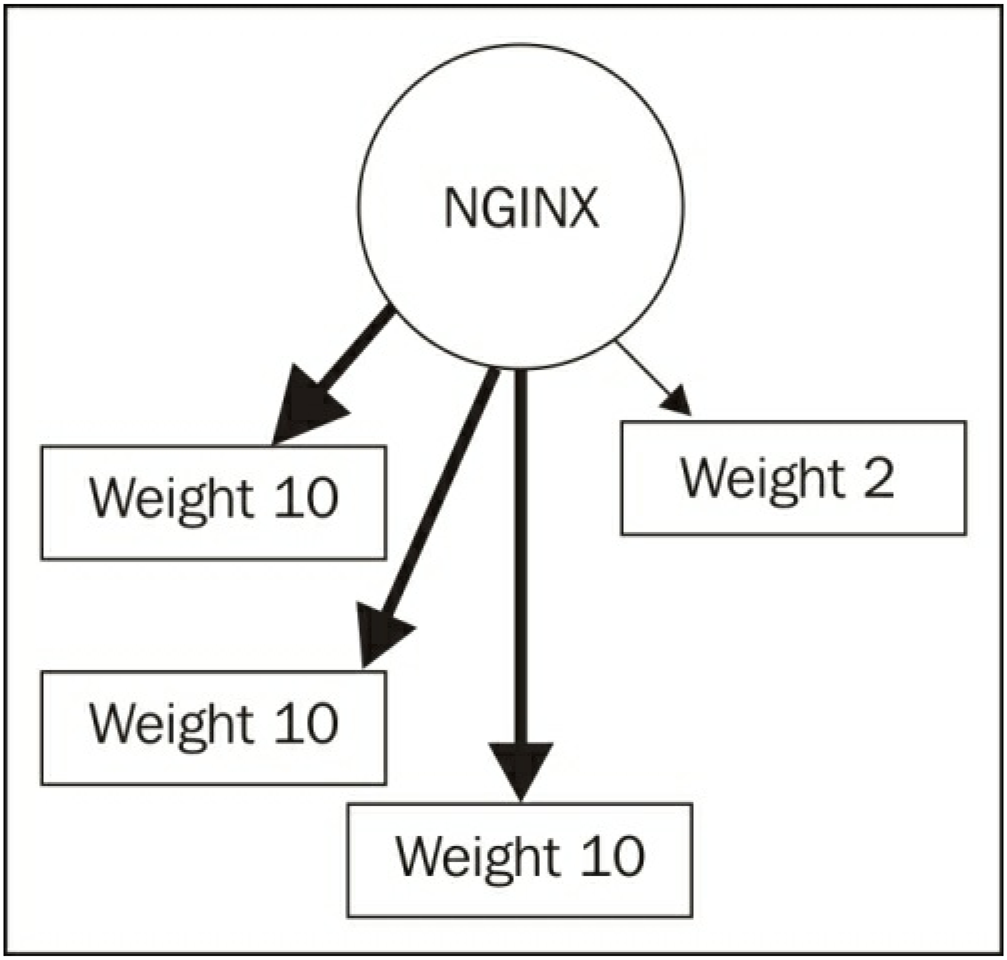
Over time, the initial set of upstream servers may need to be expanded. The traffic to the site has increased so much, that the current set can't respond in a timely enough manner. By using NGINX as the reverse proxy, this situation can easily be remedied by adding more upstream servers.



Adding more upstream servers can be done as follows:

```
upstream app {

    server 10.0.40.10;

    server 10.0.40.20;
    server 10.0.40.30;

    server 10.0.40.40;

    server 10.0.40.50;

    server 10.0.40.60;

}
```

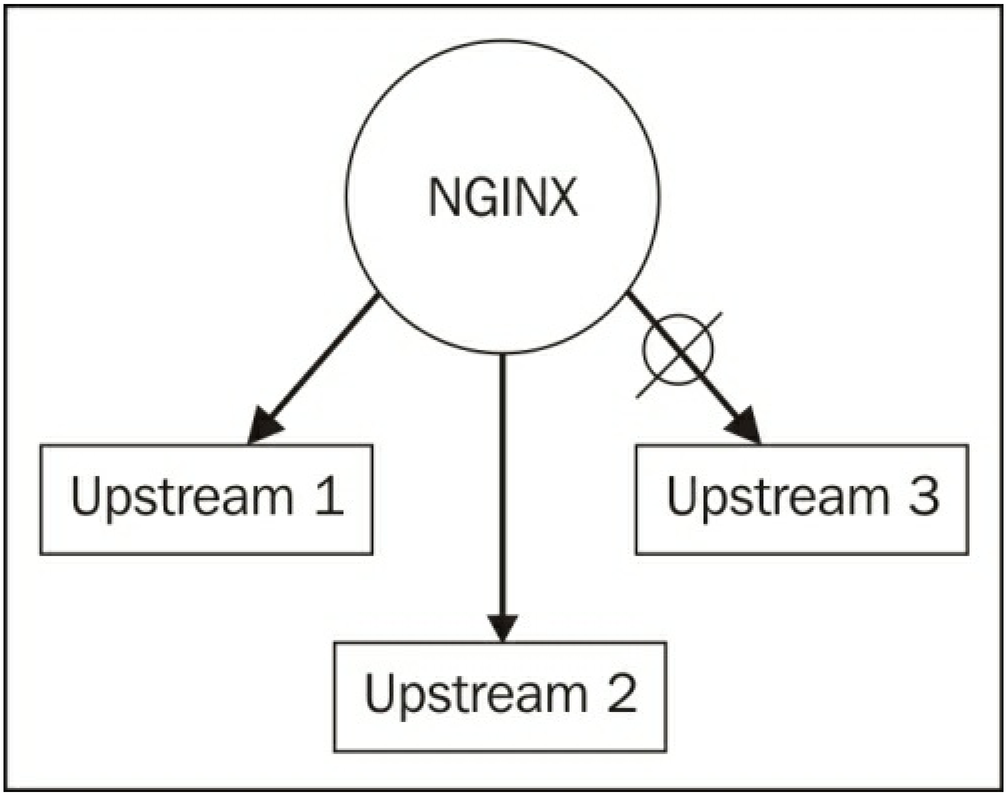
Perhaps the time has come for the application to be rewritten, or to be migrated onto a server with a different application stack. Before moving the whole application over, one server can be brought into the active pool for testing under real load with real clients. This server could be given fewer requests to help minimize any negative reactions should problems arise.



This is done with the following configuration:

```
upstream app {
    server 10.0.40.10 weight 10;
    server 10.0.40.20 weight 10;
    server 10.0.40.30 weight 10;
    server 10.0.40.100 weight 2;
}
```

Alternatively, perhaps it is time for scheduled maintenance on a particular upstream server, so it should not receive any new requests. By marking that server as `down` in the configuration, we can proceed with that maintenance work:



The following configuration describes how to mark the server `down`:

```
upstream app {
    server 10.0.40.10;
    server 10.0.40.20;
    server 10.0.40.30 down;
}
```

Unresponsive upstream servers should be handled quickly. Depending on the application, the timeout directives can be set aggressively low:

```
location / {
    proxy_connect_timeout 5;
    proxy_read_timeout 10;
    proxy_send_timeout 10;
}
```

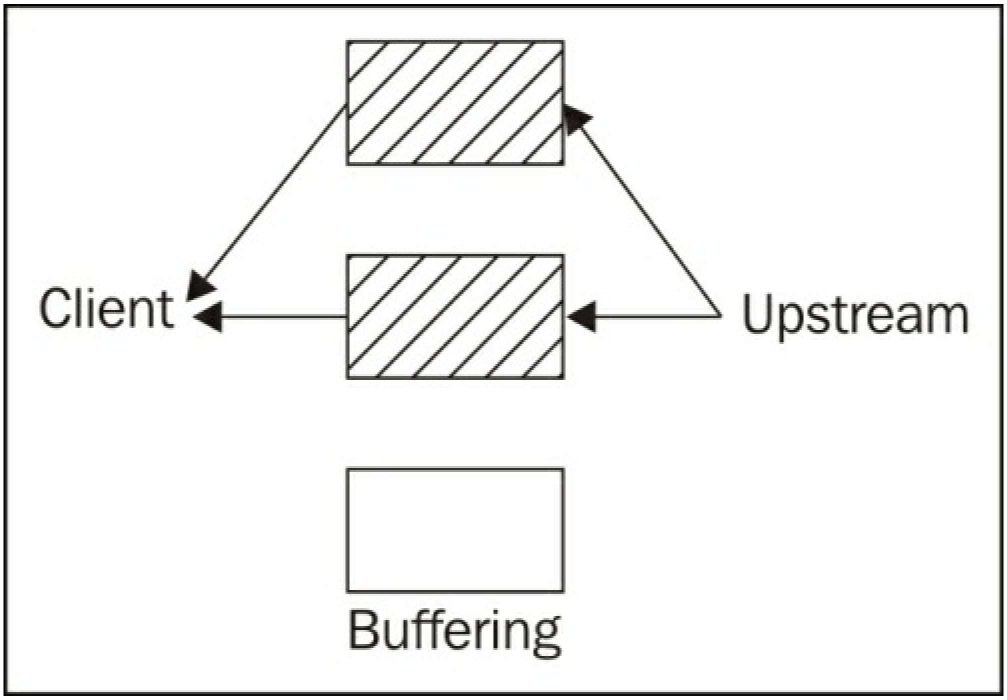
Be careful, though, that the upstream servers can usually respond within the time set by the timeout, or NGINX may deliver a **504 Gateway Timeout Error** when no upstream servers respond within this time.

Reverse proxy performance tuning

NGINX can be tuned in a number of ways to get the most out of the application for which it is acting as a reverse proxy. By buffering, caching, and compressing, NGINX can be configured to make the client's experience as snappy as possible.

Buffering

Buffering can be described with the help of the following figure:



The most important factor to consider performance-wise when proxying is buffering. NGINX, by default, will try to read as much as possible from the upstream server as fast as possible before returning that response to the client. It will buffer the response locally so that it can deliver it to the client all at once. If any part of the request from the client or the response from the upstream server is written out to disk, performance might drop. This is a trade-off between RAM and disk. So it is very important to consider the following directives when configuring NGINX to act as a reverse proxy:

Table: Proxy module buffering directives

Directive	Explanation
`proxy_buffer_size`	The size of the buffer used for the first part of the response from the upstream server, in which the response headers are

	found.
proxy_buffering	Activates buffering of proxied content; when switched off, responses are sent synchronously to the client as soon as they are received, provided the proxy_max_temp_file_size parameter is set to 0. Setting this to 0 and turning proxy_buffering to on ensures that there is no disk usage during proxying, while still enabling buffering.
proxy_buffers	The number and size of buffers used for responses from upstream servers.
proxy_busy_buffers_size	The total size of buffer space allocated to sending the response to the client while still being read from the upstream server. This is typically set to two proxy_buffers.

In addition to the preceding directives, the upstream server may influence buffering by setting the X-Accel-Buffering header. The default value of this header is yes, meaning that responses will be buffered. Setting the value to no is useful for Comet and HTTP streaming applications, where it is important to not buffer the response.

By measuring the average request and response sizes going through the reverse proxy, the proxy buffer sizes can be tuned optimally. Each buffer directive counts per connection, in addition to an OS-dependent per-connection overhead, so we can calculate how many simultaneous client connections we can support with the amount of memory on a system.

The default values for the proxy_buffers directive (8 4k or 8 8k, depending on the operating system), enable a large number of simultaneous connections. Let's figure out just how many connections that is. On a typical 1 GB machine, where only NGINX runs, most of the memory can be dedicated to its use. Some will be used by the operating system for the filesystem cache and other needs, so let's be conservative and estimate that NGINX would have up to 768 MB.

Eight 4 KB buffers is 32,768 bytes (8 * 4 * 1024) per active connection.

The 768 MB we allocated to NGINX is 805,306,368 bytes (768 * 1024 * 1024).

Dividing the two, we come up with 805306368 / 32768 = 24576 active connections.

So, NGINX would be able to handle just under 25,000 simultaneous, active connections in its default configuration, assuming that these buffers will be constantly filled. There are a number of other factors that come into play, such as cached content and idle connections, but this gives us a good ballpark estimate to work with.

Now, if we take the following numbers as our average request and response sizes, we see that eight 4 KB buffers just aren't enough to process a typical request. We want NGINX to buffer as much of the response as possible so that the user receives it all at once, provided the user is on a fast link.

- Average request size: 800 bytes
- Average response size: 900 KB

> ## Note
>
> The tuning examples in the rest of this section will use more memory at the expense of concurrent, active connections. They are optimizations, and shouldn't be understood as recommendations for a general configuration. NGINX is already optimally tuned to provide for many, slow clients and a few, fast upstream servers. As the trend in computing is more towards mobile users, the client connection is considerably slower than a broadband user's connection. So, it's important to know your users and how they will be connecting, before embarking on any optimizations.

We would adjust our buffer sizes accordingly so that the whole response would fit in the buffers:

```
http {

    proxy_buffers 30 32k;

}
```

This means, of course, that we would be able to handle far fewer concurrent users.

Thirty 32 KB buffers is 983,040 bytes (30 * 32 * 1024) per connection.

The 768 MB we allocated to NGINX is 805,306,368 bytes (768 * 1024 * 1024).

Dividing the two, we come up with 805306368 / 983040 = 819.2 active connections.

That isn't too many concurrent connections at all. Let's adjust the number of buffers down, and ensure that NGINX will start transferring something to the client while the rest of the response is read into the remaining `proxy_buffers` space:

```
http {
    proxy_buffers 4 32k;
    proxy_busy_buffers_size 64k;
}
```

Four 32 KB buffers is 131,072 bytes (4 * 32 * 1024) per connection.

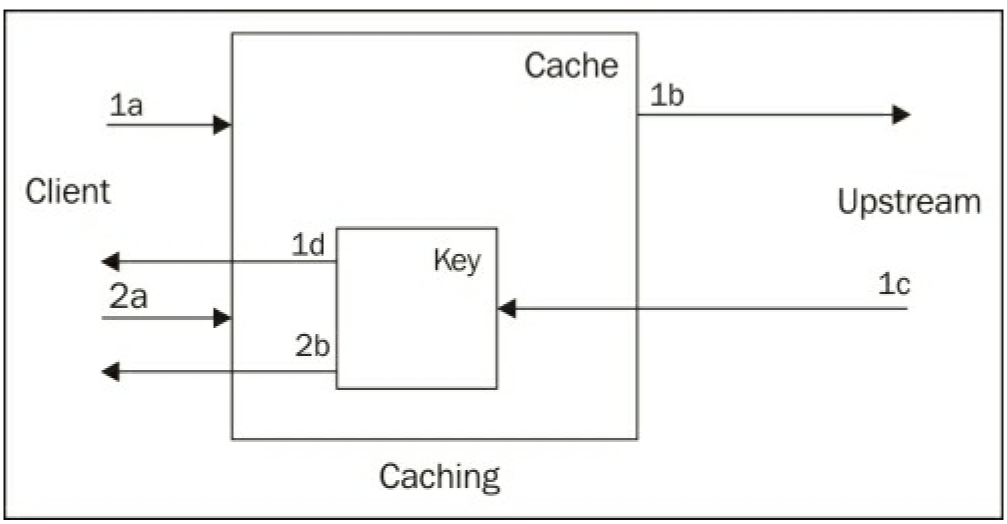
The 768 MB we allocated to NGINX is 805,306,368 bytes (768 * 1024 * 1024).

Dividing the two, we come up with 805306368 / 131072 = 6144 active connections.

For a reverse-proxy machine, we may therefore want to scale up by adding more memory (6 GB RAM will yield us approximately 37,000 connections) or scale out by adding more 1 GB machines behind a load balancer, up to the number of concurrent, active users we can expect.

Caching

Caching can be described with the following figure:



NGINX is also capable of caching the response from the upstream server, so that the same request asked again doesn't have to go back to the upstream server to be served. The preceding figure illustrates this as follows:

- **1a**: A client makes a request
- **1b**: The request's cache key is not currently found in the cache, so NGINX requests it from the upstream server
- **1c**: The upstream responds and NGINX places the response corresponding to that request's cache key into the cache
- **1d**: The response is delivered to the client

- **2a**: Another client makes a request that has a matching cache key
- **2b**: NGINX is able to serve the response directly from the cache without needing to first get the response from the upstream server

Table: Proxy module caching directives

Directive	Explanation
`proxy_cache`	Defines a shared memory zone to be used for caching.
`proxy_cache_bypass`	One or more string variables, which when non-empty or non-zero, will cause the response to be taken from the upstream server instead of the cache.
`proxy_cache_key`	A string used as the key for storing and retrieving cache values. Variables may be used, but care should be taken to avoid caching multiple copies of the same content.
`proxy_cache_lock`	Enabling this directive will prevent multiple requests to the upstream server(s) during a cache miss. The requests will wait for the first to return and make an entry into the cache key. This lock is per worker.
`proxy_cache_lock_timeout`	The length of time a request will wait for an entry to appear in the cache or for the `proxy_cache_lock` to be released.
`proxy_cache_min_uses`	The number of requests for a certain key needed before a response is cached.
	A directory in which to place the cached responses and a shared memory zone (`keys_zone=name:size`) to store active keys and response metadata. Optional parameters are: • `levels`: Colon-separated length of subdirectory name at each level (1 or 2), maximum of three levels deep

proxy_cache_path	• inactive: The maximum length of time an inactive response stays in the cache before being ejected • max_size: The maximum size of the cache; when the size exceeds this value, a cache manager process removes the least recently used items • loader_files: The maximum number of cached files whose metadata are loaded per iteration of the cache loader process • loader_sleep: The number of milliseconds paused between each iteration of the cache loader process • loader_threshold: The maximum length of time a cache loader iteration may take
proxy_cache_use_stale	The cases under which it is acceptable to serve stale cached data when an error occurs while accessing the upstream server. The updating parameter indicates the case when fresh data are being loaded.
proxy_cache_valid	Indicates the length of time for which a cached response with response code 200, 301, or 302 is valid. If an optional response code is given before the time parameter, that time is only for that response code. The special parameter any indicates that any response code should be cached for that length of time.

The following configuration is designed to cache all responses for six hours, up to a total cache size of 1 GB. Any items that stay fresh, that is, are called within the six hour timeout, are valid for up to one day. After this time, the upstream server will be called again to provide the response. If the upstream isn't able to respond due to an error, timeout, invalid header, or if the cached item is being updated, a stale cache element may be used. The shared memory zone, **CACHE**, is defined to be 10 MB large and is referenced within the location where the cache keys need to be set and looked-up.

```
http {

    # we set this to be on the same filesystem as proxy_cache_path
    proxy_temp_path /var/spool/nginx;

    # good security practice dictates that this directory is owned
by the
    #  same user as the user directive (under which the workers
run)
    proxy_cache_path /var/spool/nginx keys_zone=CACHE:10m
levels=1:2 inactive=6h max_size=1g;

    server {

        location / {

            # using include to bring in a file with commonly-used
settings
            include proxy.conf;

            # referencing the shared memory zone defined above
            proxy_cache CACHE;

            proxy_cache_valid any 1d;

            proxy_cache_use_stale error timeout invalid_header
updating http_500 http_502 http_503 http_504;

            proxy_pass http://upstream;

        }

    }

}
```

Using this configuration, NGINX will set up a series of directories under `/var/spool/nginx` that will first differentiate on the last character of the MD5 hash of the URI, followed by the next two characters from the last. For example, the response for "/this-is-a-typical-url" will be stored as:

```
/var/spool/nginx/3/f1/614c16873c96c9db2090134be91cbf13
```

In addition to the `proxy_cache_valid` directive, a number of headers control how NGINX caches responses. The header values take precedence over the directive.

- The `X-Accel-Expires` header can be set by the upstream server to control cache behavior:
    - An integer value indicates the time in seconds for which a response may be cached
    - If the value of this header is `0`, caching for that response is disabled

completely

- A value beginning with `@` indicates the time in seconds since the epoch. The response is valid only up to this absolute time.
- The `Expires` and `Cache-Control` headers have the same precedence level.
- If the value of the `Expires` header is in the future, the response will be cached until then.
- The `Cache-Control` header can have multiple values:
    - `no-cache`
    - `no-store`
    - `private`
    - `max-age`
- The only value for which the response is actually cached is a `max-age`, which is numeric and non-zero, that is, `max-age=x` where `x` > 0.
- If the `Set-Cookie` header is present, the response is not cached.

  This may be overridden, though, by using the `proxy_ignore_headers` directive:

  ```
  proxy_ignore_headers Set-Cookie;
  ```

- But if doing so, be sure to make the cookie value part of the `proxy_cache_key`:

  ```
  proxy_cache_key "$host$request_uri $cookie_user";
  ```

Care should be taken when doing this, though, to prevent multiple response bodies from being cached for the same URI. This can happen when public content inadvertently has the `Set-Cookie` header set for it, and this then becomes part of the key used to access this data. Separating public content out to a different location is one way to ensure that the cache is being used effectively. For example, serving images from an `/img` location where a different `proxy_cache_key` is defined:

```
server {
    proxy_ignore_headers Set-Cookie;
    location /img {
        proxy_cache_key "$host$request_uri";
        proxy_pass http://upstream;
    }
    location / {
        proxy_cache_key "$host$request_uri $cookie_user";
        proxy_pass http://upstream;
    }
}
```

Storing

Related to the concept of a cache is a **store**. If you are serving large, static files that will never change, that is, there is no reason to expire the entries, then NGINX offers something called a store to help serve these files faster. NGINX will store a local copy of any files that you configure it to fetch. These files will remain on disk and the upstream server will not be asked for them again. If any of these files should change upstream, they need to be deleted by some external process, or NGINX will continue serving them, so for smaller, static files, using the cache is more appropriate.

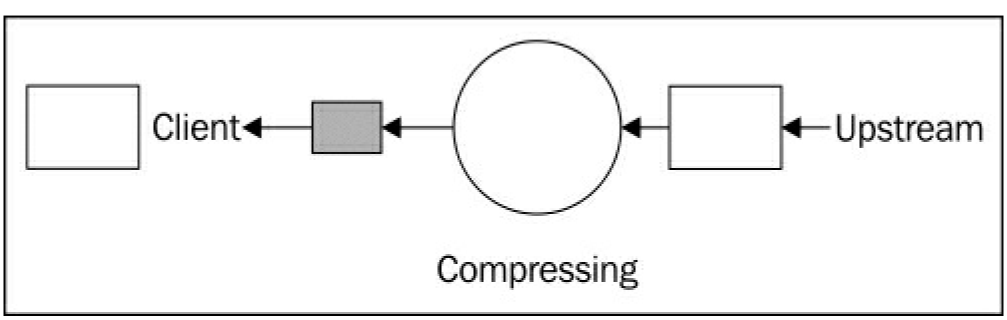
The following configuration summarizes the directives used to store these files:

```
http {

    proxy_temp_path /var/www/tmp;

    server {

        root /var/www/data

        location /img {

            error_page 404 = @store;

        }

        location @store {

            internal;

            proxy_store on;

            proxy_store_access group:r all:r;

            proxy_pass http://upstream;

        }

    }

}
```

In this configuration, we define a `server` with a `root` under the same filesystem as the `proxy_temp_path`. The `location` directive `/img` will inherit this `root`, serving files of the same name as the URI path under `/var/www/data`. If a file is not found (error code 404), the named `location` directive `@store` is called to fetch the file from the upstream. The `proxy_store` directive indicates that we want to store files under the inherited `root` with permissions `0644` (the `user:rw` is understood, while `group` or `all` are specified in `proxy_store_access`). That's all it takes for NGINX to store a local copy of static files served by the upstream server.

Compressing

Compressing can be described with the following figure:



Optimizing for bandwidth can help reduce a response's transfer time. NGINX has the capability of compressing a response it receives from an upstream server before passing it on to the client. The `gzip` module, enabled by default, is often used on a reverse proxy to compress content where it makes sense. Some file types do not compress well. Some clients do not respond well to compressed content. We can take both cases into account in our configuration:

```
http {

    gzip on;

    gzip_http_version 1.0;

    gzip_comp_level 2;

    gzip_types text/plain text/css application/x-javascript
text/xml application/xml application/xml+rss text/javascript
application/javascript application/json;

    gzip_disable msie6;

}
```

Here we've specified that we want files of the preceding MIME types to be compressed at a gzip compression level of 2 if the request has come over at least HTTP/1.0, except if the user agent reports being an older version of Internet Explorer. We've placed this configuration in the `http` context so that it will be valid for all servers we define.

The following table lists the directives available with the `gzip` module:

Table: Gzip module directives

Directive	Explanation
`gzip`	Enables or disables the compression of responses.
`gzip_buffers`	Specifies the number and size of buffers used for compressing a response.
`gzip_comp_level`	The gzip compression level (1-9).

`gzip_disable`	A regular expression of `User-Agents` that shouldn't receive a compressed response. The special value `msie6` is a shortcut for `MSIE [4-6]\.` excluding `MSIE 6.0; ... SV1`.
`gzip_min_length`	The minimum length of a response before compression is considered, determined by the `Content-Length` header.
`gzip_http_version`	The minimum HTTP version of a request before compression is considered.
`gzip_proxied`	Enables or disables compression if the request has already come through a proxy. Takes one or more of the following parameters: • `off`: Disables compression • `expired`: Enables compression if the response should not be cached, as determined by the `Expires` header • `no-cache`: Enables compression if the `Cache-Control` header is equal to `no-cache` • `no-store`: Enables compression if the `Cache-Control` header is equal to `no-store` • `private`: Enables compression if the `Cache-Control` header is equal to `private` • `no_last_modified`: Enables compression if the response doesn't have a `Last-Modified` header • `no_etag`: Enables compression if the response doesn't have an `ETag` header • `auth`: Enables compression if the request contains an `Authorization` header • `any`: Enables compression for any response whose request includes the `Via` header
`gzip_types`	The MIME types that should be compressed, in addition to the default value `text/html`.
`gzip_vary`	Enables or disables the response header `Vary: Accept-Encoding` if gzip is active.

When gzip compression is enabled and you find large files being truncated, the likely culprit is `gzip_buffers`. The default value of `32 4k` or `16 8k` buffers (depending on the platform) leads to a total buffer size of 128 KB. This means that the file NGINX is to compress cannot be larger than 128 KB. If you're using an unzipped large JavaScript library, you may find yourself over this limit. If that is the case, just increase the number of buffers so that the total buffer size is large enough to fit the whole file.

```
http {

    gzip on;

    gzip_min_length 1024;

    gzip_buffers 40 4k;

    gzip_comp_level 5;

    gzip_types text/plain application/x-javascript
application/json;

}
```

For example, the preceding configuration will enable compression of any file up to 40 * 4 * 1024 = 163840 bytes (or 160 KB) large. We also use the `gzip_min_length` directive to tell NGINX to only compress a file if it is larger than 1 KB. A `gzip_comp_level` of 4 or 5 is usually a good trade-off between speed and compressed file size. Measuring on your hardware is the best way to find the right value for your configuration.

Besides on-the-fly compression of responses, NGINX is capable of delivering precompressed files, using the `gzip_static` module. This module is not compiled by default, but can be enabled with the `--with-http_gzip_static_module` compile-time switch. The module itself has one directive, `gzip_static`, but also uses the following directives of the `gzip` module in order to determine when to check for precompressed files:

- `gzip_http_version`
- `gzip_proxied`
- `gzip_disable`
- `gzip_vary`

In the following configuration, we enable delivery of precompressed files if the request contains an `Authorization` header and if the response contains one of the `Expires` or `Cache-Control` headers disabling caching:

```
http {
    gzip_static on;
    gzip_proxied expired no-cache no-store private auth;
}
```

Summary

We have seen in this chapter how NGINX can be used effectively as a reverse proxy. It can act in three roles, either individually or in some combination, which are to enhance security, to enable scalability, and/or to enhance performance. Security is achieved through separation of the application from the end user. NGINX can be combined with multiple upstream servers to achieve scalability. The performance of an application relates directly to how responsive it is to a user's request. We explored different mechanisms to achieve a more responsive application. Faster response times mean happier users.

Up next is an exploration of NGINX as an HTTP server. We have so far only discussed how NGINX can act as a reverse proxy, but there is so much more that NGINX is capable of.

Chapter 6. The NGINX HTTP Server

An HTTP server is primarily a piece of software that will deliver web pages to clients when requested. These web pages can be anything from a simple HTML file on disk to a multicomponent framework delivering user-specific content, dynamically updated through AJAX or WebSocket. NGINX is modular, and is designed to handle any kind of HTTP serving necessary.

In this chapter, we will investigate the various modules that work together to make NGINX such a scalable HTTP server. The following topics are included in this chapter:

- NGINX's architecture
- The HTTP core module
- Using limits to prevent abuse
- Restricting access
- Streaming media files
- Predefined variables
- Using NGINX with PHP-FPM
- Wiring NGINX and uWSGI together

NGINX's architecture

NGINX consists of a single master process and multiple worker processes. Each of these is single-threaded and designed to handle thousands of connections simultaneously. The worker process is where most of the action takes place, as this is the component that handles client requests. NGINX makes use of the operating system's event mechanism to respond quickly to these requests.

The NGINX **master process** is responsible for reading the configuration, handling sockets, spawning workers, opening log files, and compiling embedded Perl scripts. The master process is the one that responds to administrative requests via signals.

The NGINX **worker process** runs in a tight event loop to handle incoming connections. Each NGINX module is built into the worker, so that any request processing, filtering, handling of proxy connections, and much more is done within the worker process. Due to this worker model, the operating system can handle each process separately and schedule the processes to run optimally on each processor core. If there are any processes that would block a worker, such as disk I/O, more workers than cores can be configured to handle the load.

There are also a small number of helper processes that the NGINX master process spawns to handle dedicated tasks. Among these are the **cache loader** and **cache manager** processes. The cache loader is responsible for preparing the metadata for worker processes to use the cache. The cache manager process is responsible for checking cache items and expiring invalid ones.

NGINX is built in a modular fashion. The master process provides the foundation upon which each module may perform its function. Each protocol and handler is implemented as its own module. The individual modules are chained together into a pipeline to handle connections and process requests. After a request is handled, it is then passed on to a series of filters, in which the response is processed. One of these filters is responsible for processing subrequests, one of NGINX's most powerful features.

Subrequests are how NGINX can return the results of a request that differs from the URI that the client sent. Depending on the configuration, they may be multiply nested and call other subrequests. Filters can collect the responses from multiple subrequests and combine them into one response to the client. The response is then finalized and sent to the client. Along the way, multiple modules come into play. See http://www.aosabook.org/en/nginx.html for a detailed explanation of NGINX internals.

We will be exploring the `http` module and a few helper modules in the remainder of this chapter.

The HTTP core module

The `http` module is NGINX's central module, which handles all interactions with clients over HTTP. We have already discussed the following aspects of this module in Chapter 2, *A Configuration Guide*:

- Client directives
- File I/O directives
- Hash directives
- Socket directives
- The `listen` directive
- Matching a request to a `server_name` and `location` directive

We will have a look at the remaining directives in the rest of this section, again divided by type.

The server

The `server` directive starts a new context. We have already seen examples of its usage throughout the book so far. One aspect that has not yet been examined in-depth is the concept of a **default server**.

A default server in NGINX means that it is the first server defined in a particular configuration with the same `listen` IP address and port as another server. A default server may also be denoted by the `default_server` parameter to the `listen` directive.

The default server is useful to define a set of common directives that will then be reused for subsequent servers listening on the same IP address and port:

```
server {

    listen 127.0.0.1:80;

    server_name default.example.com;

    server_name_in_redirect on;

}

server {

    listen 127.0.0.1:80;

    server_name www.example.com;

}
```

In this example, the `www.example.com` server will have the `server_name_in_redirect` directive set to `on` as well as the `default.example.com` server. Note that this would also work if both servers had no `listen` directive, since they would still both match the same IP address and port number (that of the default value for listen, which is `*:80`). Inheritance, though, is not guaranteed. There are only a few directives that are inherited, and which ones are changes over time.

A better use for the default server is to handle any request that comes in on that IP address and port, and does not have a `Host` header. If you do not want the default server to handle requests without a `Host` header, it is possible to define an empty `server_name` directive. This server will then match those requests.

```
server {

    server_name "";

}
```

The following table summarizes the directives relating to `server`:

Table: HTTP server directives

Directive	Explanation
`port_in_redirect`	Determines whether or not the port will be specified in a redirect issued by NGINX.
`server`	Creates a new configuration context, defining a virtual host. The `listen` directive specifies the IP address(es) and port(s); the `server_name` directive lists the `Host` header values that this context matches.
`server_name`	Configures the names that a virtual host may respond to.
`server_name_in_redirect`	Activates using the first value of the `server_name` directive in any redirect issued by NGINX within this context.

`server_tokens`	Disables sending the NGINX version string in error messages and the `Server` response header (default value is `on`).

Logging

NGINX has a very flexible logging model. Each level of configuration may have an access log. In addition, more than one access log may be specified per level, each with a different `log_format`. The `log_format` directive allows you to specify exactly what will be logged, and needs to be defined within the `http` section.

The path to the log file itself may contain variables, so that you can build a dynamic configuration. The following example describes how this can be put into practice:

```
http {

    log_format vhost '$host $remote_addr - $remote_user
[$time_local] '
                     '"$request" $status $body_bytes_sent '
                     '"$http_referer" "$http_user_agent"';

    log_format downloads '$time_iso8601 $host $remote_addr '
                     '"$request" $status $body_bytes_sent
$request_time';

    open_log_file_cache max=1000 inactive=60s;

    access_log logs/access.log;

    server {

        server_name ~^(www\.)?(.+)$;

        access_log logs/combined.log vhost;

        access_log logs/$2/access.log;

        location /downloads {

            access_log logs/downloads.log downloads;

        }

    }

}
```

The following table describes the directives used in the preceding code:

Table: HTTP logging directives

Directive	Explanation
`access_log`	Describes where and how access logs are to be written. The first parameter is a path to the file where the logs are to be stored. Variables may be used in constructing the path. The special value `off` disables the access log. An optional second parameter indicates `log_format` that will be used to write the logs. If no second parameter is configured, the predefined combined format is used. An optional third parameter indicates the size of the buffer if write buffering should be used to record the logs. If write buffering is used, this size cannot exceed the size of the atomic disk write for that filesystem. If this third parameter is `gzip`, then the buffered logs will be compressed on-the-fly, provided that the `nginx` binary was built with the `zlib` library. A final `flush` parameter indicates the maximum length of time buffered log data may remain in memory before being flushed to disk.
`log_format`	Specifies which fields should appear in the log file and what format they should take. See the next table for a description of the log-specific variables.
`log_not_found`	Disables reporting of 404 errors in the error log (default value is `on`).
`log_subrequest`	Enables logging of subrequests in the access log (default value is `off`).
`open_log_file_cache`	Stores a cache of open file descriptors used in `access_logs` with a variable in the path. The parameters used are: • `max`: The maximum number of file descriptors present in the cache • `inactive`: NGINX will wait this amount of time for something to be written to this log before its file descriptor is closed • `min_uses`: The file descriptor has to be used this amount of times within the `inactive` period in order to remain open • `valid`: NGINX will check this often to see if the file descriptor still matches a file with the same name • `off`: Disables the cache

In the following example, log entries will be compressed at a gzip level of 4. The buffer size is the default of 64 KB and will be flushed to disk at least every minute.

```
access_log /var/log/nginx/access.log.gz combined gzip=4 flush=1m;
```

Note that when specifying `gzip` the `log_format` parameter is not optional.

The default combined `log_format` is constructed like this:

```
log_format combined '$remote_addr - $remote_user [$time_local] '
                    '"$request" $status $body_bytes_sent '
                    '"$http_referer" "$http_user_agent"';
```

As you can see, line breaks may be used to improve readability. They do not affect the `log_format` itself. Any variables may be used in the `log_format` directive. The variables in the following table which are marked with an asterisk (`*`) are specific to logging and may only be used in the `log_format` directive. The others may be used elsewhere in the configuration, as well.

Table: Log format variables

Variable Name	**Value**
`$body_bytes_sent`	The number of bytes sent to the client, excluding the response header.
`$bytes_sent`	The number of bytes sent to the client.
`$connection`	A serial number, used to identify unique connections.
`$connection_requests`	The number of requests made through a particular connection.
`$msec`	The time in seconds, with millisecond resolution.

`$pipe *`	Indicates if the request was pipelined (`p`) or not (`.`).
`$request_length *`	The length of the request, including the HTTP method, URI, HTTP protocol, header, and request body.
`$request_time`	The request processing time, with millisecond resolution, from the first byte received from the client to the last byte sent to the client.
`$status`	The response status.
`$time_iso8601 *`	Local time in ISO8601 format.
`$time_local *`	Local time in common log format (`%d/%b/%Y:%H:%M:%S %z`).

In this section, we have focused solely on `access_log` and how that can be configured. You can also configure NGINX to log errors. The `error_log` directive is described in Chapter 8, *Troubleshooting*.

Finding files

In order for NGINX to respond to a request, it passes it to a content handler, determined by the configuration of the `location` directive. The unconditional content handlers are tried first: `perl`, `proxy_pass`, `flv`, `mp4`, and so on. If none of these is a match, the request is passed to one of the following, in order: `random index`, `index`, `autoindex`, `gzip_static`, `static`. Requests with a trailing slash are handled by one of the index handlers. If gzip is not activated, then the static module handles the request. How these modules find the appropriate file or directory on the filesystem is determined by a combination of certain directives. The `root` directive is best defined in a default `server` directive, or at least outside of a specific `location` directive, so that it will be valid for the whole server:

```
server {

    root /home/customer/html;

    location / {

        index index.html index.htm;

    }
    location /downloads {

        autoindex on;

    }

}
```

In the preceding example any files to be served are found under the root `/home/customer/html`. If the client entered just the domain name, NGINX will try to serve `index.html`. If that file does not exist, then NGINX will serve `index.htm`. When a user enters the `/downloads` URI in their browser, they will be presented with a directory listing in HTML format. This makes it easy for users to access sites hosting software that they would like to download. NGINX will automatically rewrite the URI of a directory so that the trailing slash is present, and then issue an HTTP redirect. NGINX appends the URI to the `root` to find the file to deliver to the client. If this file does not exist, the client receives a **404 Not Found** error message. If you don't want the error message to be returned to the client, one alternative is to try to deliver a file from different filesystem locations, falling back to a generic page, if none of those options are available. The `try_files` directive can be used as follows:

```
location / {

    try_files $uri $uri/ backups/$uri /generic-not-found.html;

}
```

As a security precaution, NGINX can check the path to a file it's about to deliver, and if part of the path to the file contains a symbolic link, it returns an error message to the client:

```
server {

    root /home/customer/html;

    disable_symlinks if_not_owner from=$document_root;

}
```

In the preceding example, NGINX will return a "Permission Denied" error if a symlink is found after `/home/customer/html`, and that symlink and the file it points to do not both belong to the same user ID.

The following table summarizes these directives:

Table: HTTP file-path directives

Directive	Explanation
`disable_symlinks`	Determines if NGINX should perform a symbolic link check on the path to a file before delivering it to the client. The following parameters are recognized: • `off`: Disables checking for symlinks (default) • `on`: If any part of a path is a symlink, access is denied • `if_not_owner`: If any part of a path contains a symlink in which the link and the referent have different owners, access to the file is denied • `from=part`: When specified, the path up to `part` is not checked for symlinks, everything afterward is according to either the `on` or `if_not_owner` parameter
`root`	Sets the path to the document root. Files are found by appending the URI to the value of this directive.
`try_files`	Tests the existence of files given as parameters. If none of the previous files are found, the last entry is used as a fallback, so ensure that this path or named `location` exists, or is set to return a status code indicated by =<status code>.

Name resolution

If logical names instead of IP addresses are used in an `upstream` or `*_pass` directive, NGINX will by default use the operating system's resolver to get the IP address, which is what it really needs to connect to that server. This will happen only once, the first time `upstream` is requested, and won't work at all if a variable is used in the `*_pass` directive. It is possible, though, to configure a separate resolver for NGINX to use. By doing this, you can override the TTL returned by DNS, as well as use variables in the `*_pass` directives.

```
server {
    resolver 192.168.100.2 valid=300s;
}
```

Table: Name resolution directives

Directive	Explanation
`resolver`	Configures one or more name servers to be used to resolve upstream server names into IP addresses. An optional `valid` parameter overrides the TTL of the domain name record.

In order to get NGINX to resolve an IP address anew, place the logical name into a variable. When NGINX resolves that variable, it implicitly makes a DNS look-up to find the IP address. For this to work, a `resolver` directive must be configured:

```
server {
    resolver 192.168.100.2;
    location / {
        set $backend upstream.example.com;
        proxy_pass http://$backend;
    }
}
```

Of course, by relying on DNS to find an upstream, you are dependent on the resolver always being available. When the resolver is not reachable, a gateway error occurs. In order to make the client wait time as short as possible, the `resolver_timeout` parameter should be set low. The gateway error can then be handled by an `error_page` designed for that purpose.

```
server {

    resolver 192.168.100.2;

    resolver_timeout 3s;

    error_page 504 /gateway-timeout.html;
    location / {

        proxy_pass http://upstream.example.com;

    }

}
```

Client interaction

There are a number of ways in which NGINX can interact with clients. This can range from attributes of the connection itself (IP address, timeouts, keepalive, and so on) to content negotiation headers. The directives listed in the following table describe how to set various headers and response codes to get the clients to request the correct page or serve up that page from its own cache:

Table: HTTP client interaction directives

Directive	Explanation
`default_type`	Sets the default MIME type of a response. This comes into play if the MIME type of the file cannot be matched to one of those specified by the `types` directive.
`error_page`	Defines a URI to be served when an error level response code is encountered. Adding an `=` parameter allows the response code to be changed. If the argument to this parameter is left empty, the response code will be taken from the URI, which must in this case be served by an upstream server of some sort.
`etag`	Disables automatically generating the `ETag` response header for static resources (default is `on`).

if_modified_since	Controls how the modification time of a response is compared to the value of the If-Modified-Since request header: • off: The If-Modified-Since header is ignored • exact: An exact match is made (default) • before: The modification time of the response is less than or equal to the value of the If-Modified-Since header
ignore_invalid_headers	Disables ignoring headers with invalid names (default is on). A valid name is composed of ASCII letters, numbers, the hyphen, and possibly the underscore (controlled by the underscores_in_headers directive).
merge_slashes	Disables the removal of multiple slashes. The default value of on means that NGINX will compress two or more / characters into one.
recursive_error_pages	Enables doing more than one redirect using the error_page directive (default is off).
types	Sets up a map of MIME types to file name extensions. NGINX ships with a conf/mime.types file that contains most MIME type mappings. Using include to load this file should be sufficient for most purposes.
underscores_in_headers	Enables the use of the underscore character in client request headers. If left at the default value off, evaluation of such headers is subject to the value of the ignore_invalid_headers directive.

The error_page directive is one of NGINX's most flexible. Using this directive, we may serve any page when an error condition presents. This page could be on the local machine, but could also be a dynamic page produced by an application server, and could even be a page on a completely different site.

```
http {

    # a generic error page to handle any server-level errors
    error_page 500 501 502 503 504 share/examples/nginx/50x.html;

    server {

        server_name www.example.com;

        root /home/customer/html;

        # for any files not found, the page located at
        #  /home/customer/html/404.html will be delivered
        error_page 404 /404.html;
        location / {

            # any server-level errors for this host will be
directed
            # to a custom application handler
            error_page 500 501 502 503 504 = @error_handler;

        }

        location /microsite {

            # for any non-existent files under the /microsite URI,
            #  the client will be shown a foreign page
            error_page 404 http://microsite.example.com/404.html;

        }

        # the named location containing the custom error handler
        location @error_handler {

            # we set the default type here to ensure the browser
            # displays the error page correctly
            default_type text/html;

            proxy_pass http://127.0.0.1:8080;

        }

    }

}
```

Using limits to prevent abuse

We build and host websites because we want users to visit them. We want our websites to always be available for legitimate access. This means that we may have to take measures to limit access to abusive users. We may define "abusive" to mean anything from one request per second to a number of connections from the same IP address. Abuse can also take the form of a **DDOS** (**distributed denial-of-service**) attack, where bots running on multiple machines around the world all try to access the site as many times as possible at the same time. In this section, we will explore methods to counter each type of abuse to ensure that our websites are available.

First, let's take a look at the different configuration directives that will help us achieve our goal:

Table: HTTP limits directives

Directive	**Explanation**
`limit_conn`	Specifies a shared memory zone (configured with `limit_conn_zone`) and the maximum number of connections that are allowed per key value.
`limit_conn_log_level`	When NGINX limits a connection due to the `limit_conn` directive, this directive specifies at which log level that limitation is reported.
`limit_conn_zone`	Specifies the key to be limited in `limit_conn` as the first parameter. The second parameter, zone, indicates the name of the shared memory zone used to store the key and current number of connections per key and the size of that zone (`name:size`).
`limit_rate`	Limits the rate (in bytes per second) at which clients can download content. The rate limit works on a connection level, meaning that a single client could increase their throughput by opening multiple connections.

`limit_rate_after`	Starts the `limit_rate` after this number of bytes have been transferred.
`limit_req`	Sets a limit with bursting capability on the number of requests for a specific key in a shared memory store (configured with `limit_req_zone`). The burst can be specified with the second parameter. If there shouldn't be a delay in between requests up to the burst, a third parameter `nodelay` needs to be configured.
`limit_req_log_level`	When NGINX limits the number of requests due to the `limit_req` directive, this directive specifies at which log level that limitation is reported. A delay is logged at a level one less than the one indicated here.
`limit_req_zone`	Specifies the key to be limited in `limit_req` as the first parameter. The second parameter, zone, indicates the name of the shared memory zone used to store the key and current number of requests per key and the size of that zone (`name:size`). The third parameter, `rate`, configures the number of requests per second (r/s) or per minute (r/m) before the limit is imposed.
`max_ranges`	Sets the maximum number of ranges allowed in a byte-range request. Specifying `0` disables byte-range support.

Here we limit access to 10 connections per unique IP address. This should be enough for normal browsing, as modern browsers open two to three connections per host. Keep in mind, though, that any users behind a proxy will all appear to come from the same address. So observe the logs for error code 503 (Service Unavailable), meaning that this limit has come into effect:

```
http {
    limit_conn_zone $binary_remote_addr zone=connections:10m;
    limit_conn_log_level notice;
    server {
        limit_conn connections 10;
    }
}
```

Limiting access based on a rate looks almost the same, but works a bit differently. When limiting how many pages per unit of time a user may request, NGINX will insert a delay after the first page request, up to a burst. This may or may not be what you want, so NGINX offers the possibility to remove this delay with the `nodelay` parameter:

```
http {
    limit_req_zone $binary_remote_addr zone=requests:10m rate=1r/s;
    limit_req_log_level warn;
    server {
        limit_req zone=requests burst=10 nodelay;
    }
}
```

Tip

Using $binary_remote_addr

We use the `$binary_remote_addr` variable in the preceding example to know exactly how much space storing an IP address will take. This variable takes 32 bytes on 32-bit platforms and 64 bytes on 64-bit platforms. So the `10m` zone we configured previously is capable of holding up to 320,000 states on 32-bit platforms or 160,000 states on 64-bit platforms.

We can also limit the bandwidth per client. This way we can ensure that a few clients don't take up all the available bandwidth. One caveat, though: the `limit_rate` directive works on a connection basis. A single client that is allowed to open multiple connections will still be able to get around this limit:

```
location /downloads {

    limit_rate 500k;

}
```

Alternatively, we can allow a kind of bursting to freely download smaller files, but make sure that larger ones are limited:

```
location /downloads {

    limit_rate_after 1m;

    limit_rate 500k;

}
```

Combining these different rate limitations enables us to create a configuration that is very flexible as to how and where clients are limited:

```
http {

    limit_conn_zone $binary_remote_addr zone=ips:10m;

    limit_conn_zone $server_name zone=servers:10m;

    limit_req_zone $binary_remote_addr zone=requests:10m rate=1r/s;

    limit_conn_log_level notice;

    limit_req_log_level warn;

    reset_timedout_connection on;

    server {

        # these limits apply to the whole virtual server
        limit_conn ips 10;
        # only 1000 simultaneous connections to the same
server_name
        limit_conn servers 1000;

        location /search {

            # here we want only the /search URL to be rate-limited
            limit_req zone=requests burst=3 nodelay;

        }

        location /downloads {

            # using limit_conn to ensure that each client is #
bandwidth-limited
            #  with no getting around it
            limit_conn connections 1;

            limit_rate_after 1m;

            limit_rate 500k;

        }

    }

}
```

Restricting access

In the previous section, we explored ways to limit abusive access to websites running under NGINX. Now we will take a look at ways to restrict access to a whole website or certain parts of it. Access restriction can take two forms here: restricting to a certain set of IP addresses, or restricting to a certain set of users. These two methods can also be combined to satisfy requirements that some users can access the website either from a certain set of IP addresses or if they are able to authenticate with a valid username and password.

The following directives will help us achieve these goals:

Table: HTTP access module directives

Directive	Explanation
`allow`	Allows access from this IP address, network, or `all`.
`auth_basic`	Enables authentication using HTTP Basic Authentication. The parameter string is used as the realm name. If the special value `off` is used, this indicates that the `auth_basic` value of the parent configuration level is negated.
`auth_basic_user_file`	Indicates the location of a file of `username:password:comment` tuples used to authenticate users. The `password` field needs to be encrypted with the crypt algorithm. The `comment` field is optional.
`deny`	Denies access from this IP address, network, or `all`.
`satisfy`	Allows access if `all` or `any` of the preceding directives grant access. The default value `all` indicates that a user must come from a specific network address and enter the correct password.

To restrict access to clients coming from a certain set of IP addresses, the `allow` and `deny` directives can be used as follows:

```
location /stats {

    allow 127.0.0.1;
    deny all;

}
```

This configuration will allow access to the `/stats` URI from the localhost only.

To restrict access to authenticated users, the `auth_basic` and `auth_basic_user_ file` directives are used as follows:

```
server {

    server_name restricted.example.com;

    auth_basic "restricted";

    auth_basic_user_file conf/htpasswd;

}
```

Any user wanting to access `restricted.example.com` would need to provide credentials matching those in the `htpasswd` file located in the `conf` directory of NGINX's root. The entries in the `htpasswd` file can be generated using any available tool that uses the standard UNIX `crypt()` function. For example, the following Ruby script will generate a file of the appropriate format:

```
#!/usr/bin/env ruby

# setup the command-line options
require 'optparse'

OptionParser.new do |o|

  o.on('-f FILE') { |file| $file = file }

  o.on('-u', "--username USER") { |u| $user = u }

  o.on('-p', "--password PASS") { |p| $pass = p }

  o.on('-c', "--comment COMM (optional)") { |c| $comm = c }

  o.on('-h') { puts o; exit }

  o.parse!

  if $user.nil? or $pass.nil?
    puts o; exit
```

```
  end

end

# initialize an array of ASCII characters to be used for the salt
ascii = ('a'..'z').to_a + ('A'..'Z').to_a + ('0'..'9').to_a + [
".", "/" ]

$lines = []

begin

  # read in the current http auth file
  File.open($file) do |f|

    f.lines.each { |l| $lines << l }

  end

rescue Errno::ENOENT

  # if the file doesn't exist (first use), initialize the array
  $lines = ["#{$user}:#{$pass}\n"]

end

# remove the user from the current list, since this is the one
we're editing
$lines.map! do |line|

  unless line =~ /#{$user}:/

    line

  end

end

# generate a crypt()ed password
pass = $pass.crypt(ascii[rand(64)] + ascii[rand(64)])
# if there's a comment, insert it
if $comm

  $lines << "#{$user}:#{pass}:#{$comm}\n"

else

  $lines << "#{$user}:#{pass}\n"

end

# write out the new file, creating it if necessary

File.open($file, File::RDWR|File::CREAT) do |f|

  $lines.each { |l| f << l}

end
```

Save this file as `http_auth_basic.rb` and give it a filename (`-f`), a user (`-u`), and a password (`-p`), and it will generate entries appropriate to use in NGINX's `auth_basic_user_file` directive:

```
$ ./http_auth_basic.rb -f htpasswd -u testuser -p 123456
```

To handle scenarios where a username and password should only be entered if not coming from a certain set of IP addresses, NGINX has the `satisfy` directive. The `any` parameter is used here for this either/or scenario:

```
server {

    server_name intranet.example.com;

    location / {

        auth_basic "intranet: please login";

        auth_basic_user_file conf/htpasswd-intranet;

        allow 192.168.40.0/24;

        allow 192.168.50.0/24;

        deny all;
          satisfy any;

    }
```

If, instead, the requirements are for a configuration in which the user must come from a certain IP address and provide authentication, the `all` parameter is the default. So, we omit the `satisfy` directive itself and include only `allow`, `deny`, `auth_basic`, and `auth_basic_user_file`:

```
server {
    server_name stage.example.com;
    location / {
        auth_basic "staging server";
        auth_basic_user_file conf/htpasswd-stage;
        allow 192.168.40.0/24;
        allow 192.168.50.0/24;
        deny all;
    }
```

Streaming media files

NGINX is capable of serving certain video media types. The `flv` and `mp4` modules, included in the base distribution, can perform what is called **pseudo-streaming**. This means that NGINX will seek to a certain location in the video file, as indicated by the `start` request parameter.

In order to use the pseudo-streaming capabilities, the corresponding module needs to be included at compile time: `--with-http_flv_module` for Flash Video (FLV) files and/or `--with-http_mp4_module` for H.264/AAC files. The following directives will then become available for configuration:

Table: HTTP streaming directives

Directive	Explanation
`flv`	Activates the `flv` module for this location.
`mp4`	Activates the `mp4` module for this location.
`mp4_buffer_size`	Sets the initial buffer size for delivering MP4 files.
`mp4_max_buffer_size`	Sets the maximum size of the buffer used to process MP4 metadata.

Activating FLV pseudo-streaming for a location is as simple as just including the `flv` keyword:

```
location /videos {

    flv;

}
```

There are more options for MP4 pseudo-streaming, as the H.264 format includes metadata that needs to be parsed. Seeking is available once the "moov atom" has been parsed by the player. So to optimize performance, ensure that the metadata is at the beginning of the file. If an error message such as the following shows up in the logs, the `mp4_max_buffer_size` needs to be increased:

```
mp4 moov atom is too large
```

`mp4_max_buffer_size` can be increased as follows:

```
location /videos {
    mp4;
    mp4_buffer_size 1m;
    mp4_max_buffer_size 20m;
}
```

Predefined variables

NGINX makes constructing configurations based on the values of variables easy. Not only can you instantiate your own variables by using the `set` or `map` directives, but there are also predefined variables used within NGINX. They are optimized for quick evaluation and the values are cached for the lifetime of a request. You can use any of them as a key in an `if` statement, or pass them on to a proxy. A number of them may prove useful if you define your own log file format. If you try to redefine any of them, though, you will get an error message as follows:

```
<timestamp> [emerg] <master pid>#0: the duplicate "<variable_name>"
variable in <path-to-configuration-file>:<line-number>
```

They are also not made for macro expansion in the configuration—they are mostly used at run time.

The following are the variables and their values defined in the `http` module:

Table: HTTP variables

Variable Name	Value
`$arg_name`	The `name` argument present in the request parameters.
`$args`	All of the request parameters.
`$binary_remote_addr`	The client's IP address in binary form (always 4 bytes long).
`$content_length`	The value of the `Content-Length` request header.
`$content_type`	The value of the `Content-Type` request header.
`$cookie_name`	The cookie labeled `name`.

`$document_root`	The value of the `root` or `alias` directive for the current request.
`$document_uri`	An alias for `$uri`.
`$host`	The value of the `Host` request header, if present. If this header is not present, the value is equal to the `server_name` matching the request.
`$hostname`	The name of the host where NGINX is running.
`$http_name`	The value of the `name` request header. If this header has dashes, they are converted to underscores; capital letters to lower case.
`$https`	If the connection was made over SSL, the value of this variable is `on`. Otherwise, it's an empty string.
`$is_args`	If the request has arguments, the value of this variable is `?`. Otherwise, it's an empty string.
`$limit_rate`	The value of the `limit_rate` directive. If not set, allows rate limitation to be set using this variable.
`$nginx_version`	The version of the running `nginx` binary.
`$pid`	The process ID of the worker process.
`$query_string`	An alias for `$args`.
`$realpath_root`	The value of the `root` or `alias` directive for the current request, with all symbolic links resolved.

$remote_addr	The client's IP address.
$remote_port	The client's port.
$remote_user	When using HTTP basic authentication, this variable is set to the username.
$request	The complete request, as received from the client, including the HTTP method, URI, HTTP protocol, header, and request body.
$request_body	The body of the request, for use in locations processed by a `*_pass directive`.
$request_body_file	The path to the temporary file where the request's body is saved. For this file to be saved, the `client_body_in_file_only` directive needs to be set to `on`.
$request_completion	If the request has completed, the value of this variable is `OK`. Otherwise, it's an empty string.
$request_filename	The path to the file for the current request, based on the value of the `root` or `alias` directive plus the URI.
$request_method	The HTTP method used in the current request.
$request_uri	The complete request URI, as received from the client, including arguments.
$scheme	The scheme for the current request, either HTTP or HTTPS.
$sent_http_name	The value of the `name` response header. If this header has dashes, they are converted to underscores; capital letters to lower case.

`$server_addr`	The value of the server's address that accepted the request.
`$server_name`	The `server_name` of the virtual host that accepted the request.
`$server_port`	The value of the server's port that accepted the request.
`$server_protocol`	The HTTP protocol used in the current request.
`$status`	The response's status.

`$tcpinfo_rtt`
`$tcpinfo_rttvar`
`$tcpinfo_snd_cwnd`
`$tcpinfo_rcv_space`
	If a system supports the `TCP_INFO` socket option, these variables will be filled with the relevant information.

`$uri`	The normalized URI of the current request.

Using NGINX with PHP-FPM

Apache has long been considered the only option for serving PHP websites because the `mod_php` Apache module makes integrating PHP directly into the web server an easy task. With **PHP-FPM** being accepted into PHP's core, there is now an alternative bundled with the PHP distribution. PHP-FPM is a way of running PHP under a FastCGI server. The PHP-FPM master process takes care of spawning workers, adapting to site usage, and restarting sub processes when necessary. It communicates with other services using the FastCGI protocol. You can learn more about PHP-FPM itself at http://php.net/manual/en/install.fpm.php.

NGINX has a `fastcgi` module, which is capable of communicating not only with PHP-FPM, but also with any FastCGI-compliant server. It is enabled by default, so no special consideration needs to be made to start using NGINX with FastCGI servers.

Table: FastCGI directives

Directive	**Explanation**
`fastcgi_buffer_size`	The size of the buffer used for the first part of the response from the FastCGI server, in which the response headers are found.
`fastcgi_buffers`	The number and size of buffers used for the response from a FastCGI server, for a single connection.
`fastcgi_busy_buffers_size`	The total size of buffer space allocated to sending the response to the client while still being read from the FastCGI server. This is typically set to two `fastcgi_buffers`.
`fastcgi_cache`	Defines a shared memory zone to be used for caching.
`fastcgi_cache_bypass`	One or more string variables, which when non-empty or non-zero, will cause the response to be taken from the

	FastCGI server instead of the cache.
`fastcgi_cache_key`	A string used as the key for storing and retrieving cache values.
`fastcgi_cache_lock`	Enabling this directive will prevent multiple requests from making an entry into the same cache key.
`fastcgi_cache_lock_timeout`	The length of time a request will wait for an entry to appear in the cache or for the `fastcgi_cache_lock` to be released.
`fastcgi_cache_min_uses`	The number of requests for a certain key needed before a response is cached.
`fastcgi_cache_path`	A directory in which to place the cached responses and a shared memory zone (`keys_zone = name:size`) to store active keys and response metadata. Optional parameters are: • `levels`: Colon-separated length of subdirectory name at each level (one or two), maximum of three levels deep • `inactive`: The maximum length of time an inactive response stays in the cache before being ejected • `max_size`: The maximum size of the cache; when the size exceeds this value, a cache manager process removes the least recently used items • `loader_files`: The maximum number of cached files whose metadata are loaded per iteration of the cache loader process • `loader_sleep`: The number of milliseconds paused between each iteration of the cache loader process • `loader_threshold`: The maximum length of time a cache loader iteration may take
	The cases under which it is acceptable to serve stale

fastcgi_cache_use_stale	cached data if an error occurs when accessing the FastCGI server. The updating parameter indicates the case when fresh data are being loaded.
fastcgi_cache_valid	Indicates the length of time for which a cached response with response code 200, 301, or 302 is valid. If an optional response code is given before the time parameter, that time is only for that response code. The special parameter any indicates that any response code should be cached for that length of time.
fastcgi_connect_timeout	The maximum amount of time NGINX will wait for its connection to be accepted when making a request to a FastCGI server.
fastcgi_hide_header	A list of header fields that should not be passed on to the client.
fastcgi_ignore_client_abort	If set to on, NGINX will not abort the connection to a FastCGI server if the client aborts the connection.
fastcgi_ignore_headers	Sets which headers may be disregarded when processing the response from the FastCGI server.
fastcgi_index	Sets the name of a file to be appended to $fastcgi_script_name that ends with a slash.
fastcgi_intercept_errors	If enabled, NGINX will display a configured error_page instead of the response directly from the FastCGI server.
fastcgi_keep_conn	Enables keepalive connections to FastCGI servers by instructing the server not to immediately close the connection.
	The maximum size of the overflow file, written when the

fastcgi_max_temp_file_size	response doesn't fit into memory buffers.
fastcgi_next_upstream	Indicates the conditions under which the next FastCGI server will be selected for the response. This won't be used if the client has already been sent something. The conditions are specified using the following parameters: • error: An error occurred while communicating with the FastCGI server • timeout: A timeout occurred while communicating with the FastCGI server • invalid_header: The FastCGI server returned an empty or otherwise invalid response • http_500: The FastCGI server responded with a 500 error code • http_503: The FastCGI server responded with a 503 error code • http_404: The FastCGI server responded with a 404 error code • off: Disables passing the request to the next FastCGI server when an error occurs
fastcgi_no_cache	One or more string variables, which when non-empty or non-zero, will instruct NGINX to not save the response from the FastCGI server in the cache.
fastcgi_param	Sets a parameter and its value to be passed to the FastCGI server. If the parameter should only be passed when the value is non-empty, the if_not_empty additional parameter should be set.
fastcgi_pass	Specifies the FastCGI server to which the request is passed, either as an address:port combination or as unix:path for a UNIX-domain socket.
fastcgi_pass_header	Overrides the disabled headers set in fastcgi_hide_header, allowing them to be sent to the client.

fastcgi_read_timeout	Specifies the length of time that needs to elapse between two successive read operations from a FastCGI server before the connection is closed.
fastcgi_send_timeout	The length of time that needs to elapse between two successive write operations to a FastCGI server before the connection is closed.
fastcgi_split_path_info	Defines a regular expression with two captures. The first capture will be the value of the `$fastcgi_script_name` variable. The second capture becomes the value of the `$fastcgi_path_info` variable. Only necessary for applications that rely upon `PATH_INFO`.
fastcgi_store	Enables storing responses retrieved from a FastCGI server as files on disk. The `on` parameter will use the `alias` or `root` directive as the base path under which to store the file. A string may instead be given, to indicate an alternative location to store the files.
fastcgi_store_access	Sets file access permissions for newly-created `fastcgi_store` files.
fastcgi_temp_file_write_size	Limits the amount of data buffered to a temporary file at one time, so that NGINX will not block too long on a single request.
fastcgi_temp_path	A directory where temporary files may be buffered as they are proxied from the FastCGI server, optionally multilevel deep.

An example Drupal configuration

Drupal (http://drupal.org) is a popular open source content management platform. There is a large installed user base, and many popular websites are run on Drupal. As with most PHP web frameworks, Drupal is typically run under Apache using `mod_php`. We are going to explore how to configure NGINX to run Drupal.

There is a very comprehensive Drupal configuration guide for NGINX found at https://github.com/perusio/drupal-with-nginx. It goes more in-depth than we are able to do here, but we will point out some features mentioned, and go through some of the differences between Drupal 6 and Drupal 7:

```
## Defines the $no_slash_uri variable for drupal 6.
map $uri $no_slash_uri {

    ~^/(?<no_slash>.*)$ $no_slash;
}

server {

    server_name www.example.com;

    root /home/customer/html;

    index index.php;

    # keep alive to the FastCGI upstream (used in conjunction with
    #  the "keepalive" directive in the upstream section)
    fastcgi_keep_conn on;

    # The 'default' location.
    location / {
        ## (Drupal 6) Use index.html whenever there's no index.php.
        location = / {
            error_page 404 =200 /index.html;
        }
        # Regular private file serving (i.e. handled by Drupal).
        location ^~ /system/files/ {

            include fastcgi_private_files.conf;

            fastcgi_pass 127.0.0.1:9000;
            # For not signaling a 404 in the error log whenever the
            # system/files directory is accessed add the line
below.
            # Note that the 404 is the intended behavior.
            log_not_found off;

        }

        # Trying to access private files directly returns a 404.
        location ^~ /sites/default/files/private/ {
            internal;
        }

        ## (Drupal 6) If accessing an image generated by
imagecache,
        ## serve it directly if available, if not relay the request
```

```
to# Drupal
        ## to (re)generate the image.
        location ~* /imagecache/ {

            access_log off;

            expires 30d;

            try_files $uri /index.php?q=$no_slash_uri&$args;

        }

        # Drupal 7 image handling, i.e., imagecache in core
        location ~* /files/styles/ {

            access_log off;

            expires 30d;

            try_files $uri @drupal;

        }
```

The Advanced Aggregation module configuration coming up next differs only in the `location` used. The Advanced Aggregation module configuration for CSS is as follows:

```
        # Advanced Aggregation module CSS support.
        location ^~ /sites/default/files/advagg_css/ {
            location ~*
/sites/default/files/advagg_css/css_[[:alnum:]]+\.css$ {
```

And for JavaScript is as follows:

```
        # Advanced Aggregation module JS
        location ^~ /sites/default/files/advagg_js/ {
            location ~*
/sites/default/files/advagg_js/js_[[:alnum:]]+\.js$ {
```

The common lines to both sections are as follows:

```
                access_log off;

                add_header Pragma '';

                add_header Cache-Control 'public, max-
age=946080000';

                add_header Accept-Ranges '';

                # This is for Drupal 7
                try_files $uri @drupal;

                ## This is for Drupal 6 (use only one)
                try_files $uri /index.php?q=$no_slash_uri&$args;

            }

        }


        # All static files will be served directly.
        location ~* ^.+\.(?:css|cur|js|jpe?
g|gif|htc|ico|png|html|xml)$ {

            access_log off;

            expires 30d;

            # Send everything all at once.
            tcp_nodelay off;

            # Set the OS file cache.
            open_file_cache max=3000 inactive=120s;
            open_file_cache_valid 45s;

            open_file_cache_min_uses 2;

            open_file_cache_errors off;

        }

        # PDFs and powerpoint files handling.
        location ~* ^.+\.(?:pdf|pptx?)$ {

            expires 30d;

            # Send everything all at once.
            tcp_nodelay off;

        }
```

Serving audio files exemplifies the use of AIO. The MP3 `location` is as follows:

```
# MP3 files are served using AIO where supported by the OS.
location ^~ /sites/default/files/audio/mp3 {

    location ~* ^/sites/default/files/audio/mp3/.*\.mp3$ {
```

And Ogg/Vorbis `location` is as follows:

```
# Ogg/Vorbis files are served using AIO where supported by
theOS.
location ^~ /sites/default/files/audio/ogg {

    location ~* ^/sites/default/files/audio/ogg/.*\.ogg$ {
```

These have the following lines in common:

```
        directio 4k; # for XFS

        tcp_nopush off;
        aio on;
        output_buffers 1 2M;
    }

}
# Pseudo-streaming of FLV files
location ^~ /sites/default/files/video/flv {

    location ~* ^/sites/default/files/video/flv/.*\.flv$ {

        flv;

    }

}
```

The next two pseudo-streaming sections are also similar. The pseudo-streaming for H264 file is specified in the following code:

```
# Pseudo-streaming of H264 files.
location ^~ /sites/default/files/video/mp4 {

    location ~* ^/sites/default/files/video/mp4/.*\.
(?:mp4|mov)$ {
```

And pseudo-streaming for AAC files is specified in the following code:

```
# Pseudo-streaming of AAC files.
location ^~ /sites/default/files/video/m4a {

    location ~* ^/sites/default/files/video/m4a/.*\.m4a$ {
```

These have the following common between them:

```
                mp4;

                mp4_buffer_size         1M;

                mp4_max_buffer_size 5M;

            }

        }

        # Advanced Help module makes each module-provided
        # README available.
        location ^~ /help/ {

            location ~* ^/help/[^/]*/README\.txt$ {
                include fastcgi_private_files.conf;

                fastcgi_pass 127.0.0.1:9000;

            }
        }

        # Replicate the Apache <FilesMatch> directive of Drupal #
standard
        # .htaccess. Disable access to any code files. Return a 404
to# curtail
        # information disclosure. Also hide the text files.
        location ~* ^(?:.+\.
(?:htaccess|make|txt|engine|inc|info|install|module|profile|po|sh|.
*sql|test|theme|tpl(?:\.php)?|xtmpl)|code-
style\.pl|/Entries.*|/Repository|/Root|/Tag|/Template)$ {

            return 404;

        }

        #First we try the URI and relay to the /index.php?
q=$uri&$argsif not found.
        try_files $uri @drupal;

        ## (Drupal 6) First we try the URI and relay to the
/index.php?q=$no_slash_uri&$args if not found. (use only one)
        try_files $uri /index.php?q=$no_slash_uri&$args;

    } # default location ends here

    # Restrict access to the strictly necessary PHP files.
Reducingthe
    # scope for exploits. Handling of PHP code and the Drupal
eventloop.
    location @drupal {

        # Include the FastCGI config.
        include fastcgi_drupal.conf;
```

```
        fastcgi_pass 127.0.0.1:9000;

    }

    location @drupal-no-args {
        include fastcgi_private_files.conf;

        fastcgi_pass 127.0.0.1:9000;

    }

    ## (Drupal 6)
    ## Restrict access to the strictly necessary PHP files.
Reducing# the
    ## scope for exploits. Handling of PHP code and the Drupal
event # loop.
    ## (use only one)
    location = /index.php {

        # This is marked internal as a pro-active security
practice.
        # No direct access to index.php is allowed; all accesses
are# made
        #  by NGINX from other locations or internal redirects.
        internal;

        fastcgi_pass 127.0.0.1:9000;

    }
```

The following `locations` all have `return 404` in order to deny access:

```
    # Disallow access to .git directory: return 404 as not to
disclose
    # information.
    location ^~ /.git { return 404; }
    # Disallow access to patches directory.
    location ^~ /patches { return 404; }
    # Disallow access to drush backup directory.
    location ^~ /backup { return 404; }
    # Disable access logs for robots.txt.
    location = /robots.txt {

        access_log off;

    }

    # RSS feed support.
    location = /rss.xml {

        try_files $uri @drupal-no-args;
        ## (Drupal 6: use only one)
        try_files $uri /index.php?q=$uri;

    }

    # XML Sitemap support
```

```
        # XML sitemap support.
        location = /sitemap.xml {
            try_files $uri @drupal-no-args;

            ## (Drupal 6: use only one)
            try_files $uri /index.php?q=$uri;
        }

        # Support for favicon. Return an 1x1 transparent GIF if it
    doesn't
        # exist.
        location = /favicon.ico {

            expires 30d;

            try_files /favicon.ico @empty;

        }

        # Return an in-memory 1x1 transparent GIF.
        location @empty {

            expires 30d;

            empty_gif;

        }

        # Any other attempt to access PHP files returns a 404.
        location ~* ^.+\.php$ {

            return 404;

        }

    } # server context ends here
```

The `include` files mentioned above are not reproduced here, for brevity's sake. They can be found in perusio's GitHub repository mentioned at the beginning of this section.

Wiring NGINX and uWSGI together

The Python **WSGI** (**Web Server Gateway Interface**) is an interface specification formalized as PEP-3333 (http://www.python.org/dev/peps/pep-3333/). Its purpose is to provide a "standard interface between web servers and Python web applications or frameworks to promote web application portability across a variety of web servers". Due to its popularity in the Python community, a number of other languages have implementations that conform to the WSGI specification. The uWSGI server, although not written exclusively for Python, provides a way of running applications that conform to this specification. The native protocol used to communicate with the uWSGI server is called uwsgi. More details about the uWSGI server, including installation instructions, example configurations, and other supported languages can be found at http://projects.unbit.it/uwsgi/ and https://github.com/unbit/uwsgi-docs.

NGINX's `uwsgi` module can be configured to talk to this server using directives similar to the `fastcgi_*` directives discussed in the previous section. Most directives have the same meaning as their FastCGI counterparts, with the obvious difference being that they begin with `uwsgi_` instead of `fastcgi_`. There are a few exceptions however—`uwsgi_modifier1` and `uwsgi_modifier2`, as well as `uwsgi_string`. The first two directives set either the first or second modifier, respectively, of the uwsgi packet header. `uwsgi_string` enables NGINX to pass an arbitrary string to uWSGI, or any other uwsgi server that supports the eval modifier. These modifiers are specific to the uwsgi protocol. A table of valid values and their meanings can be found at http://uwsgi-docs.readthedocs.org/en/latest/Protocol.html.

An example Django configuration

Django (https://www.djangoproject.com/) is a Python web framework in which developers can quickly create high-performing web applications. It has become a popular framework in which many different kinds of web applications are written.

The following configuration is an example of how to connect NGINX to multiple Django applications running under an Emperor mode uWSGI server with FastRouter activated. See the URLs embedded in the comments in the following code for more information about running uWSGI like this:

```
http {
    # spawn a uWSGI server to connect to
    # uwsgi --master --emperor /etc/djangoapps --fastrouter
127.0.0.1:3017 --fastrouter-subscription-server 127.0.0.1:3032
    # see http://uwsgi-docs.readthedocs.org/en/latest/Emperor.html
    # and http://projects.unbit.it/uwsgi/wiki/Example
    upstream emperor {
        server 127.0.0.1:3017;
    }
```

```
    server {
        # the document root is set with a variable so that multiple
# sites
        # may be served - note that all static application files
are
        # expected to be found under a subdirectory "static" and
all# user
        # uploaded files under a subdirectory "media"
        # see https://docs.djangoproject.com/en/dev/howto/static-
files/
        root /home/www/sites/$host;

        location / {
            # CSS files are found under the "styles" subdirectory
            location ~* ^.+\.$ {
                root /home/www/sites/$host/static/styles;
                expires 30d;
            }
            # any paths not found under the document root get
passed # to
            #  the Django running under uWSGI
            try_files $uri @django;
        }

        location @django {
            # $document_root needs to point to the application code
            root /home/www/apps/$host;
            # the uwsgi_params file from the nginx distribution
            include uwsgi_params;
            # referencing the upstream we defined earlier, a uWSGI
# server
            #  running in Emperor mode with FastRouter
            uwsgi_param UWSGI_FASTROUTER_KEY $host;
            uwsgi_pass emperor;
        }

        # the robots.txt file is found under the "static"
subdirectory
        # an exact match speeds up the processing

        location = /robots.txt {
            root /home/www/sites/$host/static;
            access_log off;
        }

        # again an exact match
        location = /favicon.ico {
            error_page 404 = @empty;
            root /home/www/sites/$host/static;
            access_log off;
            expires 30d;
        }

        # generates the empty image referenced above
        location @empty {
            empty_gif;
        }
```

```
            # if anyone tries to access a '.py' file directly,
            #  return a File Not Found code
            location ~* ^.+\.py$ {
                return 404;
            }
        }
    }
```

This enables multiple sites to be dynamically hosted without changing the NGINX configuration.

Summary

In this chapter, we have explored a number of directives used to make NGINX serve files over HTTP. Not only does the `http` module provide this functionality, but there are also a number of helper modules that are essential to the normal operation of NGINX. These helper modules are enabled by default. Combining the directives of these various modules enables us to build a configuration that meets our needs. We explored how NGINX finds files based on the URI requested. We examined how different directives control how the HTTP server interacts with the client, and how the `error_page` directive can be used to serve a number of needs. Limiting access based on bandwidth usage, request rate, and number of connections is all possible.

We saw, too, how we can restrict access based on either IP address or through requiring authentication. We explored how to use NGINX's logging capabilities to capture just the information we want. Pseudo-streaming was examined briefly, as well. NGINX provides us with a number of variables that we can use to construct our configurations. We also explored the possibility of using the `fastcgi` module to connect to the PHP-FPM applications and the `uwsgi` module to communicate with a uWSGI server. The example configurations combined the directives discussed in this chapter, as well as some discussed in other chapters.

The next chapter will introduce some modules that will help you as a developer integrate NGINX into your application.

Chapter 7. NGINX for the Developer

Throughout the book so far, we have seen how to configure NGINX for a number of different scenarios. What we have not yet done is look at the possibilities that NGINX offers the application developer. There are a number of ways that NGINX can be integrated directly into your application. We will explore those possibilities in the following sections:

- Caching integration
- Changing content on-the-fly
- Using Server Side Includes
- Decision-making in NGINX
- Creating a secure link
- Generating images
- Tracking website visitors
- Preventing inadvertent code execution

Caching integration

NGINX is superb at serving static content. It is designed to support over 100,000 simultaneous connections while using only minimal system resources. Integrating a dynamic web application into such a well-architected server may mean a performance hit for the server. We may not be able to support as many simultaneous connections, but that does not mean that we cannot still give our users a snappy web experience.

Caching was introduced in Chapter 5, *Reverse Proxy Advanced Topics*. In this section, we will take an in-depth view of integrating NGINX's caching mechanisms into a web application. Your web application may already cache to a certain extent. Perhaps it writes pre-rendered pages into a database so that an expensive rendering task does not have to be repeated at each page view. Or, even better, your application may write prerendered pages into the filesystem, so that they can simply be served by NGINX's stellar static file performance. No matter the caching mechanism your application already has (even if it has none), NGINX offers a way to integrate it into the server.

No application caching

When your application does no caching at all, NGINX can still help speed up your users' response times. Both the `proxy` and the `fastcgi` modules are able to make use of this caching feature. You will therefore either be using the `proxy_cache_*` or the `fastcgi_cache_*` directives to configure caching for your application. The `proxy_cache_*` directives were described in the *Caching* section in Chapter 5, *Reverse Proxy Advanced Topics*; the `fastcgi_cache_*` directives summarized in Chapter 6, *The NGINX HTTP*

Server.

Here we will describe how to extend your application to instruct NGINX how to cache individual pages. This is done by using headers sent to NGINX. You can use either the standard `Expires` and `Cache-Control` headers or the special `X-Accel-Expires` header, which NGINX interprets for caching and does not pass on to the client. This header allows the application to completely control how long NGINX caches a file. This makes it very easy to expire normally long-lived objects.

Let's say that you have a news application that's suffering from slow page load times. This can happen for different reasons, but after analysis, you have determined that each page is rendered in real time from the content stored in a database. When a user visits the site, this causes a new database connection to be opened, multiple SQL queries to be made, and the result to be parsed, before a fully-rendered page can be delivered to that user. Due to multiple connections in the application's backend system, the architecture cannot easily be restructured to make use of a more reasonable rendering strategy.

Given these restrictions, you decide on the following caching strategy:

- The front page is to be cached for 1 minute, as this contains links to articles and the list is frequently updated
- Each article will be cached for 1 day because once written they don't change, but we don't want the cache to be filled with older entries that need to be removed due to lack of space
- Any image will be cached for as long as possible, due to the images also being stored in the database, making it a truly expensive operation to retrieve them

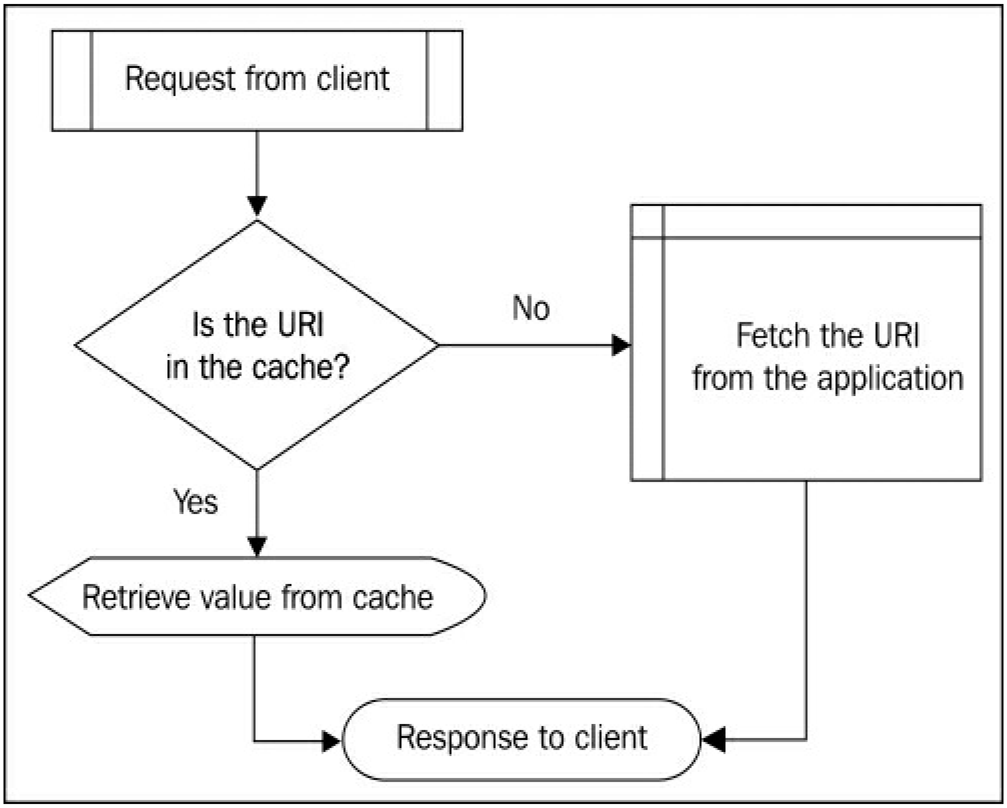
We will configure NGINX to support this strategy as follows:

```
http {

    # here we configure two separate shared memory zones for the
keys/metadata
    #   and filesystem paths for the cached objects themselves
    proxy_cache_path /var/spool/nginx/articles
keys_zone=ARTICLES:16m levels=1:2 inactive=1d;

    proxy_cache_path /var/spool/nginx/images keys_zone=IMAGES:128m
levels=1:2 inactive=30d;

    # but both paths still lie on the same filesystem as
proxy_temp_path
    proxy_temp_path /var/spool/nginx;

    server {

        location / {

            # this is where the list of articles is found
            proxy_cache_valid 1m;

        }

        location /articles {

            # each article has a URI beginning with "/articles"
            proxy_cache_valid 1d;

        }

        location /img {

            # every image is referenced with a URI under "/img"
            proxy_cache_valid 10y;

        }

}
```

That takes care of our requirements. We have now activated caching for a legacy application that has no caching support.

Caching in the database

If your application currently caches prerendered pages in a database, it should be possible without too much additional effort to place those pages into a memcached instance instead. NGINX is capable of answering requests directly from what is stored in memcached. The logic is shown in the following figure:



The interface is very simple, allowing it to be as flexible as possible. NGINX looks up a key in the store. If it is found, the value is returned to the client. Constructing the proper key is a configuration task, which we will discuss next. Storing the value at that key is outside the scope of what NGINX was designed to do. That job belongs to the application.

Determining which key to use is a fairly simple task. For resources that are not personalized, the best key to use is the URI itself. This is set in the `$memcached_key` variable:

```
location / {
    set $memcached_key $uri;
    memcached_pass 127.0.0.1:11211;
}
```

If your application reads request arguments to construct a page, then the `$memcached_key` should include these as well:

```
location / {
    set $memcached_key "$uri?$args";
    memcached_pass 127.0.0.1:11211;
}
```

If the key is not present, NGINX will need a means of requesting the page from the application. Hopefully, the application will then write the key/value pair into memcached so that the next request can be directly served from memory. NGINX will report a "Not Found" error if the key couldn't be found in memcached, so the best way to then pass the request to the application is to use the `error_page` directive and a `location` to handle the request. We should also include the error codes for a "Bad Gateway" error and a "Gateway Timeout" error, in case memcached does not respond to our key lookup:

```
server {
    location / {
        set $memcached_key "$uri?$args";
        memcached_pass 127.0.0.1:11211;
        error_page 404 502 504 = @app;
    }
    location @app {
        proxy_pass 127.0.0.1:8080;
    }
}
```

Remember that by using the equals sign (`=`) in the arguments to `error_page`, NGINX will substitute in the return code from the last argument. This enables us to turn an error condition into a normal response.

The following table describes the directives available with the `memcached` module, which is compiled into an `nginx` binary by default:

Table: Memcached module directives

Directive	Explanation
`memcached_buffer_size`	The size of the buffer for the response from memcached. This response is then sent synchronously to the client.
`memcached_connect_timeout`	The maximum length of time NGINX will wait for its connection to be accepted when making a request to a memcached server.

memcached_next_upstream	The conditions under which a request will be passed to the next memcached server, as specified by one or more of the following parameters: • error: An error occurred when communicating with the memcached server • timeout: A timeout was reached when communicating with the memcached server • invalid_response: The memcached server returned an empty or otherwise invalid response • not_found: The key was not found on this memcached instance • off: Disables passing a request to the next memcached server
memcached_pass	Specifies the name or address of a memcached server and its port. May also be a server group, as declared in an upstream context.
memcached_read_timeout	Specifies the length of time that needs to elapse between two successive read operations from a memcached server before the connection is closed.
memcached_send_timeout	The length of time that needs to elapse between two successive write operations to a memcached server before the connection is closed.

Caching in the filesystem

Suppose your application writes prerendered pages as files. You know how long each file should be valid. You can configure NGINX to deliver certain headers with each file that instruct the client, and any proxy in between, how long the file should be cached. In this way, you have enabled a local cache for your users without having to change a single line of code.

You can do this by setting the Expires and Cache-Control headers. These are standard HTTP headers understood by clients and HTTP proxies alike. No change is required in your application; you merely need to set these headers in the NGINX configuration block for the corresponding locations. NGINX makes it convenient by providing the `expires` and `add_header` directives.

Table: Header modifying directives

Directive	Explanation
`add_header`	Adds fields to a header present in the responses with HTTP codes 200, 204, 206, 301, 302, 303, 304, or 307.
`expires`	Adds or modifies the `Expires` and `Cache-Control` headers. The parameters can be an optional `modified` parameter, followed by `time`, or one of `epoch`, `max`, or `off`. If `time` alone is present, the `Expires` header will be set to the current time plus the time specified in the `time` parameter. `Cache-Control` will be set to `max-age=t`, where `t` is the time specified as an argument, in seconds. If the `modified` parameter precedes a `time` value, the `Expires` header is set to the file's modification time plus the time specified in the `time` parameter. If the `time` contains an `@`, the time specified will be interpreted as the time of day; for example, `@12h` is 12 noon. `epoch` is defined to be the exact date and time `Thu, 01 Jan 1970 00:00:01 GMT`. `max` sets `Expires` to `Thu, 31 Dec 2037 23:55:55 GMT` and `Cache-Control` to 10 years. Any negative time will set `Cache-Control` to `no-cache`.

Knowing what you do about the files your application generates, you can set these headers appropriately. Let's take an example application where the main page should be cached for 5 minutes, all JavaScript and CSS files for 24 hours, each HTML page for 3 days, and each image for as long as possible:

```
server {

    root /home/www;

    location / {

        # match the index.html page explicitly so the *.html below
        #  won't match the main page
        location = /index.html  {

            expires 5m;

        }

        # match any file ending in .js or .css (Javascript or CSS
files)
        location ~* /.*\.(js|css)$ {

            expires 24h;

        }

        # match any page ending in .html
        location ~* /.*\.html$ {

            expires 3d;

        }

    }

    # all of our images are under a separate location (/img)
    location /img {

        expires max;

    }

}
```

To see how this configuration sets the headers, let's take a look at what each location looks like in the browser. Each modern browser has a tool either built-in or available as a plug-in that enables you to view the headers of both the request and the response. The following series of screenshots show how Chrome displays the response headers for these locations:

- **The main page** (`index.html`): The `Expires` header is set to 5 minutes later than the `Date` header. The `Cache-Control` header has a `max-age` parameter set to 300 seconds.

```
▼Response Headers    view parsed
  HTTP/1.1 200 OK
  Server: nginx/1.2.2
  Date: Sat, 15 Dec 2012 19:01:33 GMT
  Content-Type: text/html
  Content-Length: 170
  Last-Modified: Sat, 15 Dec 2012 18:31:41 GMT
  Connection: keep-alive
  Expires: Sat, 15 Dec 2012 19:06:33 GMT
  Cache-Control: max-age=300
  Accept-Ranges: bytes
```

- **A CSS file**: The `Expires` header is set to 24 hours later than the `Date` header. The `Cache-Control` header has a `max-age` parameter of 86400 seconds.

```
▼Response Headers    view parsed
  HTTP/1.1 200 OK
  Server: nginx/1.2.2
  Date: Sat, 15 Dec 2012 19:07:43 GMT
  Content-Type: text/plain
  Content-Length: 69
  Last-Modified: Sat, 15 Dec 2012 18:31:33 GMT
  Connection: keep-alive
  Expires: Sun, 16 Dec 2012 19:07:43 GMT
  Cache-Control: max-age=86400
  Accept-Ranges: bytes
```

- **An HTML file**: The `Expires` header is set to 3 days later than the `Date` header. The `Cache-Control` header has a `max-age` parameter set to 259200 seconds.

```
▼Response Headers    view parsed
  HTTP/1.1 200 OK
  Server: nginx/1.2.2
  Date: Sat, 15 Dec 2012 19:10:16 GMT
  Content-Type: text/html
  Content-Length: 170
  Last-Modified: Sat, 15 Dec 2012 18:39:12 GMT
  Connection: keep-alive
  Expires: Tue, 18 Dec 2012 19:10:16 GMT
  Cache-Control: max-age=259200
  Accept-Ranges: bytes
```

- **An image**: The `Expires` header is set to `Thu, 31 Dec 2037 23:55:55 GMT`. The `Cache-Control` header has a `max-age` parameter set to 315360000 seconds.

```
▼Response Headers    view parsed
  HTTP/1.1 200 OK
  Server: nginx/1.2.2
  Date: Sat, 15 Dec 2012 19:07:43 GMT
  Content-Type: image/jpeg
  Content-Length: 26246
  Last-Modified: Sat, 15 Dec 2012 18:28:41 GMT
  Connection: keep-alive
  Expires: Thu, 31 Dec 2037 23:55:55 GMT
  Cache-Control: max-age=315360000
  Accept-Ranges: bytes
```

Just by setting the one directive, `expires`, in the appropriate location, we can ensure that our prerendered files are cached locally for as long as they should be.

Changing content on-the-fly

Sometimes it may be helpful post-process what comes from your application. Maybe you would like to add a string at a certain point in your page to show which frontend server delivered that page to the client. Or maybe you would like to perform a transformation on the rendered HTML page. NGINX provides three modules that could be useful here: the `addition` module, the `sub` module, and the `xslt` module.

The addition module

The `addition` module works as a filter to add text before and/or after a response. It is not compiled by default, so if you want to make use of this feature, you must enable it at configure time by adding `--with-http_addition_module`.

This filter works by referencing a subrequest, which is then either appended to a request, or placed at the beginning of one:

```
server {
    root /home/www;
    location / {
        add_before_body /header;
        add_after_body /footer;
    }
    location /header {
        proxy_pass http://127.0.0.1:8080/header;
    }
    location /footer {
        proxy_pass http://127.0.0.1:8080/footer;
    }
}
```

The `addition` module directives are summarized in the following table:

Table: HTTP addition module directives

Directive	Explanation
`add_before_body`	Adds the result of processing a subrequest before the response body.
`add_after_body`	Adds the result of processing a subrequest after the response body.
`addition_types`	Lists the MIME types of a response in addition to `text/html`, in which an addition will be made. It may be `*` to enable all MIME types.

The sub module

The `sub` module works as a filter to replace (substitute) one text for another. It is not compiled by default, so if you want to make use of this feature, you must enable it at configure time by adding `--with-http_sub_module`.

It is fairly easy to work with. You use the `sub_filter` directive to specify a string to be replaced and its replacement, and the filter makes a case-insensitive match for your string, and substitutes in the replacement:

```
location / {

    sub_filter </head> '<meta name="frontend" content="web3"></head>';

}
```

In the preceding example, we added a new meta tag to the header of the page as it passed through NGINX.

It's also possible to make the match more than once. To do this, you set the `sub_filter_once` directive to `off`. This can be useful to replace all relative links in a page with absolute ones, for example:

```
location / {

    sub_filter_once off;

    sub_filter '<img src="img/' '<img src="/img/';

}
```

If there are any spaces or embedded quotes in the string to be matched, they must be enclosed in quotes in order for NGINX to recognize them as the first parameter.

NGINX will automatically use the `sub_filter` directive on any HTML file. If you want to use substitution on other types of files, such as JavaScript or CSS, just add the corresponding MIME type to the `sub_filter_types` directive.

```
location / {

    sub_filter_types text/css;

    sub_filter url(img/ 'url(/img/';

}
```

> ## Note
>
> Since `text/html` is the default value, this type doesn't need to be added—it won't be overwritten by adding additional MIME types to be transformed. This principle applies to all MIME type specification directives in NGINX.

The following table summarizes these directives:

Table: HTTP sub module directives

Directive	Explanation
`sub_filter`	Sets the string to be matched without regards to case and the string to be substituted into that match. The substitution string may contain variables.
`sub_filter_once`	Setting to `off` will cause the match in `sub_filter` to be made as many times as the string is found.

sub_filter_types	Lists the MIME types of a response in addition to text/html in which a substitution will be made. It may be * to enable all MIME types.

The xslt module

The xslt module works as a filter to transform XML using XSLT stylesheets. It is not compiled by default, so if you would like to make use of it, you will need to install the libxml2 and libxslt libraries and enable compilation of the module by passing --with-http_xslt_module to NGINX's configure script.

To use the xslt module, you define a DTD in which the character entities are declared. You then specify one or more XSLT stylesheets and their corresponding parameters to process the XML document:

```
location / {

    xml_entities /usr/local/share/dtd/entities.dtd;

    xsl_stylesheet /usr/local/share/xslt/style1.xslt;

    xsl_stylesheet /usr/local/share/xslt/style2.xslt theme=blue;

}
```

The directives included in the xslt module are summarized in the following table:

Table: HTTP XSLT module directives

Directive	Explanation
xml_entities	The path to the DTD that declares the character entities referenced in the XML to be processed.
xslt_param	Parameters passed to the stylesheets, whose values are XPath expressions.
xslt_string_param	Parameters passed to the stylesheets, whose values are strings.

xslt_stylesheet	The path to an XSLT stylesheet used to transform an XML response. Parameters may be passed as a series of key/value pairs.
xslt_types	Lists the MIME types of a response in addition to text/xml in which a substitution will be made. It may be * to enable all MIME types. If the transformation results in an HTML response, the MIME type will be changed to text/html.

Using Server Side Includes

The `ssi` module is also a filter, and one of NGINX's most flexible. It enables the use of Server Side Includes for processing logic embedded in a webpage. It supports a series of commands that are controlled by the following directives:

Table: Server Side Includes directives

Directive	Explanation
`ssi`	Enables the processing of SSI files.
`ssi_silent_errors`	Suppresses the error message normally output when an error occurs during SSI processing.
`ssi_types`	Lists the MIME types of a response in addition to `text/html` in which SSI commands are processed. It may be `*` to enable all MIME types.

The Server Side Includes commands supported by NGINX are shown in the following table. They all follow the following pattern:

```
<!--# command parameter1=value1 parameter2=value2 … -->
```

Table: Server Side Includes commands

Command	Argument	Explanation
`block`		Defines a section that can be referenced in the `include` command. Ends with `<!--# endblock -->`.
	`name`	Name of the block.

config		Sets global parameters used during SSI processing.
	errmsg	Configures the string used as the error message if something goes wrong during SSI processing. The default is `[an error occurred while processing the directive]`.
	timefmt	A string passed to `strftime()` to format a timestamp used in other commands. The default is `%A, %d-%b-%Y %H:%M:%S %Z`.
echo		Writes out the value of a variable.
	var	The name of the variable whose value is written out.
	encoding	The encoding method used for the variable. The value it can take is one of `none`, `url`, and `entity`. The default is `entity`.
	default	A value to write out if the variable is undefined. If unset, `none` is the default.
if		Evaluates a condition. If true, the block enclosed will be included. The sequence `if`, `elsif`, `else`, and `endif` is supported one level deep.
	expr	The expression to be evaluated for truth: • variable existence (expr="$var") • text comparison (`expr="$var = text"` or `expr="$var != text"`) • regular expression match (`expr="$var = /regexp/"` or `expr="$var != /regexp/"`)
include		Writes the result of a subrequest.

	file	The name of a file to include.
	virtual	The URI of a subrequest to include.
	stub	The block to be included instead of an empty body, or if there was an error in processing.
	wait	If there are multiple include commands on the same page, they will be processed serially if this parameter is present.
	set	If the subrequest made in virtual is to a proxy_pass or memcached_pass location, the result can be stored in the variable named as the argument to set.
set		Creates a variable and sets the value to it.
	var	The name of the variable to be set.
	value	The value of the variable to set.

An SSI file is nothing more than an HTML file with these commands embedded within comments. That way, if ssi isn't enabled for a particular location that contains such a file, the HTML portion will still render, albeit incompletely.

The following is an example of an SSI file which uses calls to a subrequest to render the header, footer, and menu of a page:

```
<html>
  <head>
    <title>*** SSI test page ***</title>
    <link rel="stylesheet" href="/css/layout.css" type="text/css"/>
      <!--# block name="boilerplate" -->
      <p>...</p>
      <!--# endblock -->
  </head>
  <body>
    <div id="header">
      <!--# include virtual="/render/header?page=$uri"
stub="boilerplate" -->
    </div>
    <div id="menu">
      <!--# include virtual="/render/menu?page=$uri"
stub="boilerplate" -->
    </div>
    <div id="content">
      <p>This is the content of the page.</p>
    </div>
    <div id="footer">
      <!--# include virtual="/render/footer?page=$uri"
stub="boilerplate" -->
    </div>
  </body>
</html>
```

The `stub` is used to render some default content in case of an error in processing the subrequest.

If these primitives don't offer enough flexibility in processing logic, you can use the embedded `perl` module to solve just about any other processing or configuration need you may have.

Decision-making in NGINX

You may find yourself trying to bend NGINX's configuration directives in ways that they were not meant to be used. This is frequently seen in configurations where there are a lot of `if` checks to try to emulate some sort of logic chain. A better option would be to use NGINX's embedded `perl` module. With this module, you will be able to use the flexibility of Perl to achieve your configuration goals.

The `perl` module is not built by default, so it needs to be enabled with the `--with-http_perl_module` configure switch. Ensure as well that your Perl was built with `-Dusemultiplicity=yes` (or `-Dusethreads=yes`) and `-Dusemymalloc=no`. NGINX configuration reloads will cause the `perl` module to leak memory over time, so this last parameter is included to help mitigate that problem.

After having built an `nginx` with embedded Perl, the following directives are available:

Table: Perl module directives

Directives	**Explanation**
`perl`	Activates a Perl handler for this location. The argument is the name of the handler or a string describing a full subroutine.
`perl_modules`	Specifies an additional search path for Perl modules.
`perl_require`	Indicates a Perl module that will be loaded at each NGINX reconfiguration. May be specified multiple times for separate modules.
`perl_set`	Installs a Perl handler to set the value of a variable. The argument is the name of the handler or a string describing a full subroutine.

When writing Perl scripts to be used in an NGINX configuration, you have use of the $r object, representing the request. The methods on this object are as follows:

- `$r->args`: The request arguments.

- `$r->filename`: The name of the file referenced by the URI.
- `$r->has_request_body(handler)`: If there is a request body, the handler will be called.
- `$r->allow_ranges`: Enables the use of byte ranges in a response.
- `$r->discard_request_body`: Discards the body of the request.
- `$r->header_in(header)`: The value of the specified request header.
- `$r->header_only`: Instructs NGINX to return only the header to the client.
- `$r->header_out(header, value)`: Sets the specified response header to this value.
- `$r->internal_redirect(uri)`: Makes an internal redirect to the specified URI once the Perl handler has completed execution.
- `$r->print(text)`: Prints the specified text out to the client.
- `$r->request_body`: The body of the request, if it fits in memory.
- `$r->request_body_file`: The body of the request, if written out to a temporary file.
- `$r->request_method`: The HTTP method of the request.
- `$r->remote_addr`: The client's IP address.
- `$r->flush`: Immediately send data to the client.
- `$r->sendfile(name[, offset[, length]])`: Sends the specified file to the client, with an optional offset and length, once the Perl handler has completed execution.
- `$r->send_http_header([type])`: Sends the response headers to the client, with an optional content type.
- `$r->status(code)`: Sets the HTTP status of the response.
- `$r->sleep(milliseconds, handler)`: Sets a timer to execute the handler after having waited the specified number of milliseconds. NGINX will continue processing other requests while the timer is running.
- `$r->unescape(text)`: Decodes URI-encoded text.
- `$r->uri`: The URI in the request.
- `$r->variable(name[, value])`: Either returns a named, request-local variable or sets one to the specified value.

The `perl` module may also be used within Server Side Includes. An SSI command using Perl has the following format:

```
<!--# perl sub="module::function" arg="parameter1" arg="parameter2"
... -->
```

Let's take a look at an example of using the `perl` module. Our goal is to pass requests to a different upstream server, as determined by the first letter of the request URI. We could implement this as a series of locations in NGINX, but it will be more concise expressed as a Perl handler.

The first step is to define the processing actions in a Perl handler:

```
# upstreammapper.pm

# name our package
package upstreammapper;

# include the nginx request methods and return code definitions
use nginx;

# this subroutine will be called from nginx
sub handler {

    my $r = shift;

    my @alpha = ("a".."z");

    my %upstreams = ();

    # simplistically create a mapping between letter and
    #  an IP which is between 10 and 35 of that network
    foreach my $idx (0..$#alpha) {

  $upstreams{ $alpha[$idx] } = $idx + 10;

    }

    # get the URI into an array
    my @uri = split(//,$r->uri);

    # so that we can use the first letter as a key
    my $ip = "10.100.0." . $upstreams{ $uri[1] };

    return $ip;

}

1;

__END__
```

Then we set up NGINX to use this module to do the mapping:

```
http {

    # this path is relative to the main configuration file
    perl_modules perl/lib;

    perl_require upstreammapper.pm;

    # we'll store the result of the handler in the $upstream
variable
    perl_set $upstream upstreammapper::handler;
```

Then we pass the request along to the correct upstream server:

```
        location / {
            include proxy.conf;
            proxy_pass http://$upstream;
        }
    }
```

We have seen a very simple example of implementing some configuration logic in a Perl handler. Just about any kind of special requirement can be done in a similar way.

> **Note**
>
> Request processing in a Perl handler should be as well-defined as possible. Whenever NGINX has to wait on a Perl handler finishing, the whole worker responsible for handling that request will block. So, any I/O or DNS-related tasks should be done outside of a Perl handler.

Creating a secure link

You may have cause to protect certain content on your site, but do not want to integrate full user authentication to allow access to that content. One way of enabling this is to use NGINX's `secure_link` module. By passing configure the `--with-http_secure_link` switch at compile time, you get access to the `secure_link_secret` directive, and its corresponding variable `$secure_link`.

The `secure_link` module works by computing the MD5 hash of a link concatenated with a secret word. If the hash matches that found in the URI, then the `$secure_link` variable is set to the portion of the URI after the hash. If there is no match, then `$secure_link` is set to the empty string.

One possible scenario is to generate a page of download links using a secret word. This word is then placed in the NGINX configuration to enable access to these links. The word and page are replaced periodically to prevent saved links from being called again at a later time. The following example illustrates this scenario.

We first decide on a secret word `supersecret`. Then, we generate the MD5 hash of the links we want to enable:

```
$ echo -n "alphabet_soup.pdfsupersecret" |md5sum
8082202b04066a49a1ae8da9ec4feba1  -
$ echo -n "time_again.pdfsupersecret" |md5sum
5b77faadb4f5886c2ffb81900a6b3a43  -
```

Now, we can create the HTML for our links:

```
<a
href="/downloads/8082202b04066a49a1ae8da9ec4feba1/alphabet_soup.pdf
">alphabet soup</a>
<a
href="/downloads/5b77faadb4f5886c2ffb81900a6b3a43/time_again.pdf">t
ime again</a>
```

These will only be valid if we use the same `secure_link_secret` directive in our configuration that we used to generate these hashes:

```
# any access to URIs beginning with /downloads/ will be protected
location /downloads/ {

    # this is the string we used to generate the hashes above
    secure_link_secret supersecret;

    # deny access with a Forbidden if the hash doesn't match
    if ($secure_link = "") {

        return 403;

    }

    try_files /downloads/$secure_link =404;

}
```

To ensure that links without a hash will not work, we can add an additional link to our HTML:

```
<a href="/downloads/bare_link.pdf">bare link</a>
```

Calling this link reports a "403 Forbidden" error, as it should.

Note

The technique for generating a `secure_link` module described before is just one possible way of solving this type of problem. NGINX itself even offers an alternative way described at http://wiki.nginx.org/HttpSecureLinkModule.

Generating images

Instead of writing an image manipulation module for your application, you can configure NGINX to handle some simple transformations. If your image-manipulation needs are as simple as rotating an image, resizing it, or cropping it, NGINX is capable of doing this for you.

To make use of this functionality, you need to have installed the `libgd` library, and enabled the `image_filter` module at compile-time (`--with-http_image_filter_module`). If that is the case, you now have use of the directives in the following table:

> **Note**
>
> The GD library (`libgd`) is an image generation library written in C. It is often used in combination with a programming language such as PHP or Perl to generate images for websites. NGINX's `image_filter` module uses `libgd` to provide the capability of creating a simple image resizing proxy, which we discuss in the following example.

Table: Image filter directives

Directive	Explanation
`empty_gif`	Causes a 1x1 pixel transparent GIF to be emitted for that `location`.
	Transforms an image according to one of the following parameters: • `off`: Turns off image transformation. • `test`: Ensures that responses are either GIF, JPEG, or PNG images. If not, an error 415 (Unsupported Media Type) is returned. • `size`: Emits information about an image in JSON format. • `rotate`: Rotates an image counter-clockwise by either 90, 180, or 270 degrees. • `resize`: Reduces an image proportionally by the width

image_filter	and height given. One dimension may be "-" in order to reduce by only the other dimension. If combined with rotate, rotation happens after reduction. An error will result in returning 415 (Unsupported Media Type). • crop: Reduces an image by the size of the largest side, as specified by the width and height given. Any extraneous space along the other edges will be cut. One dimension may be "-" in order to reduce by only the other dimension. If combined with rotate, rotation happens before reduction. An error will result in returning 415 (Unsupported Media Type).
image_filter_buffer	The size of the buffer used to process images. If more memory is needed, the server will return a 415 error (Unsupported Media Type).
image_filter_jpeg_quality	The quality of the resulting JPEG image, after processing. Not recommended to exceed 95.
image_filter_sharpen	Increases the sharpness of a processed image by this percentage.
image_filter_transparency	Disables preserving transparency of transformed GIF and PNG images. The default on preserves transparency.

Note that the empty_gif directive is not part of the image_filter module, but is included in a default installation of NGINX.

Using these directives, we can construct an image resizing module as follows:

```
location /img {

    try_files $uri /resize/$uri;

}

location ~* /resize/(?.<name>.*)_(?<width>[[:digit:]]*)x(?<height>
[[:digit:]]*)\.(?<extension>gif|jpe?g|png)$ {

     error_page 404 = /resizer/$name.$extension?
width=$width&height=$height;

}

location /resizer {

    image_filter resize $arg_width $arg_height;

}
```

This little snippet will first try to serve an image as requested in the URI. If it cannot find an appropriately-named image, it will then move on to the `/resize` location. The `/resize` location is defined as a regular expression so that we can capture the size we'd like the image to be. Note that we use named capture groups to create meaningful variable names. We then pass these on to the `/resizer` location so that we have the name of the original file as the URI and the width and height as named arguments.

We can now combine this with NGINX's `proxy_store` or `proxy_cache` capability to save the resized images so that another request for the same URI won't need to hit the `image_filter` module:

```
server {

    root /home/www;

    location /img {

        try_files $uri /resize/$uri;

    }

    location /resize {

        error_page 404 = @resizer;
    }

    location @resizer {

        internal;

        proxy_pass http://localhost:8080$uri;

        proxy_store /home/www/img$request_uri;

        proxy_temp_path /home/www/tmp/proxy_temp;

    }

}

server {

    listen 8080;

    root /home/www/img;

    location ~* /resize/(?.<name>.*)_(?<width>[[:digit:]]*)x(?
<height>[[:digit:]]*)\.(?<extension>gif|jpe?g|png)$ {

        error_page 404 = /resizer/$name.$extension?
width=$width&height=$height;

    }

    location /resizer {

        image_filter resize $arg_width $arg_height;

    }

}
```

As you can see in the table of directives for the `image_filter` module, any error returned by this module has the code 415. We can catch this error to replace it with an empty GIF, so that the end user will still get an image instead of an error message:

```
location /thumbnail {

    image_filter resize 90 90;

    error_page 415 = @empty;

}
location = @empty {

    access_log off;

    empty_gif;

}
```

The `size` parameter to `image_filter` deserves special mention. When this parameter is configured for a location, information about the image is delivered instead of the image itself. This could be useful in your application for discovering metadata about an image before calling a resize or crop URI:

```
location /img {

    image_filter size;

}
```

The result is a JSON object such as the following:

```
{ "img" : { "width": 150, "height": 200, "type": "png" } }
```

Tracking website visitors

A fairly unobtrusive way to track unique website visitors is to use the `userid` module. This module sets cookies that are used to identify unique clients. The value of these cookies is referenced by the `$uid_set` variable. When that same user returns to the site and the cookie is still valid, the value is available in the `$uid_got` variable. An example of how to use these is as follows:

```
http {

    log_format useridcomb '$remote_addr - $uid_got [$time_local] '
                    '"$request" $status $body_bytes_sent '
                    '"$http_referer" "$http_user_agent"';

    server {

        server_name .example.com;

        access_log logs/example.com-access.log useridcomb;

        userid          on;
        userid_name     uid;

        userid_domain   example.com;

        userid_path     /;

        userid_expires 365d;

        userid_p3p      'policyref="/w3c/p3p.xml", CP="CUR ADM OUR
NORSTA NID"';

    }

}
```

These directives are summarized in the following table:

Table: UserID module directives

Directive	Explanation
`userid`	Activates the module according to the following parameters: • `on`: Sets Version 2 cookies and logs those received

	`v1`: Sets Version 1 cookies and logs those received `log`: Disables setting of cookies, but enables logging them `off`: Disables both the setting of cookies and the logging of them
`userid_domain`	Configures a domain to be set in the cookie.
`userid_expires`	Sets the age of the cookie. If the keyword `max` is used, this translates to `31 Dec 2037 23:55:55 GMT`.
`userid_name`	Sets the name of the cookie (default is `uid`).
`userid_p3p`	Configures the P3P header; for sites which declare their privacy policy using the **Platform for Privacy Preferences Project**'s protocol.
`userid_path`	Defines the path set in the cookie.
`userid_service`	Identity of the service that set the cookie. For example, the default value for Version 2 cookies is the IP address of the server that set the cookie.

Preventing inadvertent code execution

When trying to construct a configuration that does what you expect it to do, you may inadvertently enable something that you did not expect. Take the following configuration block, for example:

```
location ~* \.php {

    include fastcgi_params;

    fastcgi_pass 127.0.0.1:9000;

}
```

Here we seem to be passing all requests for PHP files to the FastCGI server responsible for processing them. This would be OK if PHP only processed the file it was given, but due to differences in how PHP is compiled and configured this may not always be the case. This can become a problem if user uploads are made into the same directory structure that PHP files are in.

Users may be prevented from uploading files with a `.php` extension, but are allowed to upload `.jpg`, `.png`, and `.gif` files. A malicious user could upload an image file with the embedded PHP code, and cause the FastCGI server to execute this code by passing a URI with the uploaded filename in it.

To prevent this from happening, either set the PHP parameter `cgi.fix_pathinfo` to `0` or use something similar to the following in your NGINX configuration:

```
location ~* \.php {

    try_files $uri =404;

    include fastcgi_params;

    fastcgi_pass 127.0.0.1:9000;

}
```

We have used `try_files` to ensure that the file actually exists before passing the request on to the FastCGI server for PHP processing.

Note

Keep in mind that you should evaluate your configuration to see if it matches your goals. If you have only a few files, you would be better served by explicitly specifying which

PHP files may be executed instead of the regular expression `location` and corresponding `try_files`.

Summary

NGINX provides a number of ways to support developers wishing to integrate a high-performance web server into their application. We looked at various possibilities of integrating both legacy and new applications. Caching plays a key role in the modern web application. NGINX offers both passive and active ways of using caching to help deliver a web page more quickly.

We also explored how NGINX can help manipulate a response by adding or replacing text. Server Side Includes are also possible with NGINX. We saw a way of integrating these commands into normal text. We then examined the powerful embedded Perl capabilities in NGINX. Image transformation is also possible using just core NGINX. We examined how to set a unique cookie to track website visitors. We wound up the chapter with a word of caution about how to prevent code from inadvertently being executed. On the whole, there are quite a few tools at the developer's disposal when working with NGINX as a web server.

In the next chapter, we will explore troubleshooting techniques to try to get at the root of the problem when something doesn't work as expected.

Chapter 8. Troubleshooting Techniques

We live in an imperfect world. Despite our best intentions and planning, sometimes things don't turn out the way we had expected. We need to be able to step back and take a look at what went wrong. When we cannot immediately see what is causing the error, we need to be able to reach into a toolbox of techniques for helping us discover the problem. This process of figuring out what went wrong and how to fix it is what we call troubleshooting.

In this chapter, we will explore different techniques for troubleshooting NGINX:

- Analyzing log files
- Configuring advanced logging
- Common configuration errors
- Operating system limits
- Performance problems
- Using the Stub Status module

Analyzing log files

Before going into a prolonged debugging session trying to track down the cause of a problem, it is usually helpful to first look at the log files. They will often provide the clue we need to track down the error and correct it. The messages that appear in the `error_log` can sometimes be a bit cryptic, however, so we will discuss the format of the log entries and then take a look at a few examples to show you how to interpret what they mean.

Error log file formats

NGINX uses a couple of different logging functions that produce the `error_log` entries. The formats used with these functions take on the following patterns:

<timestamp> [log-level] <master/worker pid>#0: message

For example:

```
2012/10/14 18:56:41  [notice] 2761#0: using inherited sockets from
"6;"
```

This is an example of informational messages (log level `notice`). In this case, an `nginx` binary has replaced a previously-running one, and was able to successfully inherit the old binary's sockets.

The error-level logger produces a message like the following:

```
2012/10/14 18:50:34 [error] 2632#0: *1 open()
"/opt/nginx/html/blog" failed (2: No such file or directory),
client: 127.0.0.1, server: www.example.com, request: "GET /blog
HTTP/1.0", host: "www.example.com"
```

Depending on the error, you will see messages from the operating system (such as in this case), or just from NGINX itself. In this case, we see the following components:

- timestamp (`2012/10/14 18:50:34`)
- log level (`error`)
- worker pid (`2632`)
- connection number (`1`)
- system call (`open`)
- argument to the system call (`/opt/nginx/html/blog`)
- error message resulting from the system call (`2: No such file or directory`)
- which client made the request resulting in the error (`127.0.0.1`)
- which server context was responsible for handling the request (`www.example.com`)
- the request itself (`GET /blog HTTP/1.0`)
- the `Host` header sent in the request (`www.example.com`)

Here is an example of a critical-level log entry:

```
2012/10/14 19:11:50 [crit] 3142#0: the changing binary signal is
ignored: you should shutdown or terminate before either old or new
binary's process
```

A critical-level message means that NGINX cannot perform the requested action. If it was not already running, this means that NGINX would not start.

Here is an example of an emergency message:

```
2012/10/14 19:12:05 [emerg] 3195#0: bind() to 0.0.0.0:80 failed
(98: Address already in use)
```

An emergency message also means that NGINX could not do what was requested. It also means that NGINX won't start, or if it was already running when asked to read the configuration, it won't perform the requested change.

Note

If you are wondering why your configuration change is not taking effect, check the error log. NGINX has most likely encountered an error in the configuration and has not applied the change.

Error log file entry examples

The following are some examples of error messages found in real log files. After each example, a short explanation of what it could mean follows. Please note that the exact text may be different from what you see in your log files, due to improvements made in newer releases of NGINX.

Look at the following log file entry example:

```
2012/11/29 21:31:34 [error] 6338#0: *1 upstream prematurely closed
connection while reading response header from upstream, client:
127.0.0.1, server: , request: "GET / HTTP/1.1", upstream:
"fastcgi://127.0.0.1:8080", host: "www.example.com"
```

Here we have a message that could be interpreted in a couple of ways. It might mean that the server we are talking to has an error in its implementation, and does not speak the FastCGI protocol properly. It could also mean that we have mistakenly directed traffic to an HTTP server, instead of a FastCGI server. If that is the case, a simple configuration change (using `proxy_pass` instead of `fastcgi_pass`, or using the correct address for the FastCGI server) could fix the problem.

This type of message could also simply mean that the upstream server takes too long to generate a response. The reason could be due to a number of factors, but the solution, as far as NGINX is concerned, is fairly simple: increase the timeouts. Depending on which module was responsible for making this connection, the `proxy_read_timeout` or `fastcgi_read_timeout` (or other `*_read_timeout`) directive would need to be increased from the default value of `60s`.

Look at the following log file entry example:

```
2012/11/29 06:31:42 [error] 2589#0: *6437 client intended to send
too large body: 13106010 bytes, client: 127.0.0.1, server: ,
request: "POST /upload_file.php HTTP/1.1", host: "www.example.com",
referrer: "http://www.example.com/file_upload.html"
```

This one is fairly straightforward. NGINX reports that the file could not be uploaded because it is too large. To fix this problem, raise the value of `client_body_size`. Keep in mind that due to encoding, the uploaded size will be about 30 percent greater than the file size itself (for example, if you want to allow your users to upload files up to 12 MB, set this directive to `16m`).

Look at the following log file entry example:

```
2012/10/14 19:51:22 [emerg] 3969#0: "proxy_pass" cannot have URI
part in location given by regular expression, or inside named
location, or inside "if" statement, or inside "limit_except" block
in /opt/nginx/conf/nginx.conf:16
```

In this example, we see that NGINX won't start due to a configuration error. The error message is very informative as to why NGINX won't start. We see that there is a URI in the argument to the `proxy_pass` directive in a place where it should not have one. NGINX even tells us on which line (here `16`) of which file `(/opt/nginx/conf/nginx.conf`) the error occurred.

```
2012/10/14 18:46:26 [emerg] 2584#0: mkdir()
"/home/www/tmp/proxy_temp" failed (2: No such file or directory)
```

This is an example of a case where NGINX won't start because it can't perform what was asked of it. The `proxy_temp_path` directive specifies a location for NGINX to store temporary files when proxying. If NGINX cannot create this directory, it won't start, so ensure that the path leading up to this directory exists.

Look at the following log file entry example:

```
2012/10/14 18:46:54 [emerg] 2593#0: unknown directive
"client_body_temp_path" in /opt/nginx/conf/nginx.conf:6
```

We see in the preceding code what may appear to be a puzzling message. We know that `client_body_temp_path` is a valid directive, but NGINX does not accept it and gives an `unknown directive` message. When we think about how NGINX processes its configuration file, we realize that this does make sense after all. NGINX is built in a modular fashion. Each module is responsible for processing its own configuration context. We therefore conclude that this directive appeared in a part of the configuration file outside the context of the module that parses this directive.

```
2012/10/16 20:56:31 [emerg] 3039#0: "try_files" directive is not
allowed here in /opt/nginx/conf/nginx.conf:16
```

Sometimes, NGINX will give us a hint as to what is wrong. In the preceding example, NGINX has understood the `try_files` directive, but tells us that it is used in the wrong place. It very conveniently gives us the location in the configuration file where the error occurred, so that we can find it more easily.

```
2012/10/16 20:56:42 [emerg] 3043#0: host not found in upstream
"tickets.example.com" in /opt/nginx/conf/nginx.conf:22
```

This emergency-level message shows us how dependent NGINX is on DNS if hostnames are used in the configuration. If NGINX can't resolve the hostnames used in `upstream`, `proxy_pass`, `fastcgi_pass`, or other `*_pass` directives, then it won't start. This will have implications on the order in which NGINX is started after a fresh boot. Ensure that name resolution works at the time when NGINX starts.

```
2012/10/29 18:59:26 [emerg] 2287#0: unexpected "}" in
/opt/nginx/conf/nginx.conf:40
```

This type of message is indicative of a configuration error in which NGINX can't close the context. Something leading up to the line given has prevented NGINX from forming a complete context with the `{` and `}` characters. This usually means that the previous line is missing a semicolon, so NGINX reads the `}` character as part of that unfinished line.

```
2012/10/28 21:38:34 [emerg] 2318#0: unexpected end of file,
expecting "}" in /opt/nginx/conf/nginx.conf:21
```

Related to the previous error, this one means that NGINX reached the end of the configuration file before finding a matching closing brace. This kind of error occurs when there are unbalanced `{` and `}` characters. Using a text editor that matches sets of braces is helpful in locating exactly where one is missing. Depending on where that missing brace is inserted, the configuration can end up meaning something completely different from what was intended.

```
2012/10/29 18:50:11 [emerg] 2116#0: unknown "exclusion" variable
```

Here we see an example of using a variable without first declaring it. This means that `$exclusion` appeared in the configuration before a `set`, `map`, or `geo` directive defined what the value was to be. This type of error could also be indicative of a typo. We may have defined the `$exclusions` variable, but mistakenly later referenced it as `$exclusion`.

```
2012/11/29 21:26:51 [error] 3446#0: *2849 SSL3_GET_FINISHED:digest
check failed
```

This means that you need to disable SSL session reuse. You can do this by setting the `proxy_ssl_session_reuse` directive to `off`.

Configuring advanced logging

Under normal circumstances, we want logging to be as minimal as possible. Usually what's important is which URIs were called by which clients and when, and if there was an error, to show the resulting error message. If we want to see more information, that leads into a debug logging configuration.

Debug logging

To activate debug logging, the `nginx` binary needs to have been compiled with the `--with-debug` configure flag. As this flag is not recommended for high performance production systems, we may want to provide two separate `nginx` binaries for our needs: one which we use in production, and one that has all the same configure options, with the addition of `--with-debug` so that we may simply swap out the binary at runtime in order to be able to debug.

Switching binaries at runtime

NGINX provides the capability to switch out binaries at runtime. After having replaced the `nginx` binary with a different one, either because we're upgrading or we would like to load a new NGINX which has different modules compiled in, we can begin the procedure for replacing a running `nginx` binary:

1. Send the running NGINX master process a USR2 signal, to tell it to start a new master process. It will rename its PID file to `.oldbin` (for example, `/var/run/nginx.pid.oldbin`):

   ```
   # kill -USR2 `cat /var/run/nginx.pid`
   ```

   There will now be two NGINX master processes running, each with its own set of workers to handle incoming requests:

```
root 1149 0.0 0.2 20900 11768 ?? Is Fri03PM 0:00.13 nginx:
master process /usr/local/sbin/nginx
www 36660 0.0 0.2 20900 11992 ?? S 12:52PM 0:00.19 nginx:
worker process (nginx)
www 36661 0.0 0.2 20900 11992 ?? S 12:52PM 0:00.19 nginx:
worker process (nginx)
www 36662 0.0 0.2 20900 12032 ?? I 12:52PM 0:00.01 nginx:
worker process (nginx)
www 36663 0.0 0.2 20900 11992 ?? S 12:52PM 0:00.18 nginx:
worker process (nginx)
root 50725 0.0 0.1 18844 8408 ?? I 3:49PM 0:00.05 nginx:
master process /usr/local/sbin/nginx
www 50726 0.0 0.1 18844 9240 ?? I 3:49PM 0:00.00 nginx:
worker process (nginx)
www 50727 0.0 0.1 18844 9240 ?? S 3:49PM 0:00.01 nginx:
worker process (nginx)
www 50728 0.0 0.1 18844 9240 ?? S 3:49PM 0:00.01 nginx:
worker process (nginx)
www 50729 0.0 0.1 18844 9240 ?? S 3:49PM 0:00.01 nginx:
worker process (nginx)
```

2. Send the old NGINX master process a WINCH signal to tell it to stop handling new requests, and phase out its worker processes once they are done with their current requests:

   ```
   # kill -WINCH `cat /var/run/nginx.pid.oldbin`
   ```

   You'll get the following response output:

   ```
   root 1149 0.0 0.2 20900 11768 ?? Ss Fri03PM 0:00.14 nginx:
   master process /usr/local/sbin/nginx
   root 50725 0.0 0.1 18844 8408 ?? I 3:49PM 0:00.05 nginx:
   master process /usr/local/sbin/nginx
   www 50726 0.0 0.1 18844 9240 ?? I 3:49PM 0:00.00 nginx:
   worker process (nginx)
   www 50727 0.0 0.1 18844 9240 ?? S 3:49PM 0:00.01 nginx:
   worker process (nginx)
   www 50728 0.0 0.1 18844 9240 ?? S 3:49PM 0:00.01 nginx:
   worker process (nginx)
   www 50729 0.0 0.1 18844 9240 ?? S 3:49PM 0:00.01 nginx:
   worker process (nginx)
   ```

3. Send the old NGINX master process a `QUIT` signal, once all its worker processes have ended, and we will have only the new `nginx` binary running, responding to requests:

   ```
   # kill -QUIT `cat /var/run/nginx.pid.oldbin`
   ```

If there is any problem with the new binary, we can roll back to the old one before sending the `QUIT` signal to the old binary:

```
# kill -HUP `cat /var/run/nginx.pid.oldbin`
# kill -QUIT `cat /var/run/nginx.pid`
```

If the new binary still has a master process running, you can send it a `TERM` signal to force it to quit:

```
# kill -TERM `cat /var/run/nginx.pid`
```

Likewise, any new worker processes that are still running may first be stopped with a `KILL` signal.

Note

Note that some operating systems will automatically perform the binary upgrade procedure for you when the `nginx` package is upgraded.

Once we have our debug-enabled `nginx` binary running, we can configure debug logging:

```
user www;

events {

    worker_connections 1024;

}

error_log logs/debug.log debug;

http {

   …

}
```

We have placed the `error_log` directive in the main context of the NGINX configuration, so that it will be valid for each subcontext, if not overwritten within. We can have multiple `error_log` directives, each pointing to a different file and with a different logging level. In addition to `debug`, `error_log` can also take on the following values:

- `debug_core`
- `debug_alloc`
- `debug_mutex`
- `debug_event`
- `debug_http`
- `debug_imap`

Each level is to debug a specific module within NGINX.

It also makes sense to configure a separate error log per virtual server. That way, the errors related only to that server are found in a specific log. This concept can be extended to include the `core` and `http` modules as well:

```
error_log logs/core_error.log;

events {

    worker_connections 1024;

}

http {

    error_log logs/http_error.log;

    server {

        server_name www.example.com;

        error_log logs/www.example.com_error.log;

    }

    server {

        server_name www.example.org;

        error_log logs/www.example.org_error.log;

    }

}
```

Using this pattern, we are able to debug a particular virtual host, if that is the area we are interested in:

```
    server {

        server_name www.example.org;

        error_log logs/www.example.org_debug.log debug_http;

    }
```

What follows is an example of `debug_http` level output from a single request. Some comments as to what is going on at each point are interspersed throughout:

```
<timestamp> [debug] <worker pid>#0: *<connection number> http cl:-1
max:1048576
```

The `rewrite` module is activated very early on in the request processing phase:

```
<timestamp> [debug] <worker pid>#0: *<connection number> rewrite
phase: 3
<timestamp> [debug] <worker pid>#0: *<connection number> post
rewrite phase: 4
<timestamp> [debug] <worker pid>#0: *<connection number> generic
phase: 5
<timestamp> [debug] <worker pid>#0: *<connection number> generic
phase: 6
<timestamp> [debug] <worker pid>#0: *<connection number> generic
phase: 7
```

Access restrictions are checked:

```
<timestamp> [debug] <worker pid>#0: *<connection number> access
phase: 8
<timestamp> [debug] <worker pid>#0: *<connection number> access:
0100007F FFFFFFFF 0100007F
```

The `try_files` directive is parsed next. The path to the file is constructed from any string (`http script copy`) plus the value of any variable (`http script var`) in the parameters to the `try_files` directive:

```
<timestamp> [debug] <worker pid>#0: *<connection number> try files
phase: 11
<timestamp> [debug] <worker pid>#0: *<connection number> http
script copy: "/"
<timestamp> [debug] <worker pid>#0: *<connection number> http
script var: "ImageFile.jpg"
```

The evaluated parameter is then concatenated with the `alias` or `root` for that `location`, and the full path to the file is found:

```
<timestamp> [debug] <worker pid>#0: *<connection number> trying to
use file: "/ImageFile.jpg" "/data/images/ImageFile.jpg"
<timestamp> [debug] <worker pid>#0: *<connection number> try file
uri: "/ImageFile.jpg"
```

Once the file is found, its contents are processed:

```
<timestamp> [debug] <worker pid>#0: *<connection number> content
phase: 12
<timestamp> [debug] <worker pid>#0: *<connection number> content
phase: 13
<timestamp> [debug] <worker pid>#0: *<connection number> content
phase: 14
<timestamp> [debug] <worker pid>#0: *<connection number> content
phase: 15
<timestamp> [debug] <worker pid>#0: *<connection number> content
phase: 16
```

The `http filename` is the full path to the file to be sent:

```
<timestamp> [debug] <worker pid>#0: *<connection number> http
filename: "/data/images/ImageFile.jpg"
```

The `static` module receives the file descriptor for this file:

```
<timestamp> [debug] <worker pid>#0: *<connection number> http
static fd: 15
```

Any temporary content in the body of the response is no longer needed:

```
<timestamp> [debug] <worker pid>#0: *<connection number> http set
discard body
```

Once all information about the file is known, NGINX can construct the full response headers:

```
<timestamp> [debug] <worker pid>#0: *<connection number> HTTP/1.1
200 OK
Server: nginx/<version>
Date: <Date header>
Content-Type: <MIME type>
Content-Length: <filesize>
Last-Modified: <Last-Modified header>
Connection: keep-alive
Accept-Ranges: bytes
```

The next phase involves any transformations to be performed on the file due to output filters that may be active:

```
<timestamp> [debug] <worker pid>#0: *<connection number> http write
filter: l:0 f:0 s:219
<timestamp> [debug] <worker pid>#0: *<connection number> http
output filter "/ImageFile.jpg?file=ImageFile.jpg"
<timestamp> [debug] <worker pid>#0: *<connection number> http copy
filter: "/ImageFile.jpg?file=ImageFile.jpg"
<timestamp> [debug] <worker pid>#0: *<connection number> http
postpone filter "/ImageFile.jpg?file=ImageFile.jpg"
00007FFF30383040
<timestamp> [debug] <worker pid>#0: *<connection number> http write
filter: l:1 f:0 s:480317
<timestamp> [debug] <worker pid>#0: *<connection number> http write
filter limit 0
<timestamp> [debug] <worker pid>#0: *<connection number> http write
filter 0000000001911050
<timestamp> [debug] <worker pid>#0: *<connection number> http copy
filter: -2 "/ImageFile.jpg?file=ImageFile.jpg"
<timestamp> [debug] <worker pid>#0: *<connection number> http
finalize request: -2, "/ImageFile.jpg?file=ImageFile.jpg" a:1, c:1
<timestamp> [debug] <worker pid>#0: *<connection number> http run
request: "/ImageFile.jpg?file=ImageFile.jpg"
<timestamp> [debug] <worker pid>#0: *<connection number> http
writer handler: "/ImageFile.jpg?file=ImageFile.jpg"
<timestamp> [debug] <worker pid>#0: *<connection number> http
output filter "/ImageFile.jpg?file=ImageFile.jpg"
<timestamp> [debug] <worker pid>#0: *<connection number> http copy
filter: "/ImageFile.jpg?file=ImageFile.jpg"
<timestamp> [debug] <worker pid>#0: *<connection number> http
postpone filter "/ImageFile.jpg?file=ImageFile.jpg"
0000000000000000
<timestamp> [debug] <worker pid>#0: *<connection number> http write
filter: l:1 f:0 s:234338
<timestamp> [debug] <worker pid>#0: *<connection number> http write
filter limit 0
<timestamp> [debug] <worker pid>#0: *<connection number> http write
filter 0000000000000000
<timestamp> [debug] <worker pid>#0: *<connection number> http copy
filter: 0 "/ImageFile.jpg?file=ImageFile.jpg"
<timestamp> [debug] <worker pid>#0: *<connection number> http
writer output filter: 0, "/ImageFile.jpg?file=ImageFile.jpg"
<timestamp> [debug] <worker pid>#0: *<connection number> http
writer done: "/ImageFile.jpg?file=ImageFile.jpg"
```

Once the output filters have run, the request is finalized:

```
<timestamp> [debug] <worker pid>#0: *<connection number> http
finalize request: 0, "/ImageFile.jpg?file=ImageFile.jpg" a:1, c:1
```

The `keepalive` handler is responsible for determining if the connection should remain open:

```
<timestamp> [debug] <worker pid>#0: *<connection number> set http
keepalive handler
<timestamp> [debug] <worker pid>#0: *<connection number> http close
request
```

After the request has been processed, it can then be logged:

```
<timestamp> [debug] <worker pid>#0: *<connection number> http log
handler
<timestamp> [debug] <worker pid>#0: *<connection number> hc free:
0000000000000000 0
<timestamp> [debug] <worker pid>#0: *<connection number> hc busy:
0000000000000000 0
<timestamp> [debug] <worker pid>#0: *<connection number>
tcp_nodelay
```

The client has closed the connection, so NGINX will as well:

```
<timestamp> [debug] <worker pid>#0: *<connection number> http
keepalive handler
<timestamp> [info] <worker pid>#0: *<connection number> client <IP
address> closed keepalive connection
<timestamp> [debug] <worker pid>#0: *<connection number> close http
connection: 3
```

As you can see, there is quite a bit of information included here. If you have trouble figuring out why a particular configuration isn't working, going through the output of the debug log can be helpful. You can immediately see in what order the various filters run, as well as what handlers are involved in serving the request.

Using access logs for debugging

When I was learning how to program, and couldn't find the source of a problem, a friend of mine told me to "put printf's everywhere". That was how he was most quickly able to find the source of a problem. What he meant by this was to place a statement that would print a message at each code branch point, so that we could see which code path was getting executed and where the logic was breaking down. By doing this, we could visualize what was going on and could more easily see where the problem lies.

This same principle can be applied to configuring NGINX. Instead of `printf()` we can use the `log_format` and `access_log` directives to visualize request flow and analyze what's going on during request processing. Use the `log_format` directive to see the values of variables at different points in the configuration:

```
http {

    log_format sentlog '[$time_local] "$request" $status
$body_bytes_sent ';
    log_format imagelog '[$time_local] $image_file $image_type '
                    '$body_bytes_sent $status';


    log_format authlog '[$time_local] $remote_addr $remote_user '
                    '"$request" $status';



}
```

Use multiple `access_logs` to see which locations are getting called at what times. By configuring a different `access_log` for each location, we can easily see which ones are not being used. Any change to such a location will have no effect on request processing; the locations higher-up in the processing hierarchy need to be examined first.

```
http {

    log_format sentlog '[$time_local] "$request" $status
$body_bytes_sent ';

    log_format imagelog '[$time_local] $image_file $image_type '
                '$body_bytes_sent $status';

    log_format authlog '[$time_local] $remote_addr $remote_user '
                '"$request" $status';

    server {

        server_name .example.com;

        root /home/www;

        location / {

            access_log logs/example.com-access.log combined;

            access_log logs/example.com-root_access.log sentlog;

            rewrite ^/(.*)\.(png|jpg|gif)$ /images/$1.$2;

            set $image_file $1;

            set $image_type $2;
        }

        location /images {

            access_log logs/example.com-images_access.log imagelog;

        }

        location /auth {

            auth_basic "authorized area";

            auth_basic_user_file conf/htpasswd;

            deny all;

            access_log logs/example.com-auth_access.log authlog;

        }

    }

}
```

In the preceding example, there is an `access_log` declaration for each location, as well as a different `log_format` for each `access_log` declaration. We can determine which requests made it to each location depending on the entries found in the corresponding `access_log`. If there are no entries in the `example.com-images_access.log` file, for example, then we know that no requests reached the `/images` location. We can compare the contents of the various log files to see if the variables are being set to the proper values. For example, if the `$image_file` and `$image_type` variables are empty, the corresponding placeholders in the `imagelog` format `access_log` will be empty.

Common configuration errors

The next step in troubleshooting a problem is to take a look at the configuration, to see if it actually achieves the goal you are trying to accomplish. NGINX configurations have been floating around the Internet for a number of years. Often, they were designed for an older version of NGINX, and to solve a specific problem. Unfortunately, these configurations are copied without really understanding the problem they were designed to solve. There is sometimes a better way to solve the same problem, using a *newer* configuration.

Using if instead of try_files

One such case is a situation in which a user wants to deliver a static file if it is found on the filesystem, and if not, to pass the request on to a FastCGI server:

```
server {

    root /var/www/html;

    location / {

        if (!-f $request_filename) {

            include fastcgi_params;

            fastcgi_pass 127.0.0.1:9000;

            break;

        }

    }

}
```

This was the way this problem was commonly solved before NGINX had the `try_files` directive, which appeared in Version 0.7.27. The reason why this is considered a configuration error is that it involves using `if` within a `location` directive. As detailed in the *Converting an "if"-fy configuration to a more modern interpretation* section in Chapter 4, *NGINX as a Reverse Proxy*, this can lead to unexpected results or possibly even a crash. The way to correctly solve this problem is as follows:

```
server {

    root /var/www/html;

    location / {

        try_files $uri $uri/ @fastcgi;

    }

    location @fastcgi {
        include fastcgi_params;

        fastcgi_pass 127.0.0.1:9000;

    }

}
```

The `try_files` directive is used to determine if the file exists on the filesystem, and if not, passes the request on to the FastCGI server, without using `if`.

Using if as a hostname switch

There are countless examples of configurations where `if` is used to redirect requests based on the HTTP `Host` header. These types of configurations work as selectors and are evaluated for each request:

```
server {

    server_name .example.com;

    root /var/www/html;

    if ($host ~* ^example\.com) {

        rewrite ^/(.*)$ http://www.example.com/$1 redirect;

    }

}
```

Instead of incurring the processing costs associated with evaluating `if` for each request, NGINX's normal request-matching routine can route the request to the correct virtual server. The redirect can then be placed where it belongs, and even without a rewrite:

```
server {

    server_name example.com;

    return 301 $scheme://www.example.com;

}
server {

    server_name www.example.com;

    root /var/www/html;

    location / {

        …

    }

}
```

Not using the server context to best effect

Another place where copied configuration snippets often lead to incorrect configurations is the area of the `server` context. The `server` context describes the whole virtual server (everything that should be addressed under a particular `server_name`). It is underutilized in these copied configuration snippets.

Often, we will see `root` and `index` specified per `location`:

```
server {

    server_name www.example.com;

    location / {

        root /var/www/html;

        index index.php index.html index.htm;

    }

    location /ftp{

        root /var/www/html;

        index index.php index.html index.htm;

    }

}
```

This can lead to configuration errors when new locations are added, and the directives are not copied to those new locations or are copied incorrectly. The point of using the `root` and `index` directives is to indicate the document root for the virtual server and the files that should be tried when a directory is given in the URI, respectively. These values are then inherited for any `location` within that `server` context.

```
server {
    server_name www.example.com;
    root /var/www/html;
    index  index.php index.html index.htm;
    location / {
        ...
    }
    location /ftp{
        ...
    }
}
```

Here, we have specified that all files will be found under `/var/www/html` and that `index.php index.html index.htm` are to be tried, in order, as `index` files for any location.

Operating system limits

The operating system is often the last place we look to for discovering a problem. We assume that whoever set up the system has tuned the operating system for our workload and tested it under similar scenarios. This is often not the case. We sometimes need to look into the operating system itself to identify a bottleneck.

As with NGINX, there are two major areas where we can initially look for performance problems: **file descriptor limits** and **network limits**.

File descriptor limits

NGINX uses file descriptors in several different ways. The major use is to respond to client connections, each one using a file descriptor. Each outgoing connection (especially prevalent in proxy configurations) requires a unique IP:TCP port pair, which NGINX refers to using a file descriptor. If NGINX is serving any static file or a response from its cache, a file descriptor is used as well. As you can see, the number of file descriptors can climb quickly with the number of concurrent users. The total number of file descriptors that NGINX may use is limited by the operating system.

The typical UNIX-like operating system has a different set of limits for the superuser (`root`) than for a regular user, so make sure to execute the following command as the non-privileged user under which you're running NGINX (specified either by the `--user` compile-time option or the `user` configuration directive).

```
ulimit -n
```

This command will show you the number of open file descriptors allowed for that user. Usually, this number is set conservatively to 1024 or even lower. Since we know that NGINX will be the major user of file descriptors on the machine, we can set this number much higher. How to do this depends on the specific operating system. This can be done as follows:

- Linux

  ```
  vi /etc/security/limits.conf

  www-run  hard  nofile  65535
  $ ulimit -n 65535
  ```

- FreeBSD

```
vi /etc/sysctl.conf

kern.maxfiles=65535
kern.maxfilesperproc=65535
kern.maxvnodes=65535
# /etc/rc.d/sysctl reload
```

- Solaris

```
# projadd -c "increased file descriptors"  -K "process.max-file-descriptor=(basic,65535,deny)" resource.file

# usermod -K project=resource.file www
```

The preceding two commands will increase the maximum number of file descriptors allowed for a new process running as user `www`. This will also persist across a reboot.

The following two commands will increase the maximum number of file descriptors allowed for a running NGINX process:

```
# prctl -r -t privileged -n process.max-file-descriptor -v 65535 -i process `pgrep nginx`

# prctl -x -t basic -n process.max-file-descriptor -i process `pgrep nginx`
```

Each of these methods will change the operating system limit itself, but will have no effect on the running NGINX process. To enable NGINX to use the number of file descriptors specified, set the `worker_rlimit_nofile` directive to this new limit:

```
worker_rlimit_nofile  65535;

worker_processes    8;

events {

    worker_connections 8192;

}
```

Now, send the running `nginx` master process the `HUP` signal:

```
# kill -HUP `cat /var/run/nginx.pid`
```

NGINX will then be able to handle just over 65,000 simultaneous clients, connections to upstream servers, and any local static or cached files. This many `worker_processes` only makes sense if you actually have eight CPU cores or are heavily I/O bound. If that is not the case, decrease the number of `worker_processes` to match the number of CPU cores and increase `worker_connections` so that the product of the two approaches 65,000.

You can, of course, increase the number of total file descriptors and `worker_connections` up to a limit that makes sense for your hardware and use case. NGINX is capable of handling millions of simultaneous connections, provided the operating system limits and configuration are set correctly.

Network limits

If you find yourself in a situation in which no network buffers are available, you will most likely only be able to log in at the console, if at all. This can happen when NGINX receives so many client connections that all available network buffers are used up. Increasing the number of network buffers is also specific to a particular operating system and may be done as follows:

- FreeBSD

```
vi /boot/loader.conf

kern.ipc.nmbclusters=262144
```

- Solaris

```
# ndd -set /dev/tcp tcp_max_buf 16777216
```

When NGINX is acting as either a mail or an HTTP proxy, it will need to open many connections to its upstream servers. To enable as many connections as possible, the ephemeral TCP port range should be adjusted to its maximum.

- Linux

```
vi /etc/sysctl.conf

net.ipv4.ip_local_port_range = 1024 65535
# sysctl -p /etc/sysctl.conf
```

- FreeBSD

```
vi /etc/sysctl.conf

net.inet.ip.portrange.first=1024
net.inet.ip.portrange.last=65535
# /etc/rc.d/sysctl reload
```

- Solaris

```
# ndd -set /dev/tcp tcp_smallest_anon_port 1024
# ndd -set /dev/tcp tcp_largest_anon_port 65535
```

Having adjusted these basic values, we will now take a look at more specific performance-related parameters in the next section.

Performance problems

When designing an application and configuring NGINX to deliver it, we expect it to perform well. When we experience performance problems, however, we need to take a look at what could cause them. It may be in the application itself. It may be our NGINX configuration. We will investigate how to discover where the problem lies.

When proxying, NGINX does most of its work over the network. If there are any limitations at the network level, NGINX cannot perform optimally. Network tuning is again specific to the operating system and network that you are running NGINX on, so these tuning parameters should be examined in your particular situation.

One of the most important values relating to network performance is the size of the `listen` queue for new TCP connections. This number should be increased to enable more clients. Exactly how to do this and what value to use depends on the operating system and optimization goal.

- Linux

```
vi /etc/sysctl.conf

net.core.somaxconn = 3240000
# sysctl -p /etc/sysctl.conf
```

- FreeBSD

```
vi /etc/sysctl.conf

kern.ipc.somaxconn=4096
# /etc/rc.d/sysctl reload
```

- Solaris

```
# ndd -set /dev/tcp tcp_conn_req_max_q 1024
# ndd -set /dev/tcp tcp_conn_req_max_q0 4096
```

The next parameter to change is the size of the send and receive buffers. Note that these values are for illustration purposes only— they may lead to excessive memory usage, so be sure to test in your specific scenario.

- Linux

```
vi /etc/sysctl.conf

net.ipv4.tcp_wmem = 8192 87380 1048576
net.ipv4.tcp_rmem = 8192 87380 1048576
# sysctl -p /etc/sysctl.conf
```

* FreeBSD

```
vi /etc/sysctl.conf

net.inet.tcp.sendspace=1048576
net.inet.tcp.recvspace=1048576
# /etc/rc.d/sysctl reload
```

* Solaris

```
# ndd -set /dev/tcp tcp_xmit_hiwat 1048576
# ndd -set /dev/tcp tcp_recv_hiwat 1048576
```

You can also change these buffers in NGINX's configuration directly, so that they are only valid for NGINX and not for any other software you are running on the machine. This may be desirable when you have multiple services running, but want to ensure that NGINX gets the most out of your network stack:

```
server {

    listen 80 sndbuf=1m rcvbuf=1m;

}
```

Depending on your network setup, you will notice a marked change in performance. You should examine your particular setup, though, and make one change at a time, observing the results after each change. Performance tuning can be done on so many different levels that this small treatment here does not do the subject justice. If you are interested in learning more about performance tuning, there are a number of books and online resources that you should take a look at.

Tip

Making network tuning changes in Solaris persistent

In the previous two sections, we changed several TCP-level parameters on the command line. For Linux and FreeBSD, these changes would be persisted after a reboot due to the changes also being made in system configuration files (for example, `/etc/sysctl.conf`). For Solaris, the situation is different. These changes are not made in `sysctls`, so they cannot be persisted in this file.

Solaris 10 and above offers the **Service Management Framework** (**SMF**). This is a unique way of managing services and ensuring a start order at reboot. (Of course, it is much more than this, but this oversimplification serves here.) To persist the TCP-level changes mentioned before, we can write an SMF manifest and corresponding script to apply the changes.

These are detailed in Appendix D, *Persisting Solaris Network Tunings*.

Using the Stub Status module

NGINX provides an introspection module, which outputs certain statistics about how it is running. This module is called **Stub Status** and is enabled with the `--with-http_stub_status_module` configure flag.

To see the statistics produced by this module, the `stub_status` directive needs to be set to `on`. A separate `location` directive should be created for this module, so that an ACL may be applied:

```
location /nginx_status {

    stub_status on;

    access_log off;

    allow 127.0.0.1;

    deny all;

}
```

Calling this URI from the localhost (for example, with `curl http://localhost/nginx_status`) will show output similar to the following lines:

```
Active connections: 2532
server accepts handled requests
 1476737983 1476737983 3553635810
Reading: 93 Writing: 13 Waiting: 2426
```

Here we see that there are 2,532 open connections, of which NGINX is currently reading the request header of 93, and 13 connections are in a state in which NGINX is either reading the request body, processing the request, or writing a response to the client. The remaining 2,426 requests are considered `keepalive` connections. Since this `nginx` process was started, it has both accepted and handled 1,476,737,983 connections, meaning that none were closed immediately after having been accepted. There were a total of 3,553,635,810 requests handled through these 1,476,737,983 connections, meaning there were approximately 2.4 requests per connection.

This kind of data can be collected and graphed using your favorite system metrics tool chain. There are plugins for Munin, Nagios, collectd, and others, which use the `stub_status` module to collect statistics. Over time, you may notice certain trends and be able to correlate them to specific factors, but only if the data is collected. Spikes in user traffic as well as changes in the operating system should be visible in these graphs.

Summary

Problems surface on a number of levels when bringing a new piece of software into production. Some errors can be tested for and eradicated in a test environment; others surface only under real load with real users. To discover the reasons for these problems, NGINX provides very detailed logging, at a number of levels. Some of the messages may have multiple interpretations, but the overall pattern is understandable. By experimenting with the configuration and seeing what kinds of error messages are produced, we can gain a feeling for how to interpret the entries in the error log. The operating system has an influence on how NGINX runs, as it imposes certain limits due to default settings for a multiuser system. Understanding what is going on at the TCP level will help when tuning these parameters to meet the load under real conditions. Rounding off our tour of troubleshooting, we saw what kind of information the `stub_status` module was capable of delivering. This data can be useful to get an overall idea for how our NGINX is performing.

The appendices are up next. The first is a directive reference, listing all of NGINX's configuration directives in one place, including default values and in which context they may be used.

Appendix A. Directive Reference

This appendix lists the configuration directives used throughout the book. There are also some directives that did not appear in the book, but are listed here for completeness. The entries have been expanded to show under which context each directive may be used. If a directive has a default value, it has been listed as well. These directives are current as of NGINX Version 1.3.9. The most up-to-date list can be found at http://nginx.org/en/docs/dirindex.html.

Table: Directive reference

Directive	Explanation	Context/Default
`accept_mutex`	Serializes the `accept()` method on new connections by worker processes.	Valid context: `event` Default value: `on`
`accept_mutex_delay`	The maximum time a worker process will wait to accept new connections if another worker is already doing this.	Valid context: `event` Default value: `500ms`

`access_log`	Describes where and how access logs are to be written. The first parameter is a path to the file where the logs are to be stored. Variables may be used in constructing the path. The special value `off` disables the access log. An optional second parameter indicates the `log_format` that will be used to write the logs. If no second parameter is configured, the predefined combined format is used. An optional third parameter indicates the size of the buffer if write buffering should be used to record the logs. If write buffering is	Valid contexts: `http`
		`location`, `if in lo`
		`limit_except`
		
		Default value: `logs/`
		`combined`

	used, this size cannot exceed the size of the atomic disk write for that filesystem.	
`add_after_body`	Adds the result of processing a subrequest after the response body.	Valid context: `locat` Default value: -
`add_before_body`	Adds the result of processing a subrequest before the response body.	Valid context: `locat` Default value: -
`add_header`	Adds fields to a header present in responses with the HTTP codes 200, 204, 206, 301, 302, 303, 304, or 307.	Valid contexts: `http` Default value: -
`addition_types`	Lists the MIME types of a response in addition to `text/html`, in which an addition will be made. May be `*` to enable all MIME types.	Valid contexts: `http` Default value: `text/`
`aio`	This directive enables the use of asynchronous file I/O. It is available on all modern versions of FreeBSD and distributions of Linux. On FreeBSD, `aio` may be used to preload data for `sendfile`. Under Linux, `directio` is required, which automatically disables `sendfile`.	Valid contexts: `http` Default value: `off`
`alias`	Defines another name for the `location`, as found on the filesystem. If the location is specified with a regular expression, the alias should reference captures defined in that regular expression.	Valid context: `locat` Default value: -

allow	Allows access from this IP address, network, or all.	Valid contexts: http location, limit_ex Default value: -.
ancient_browser	Specifies one or more strings, which if found in the User-Agent header, will indicate that the browser is considered ancient by setting the $ancient_browser variable to the ancient_browser_value directive.	Valid contexts: http Default value: -.
ancient_browser_value	The value to which the $ancient_browser variable will be set.	Valid contexts: http Default value: 1.
auth_basic	Enables authentication using HTTP Basic Authentication. The parameter string is used as the realm name. If the special value off is used, this indicates that the auth_basic value of the parent configuration level is negated.	Valid contexts: http location, limit_ex Default value: off.
auth_basic_user_file	Indicates the location of a file of username:password:comment tuples used to authenticate users. The password needs to be encrypted with the crypt algorithm. The comment is optional.	Valid contexts: http location, limit_ex Default value: -
auth_http	This directive specifies the server used for authenticating the POP3/IMAP user.	Valid contexts: mail Default value: -
	Sets an additional header (first	Valid contexts: mail

auth_http_header	parameter) to the specified value (second parameter).	Default value: -
auth_http_timeout	The maximum amount of time NGINX will wait when communicating with an authentication server.	Valid contexts: mail Default value: 60s
autoindex	Activates the automatic generation of a directory listing page.	Valid contexts: http Default value: off
autoindex_exact_size	Indicates whether the file sizes in a directory listing page should be listed in bytes or rounded to kilobytes, megabytes, and gigabytes.	Valid contexts: http location. Default value: on
autoindex_localtime	Sets the file modification time in a directory listing page to either local time (on) or UTC (off).	Valid contexts: http Default value: off
break	Ends the processing of the rewrite module directives found within the same context.	Valid contexts: serv Default value: -
charset	Adds the character set specified to the Content-Type response header. If this is different than the source_charset directive, a conversion is performed.	Valid contexts: http location, if in lo Default value: off
charset_map	Sets up a conversion table from one character set to another. Each character code is specified in hexadecimal. The files conf/koi-win, conf/koi-utf, and conf/win-	Valid context: http

	utf include mappings from koi8-r to windows-1251, from koi8-r to utf-8, and from windows-1251 to utf-8, respectively.	Default value: -
charset_types	Lists the MIME types of a response in addition to text/html, in which a character set conversion will be made. It may be * to enable all MIME types.	Valid contexts: http Default value: text/ text/plain, text/v application/x-java application/rss+xm
chunked_transfer_encoding	Allows disabling the standard HTTP/1.1 chunked transfer encoding in responses to the clients.	Valid contexts: http Default value: on
client_body_buffer_size	Used to set a buffer size for the client request body larger than the default two memory pages, in order to prevent temporary files from being written to disk.	Valid contexts: http Default value: 8k|16 dependent)
client_body_in_file_only	Used for debugging or further processing of the client request body, this directive can be set to on to force saving the client request body to a file. The value clean will cause the files to be removed after the request processing is finished.	Valid contexts: http Default value: off
client_body_in_single_buffer	This directive will force NGINX to save the entire client request body in a single buffer, to reduce copy operations.	Valid contexts: http Default value: off
	Defines a directory path for saving the client request body. If a second, third, or fourth parameter is given,	Valid contexts: http

client_body_temp_path	these specify a subdirectory hierarchy with the parameter value as the number of characters in the subdirectory name.	Default value: clien
client_body_timeout	Specifies the length of time between successive read operations of the client body. If reached, the client receives a 408 error message (Request Timeout).	Valid contexts: http Default value: 60s
client_header_buffer_size	Used for specifying a buffer size for the client request header, when this needs to be larger than the default 1 KB.	Valid contexts: http Default value: 1k
client_header_timeout	Specifies the length of time for reading the entire client header. If reached, the client receives a 408 error message (Request Timeout).	Valid contexts: http Default value: 60s
client_max_body_size	Defines the largest allowable client request body, before a 413 (Request Entity Too Large) error is returned to the browser.	Valid contexts: http Default value: 1m
connection_pool_size	Fine tunes per-connection memory allocation.	Valid contexts: http Default value: 256
create_full_put_path	Allows recursive directory creation when using WebDAV.	Valid contexts: http Default value: off
daemon	Sets whether or not to daemonize the nginx process.	Valid context: main

		Default value: on
dav_access	Sets filesystem access permissions for newly-created files and directories. If group or all is specified, user may be omitted.	Valid contexts: http Default value: user:
dav_methods	Allows the specified HTTP and WebDAV methods. When PUT is used, a temporary file is first created and then renamed. So, it's recommended to put client_body_temp_path on the same filesystem as the destination. A modification date for such files may be specified in the Date header.	Valid contexts: http Default value: off
debug_connection	Enables debug logging for any client matching the value of this directive. It may be specified multiple times. To debug UNIX-domain sockets, use unix:.	Valid contexts: even Default value: -
debug_points	When debugging, the process will either create a core file (abort) or stop (stop) so that a system debugger may be attached.	Valid context: main Default value: -
default_type	Sets the default MIME type of a response. This comes into play if the MIME type of the file cannot be matched to one of those specified by the types directive.	Valid contexts: http Default value: text/
deny	Denies access from this IP address, network, or all.	Valid contexts: http location, limit_ex Default value: -

directio	Enables the operating system-specific flag or function for serving files larger than the parameter given. Required when using aio on Linux.	Valid contexts: http Default value: off
directio_alignment	Sets the alignment for directio. The default of 512 is usually enough, although it's recommended to increase this to 4K when using XFS on Linux.	Valid contexts: http Default value: 512
disable_symlinks	Refer to the *HTTP file path directives* table in the *Finding files* section in Chapter 6, *The NGINX HTTP Server*.	Valid contexts: http Default value: off
empty_gif	Causes a 1x1 pixel transparent GIF to be emitted for that location.	Valid context: locat Default value: -
env	Sets environment variables for use in: • inheritance during a live upgrade • making use of them in the perl module • making them available to worker processes Specifying the variable alone will use the value found in the nginx environment. Setting a variable may be done in the form var=value. N.B. NGINX is an internal variable and shouldn't be set by the user.	Valid context: main Default value: TZ

`error_log`	The `error_log` file is where all errors will be written. It may be set to a file or `stderr`. If no other `error_log` is given in a separate context, this log file will be used for all errors, globally. A second parameter to this directive indicates at which level (`debug`, `info`, `notice`, `warn`, `error`, `crit`, `alert`, `emerg`) errors will be written to the log. Note that `debug` level errors are only available if the `--with-debug` configuration switch was given at compile time.	Valid contexts: `main` `location` Default value: `logs/`
`error_page`	Defines a URI to be served when an error level response code is encountered. Adding an `=` parameter allows the response code to be changed. If the argument to this parameter is left empty, the response code will be taken from the URI, which must in this case be served by an upstream server of some sort.	Valid contexts: `http` `location`, `if in lo` Default value: -
`etag`	Disables automatically generating the `ETag` response header for static resources.	Valid contexts: `http` Default value: `on`
`events`	Defines a new context in which connection-processing directives are specified.	Valid context: `main`. Default value: -
`expires`	Refer to the *Header modifying directives* table in the *Caching in the filesystem* section in Chapter 7,	Valid contexts: `http` Default value: `off`

	NGINX for the Developer.	
fastcgi_bind	Specifies which address should be used for the outgoing connections to a FastCGI server.	Valid contexts: http Default value: -
fastcgi_buffer_size	The size of the buffer used for the first part of the response from the FastCGI server, in which the response headers are found.	Valid contexts: http Default value: 4k|8k dependent)
fastcgi_buffers	The number and size of buffers used for the response from a FastCGI server, for a single connection.	Valid contexts: http Default value: 4k|8k dependent)
fastcgi_busy_buffers_size	The total size of the buffer space allocated to sending the response to the client while still being read from the FastCGI server. This is typically set to two fastcgi_buffers.	Valid contexts: http default value: 4k|8k dependent)
fastcgi_cache	Defines a shared memory zone to be used for caching.	Valid contexts: http Default value: off
fastcgi_cache_bypass	One or more string variables, which when non-empty or non-zero, will cause the response to be taken from the FastCGI server instead of the cache.	Valid contexts: http Default value: -
fastcgi_cache_key	A string used as the key for storing and retrieving cache values.	Valid contexts: http Default value: -

fastcgi_cache_lock	Enabling this directive will prevent multiple requests from making an entry into the same cache key.	Valid contexts: http Default value: off
fastcgi_cache_lock_timeout	The length of time a request will wait for an entry to appear in the cache or for the fastcgi_cache_lock to be released.	Valid contexts: http Default value: 5s
fastcgi_cache_min_uses	The number of requests for a certain key needed before a response is cached.	Valid contexts: http Default value: 1
fastcgi_cache_path	Refer to the *FastCGI directives* table in the *Using NGINX with PHP-FPM* section in Chapter 6, *The NGINX HTTP Server*.	Valid context: http Default value: -
fastcgi_cache_use_stale	The cases under which it is acceptable to serve stale cached data when an error occurs while accessing the FastCGI server. The updating parameter indicates the case when fresh data are being loaded.	Valid contexts: http Default value: off
fastcgi_cache_valid	Indicates the length of time for which a cached response with response code 200, 301, or 302 is valid. If an optional response code is given before the time parameter, that time is only for that response code. The special parameter any indicates that any response code should be cached for that length of time.	Valid contexts: http Default value: -
	The maximum amount of time	Valid contexts: http

`fastcgi_connect_timeout`	NGINX will wait for its connection to be accepted when making a request to a FastCGI server.	Default value: `60s`
`fastcgi_hide_header`	A list of header fields that should not be passed on to the client.	Valid contexts: `http` Default value: -
`fastcgi_ignore_client_abort`	If set to `on`, NGINX will not abort the connection to a FastCGI server if the client aborts the connection.	Valid contexts: `http` Default value: `off`
`fastcgi_ignore_headers`	Sets which headers may be disregarded when processing the response from the FastCGI server.	Valid contexts: `http` Default value: -
`fastcgi_index`	Sets the name of a file to be appended to `$fastcgi_script_name` that ends with a slash.	Valid contexts: `http` Default value: -
`fastcgi_intercept_errors`	If enabled, NGINX will display a configured `error_page` directive instead of the response directly from the FastCGI server.	Valid contexts: `http` Default value: `off`
`fastcgi_keep_conn`	Enables the `keepalive` connections to the FastCGI servers by instructing the server not to immediately close the connection.	Valid contexts: `http` Default value: `off`
`fastcgi_max_temp_file_size`	The maximum size of the overflow file, written when the response doesn't fit into the memory buffers.	Valid contexts: `http` Default value: `1024m`
`fastcgi_next_upstream`	Refer to the *FastCGI directives* table in the *Using NGINX with PHP-FPM* section in Chapter 6, *The*	Valid contexts: `http`

	NGINX HTTP Server.	Default value: error
fastcgi_no_cache	One or more string variables, which when non-empty or non-zero will instruct NGINX not to save the response from the FastCGI server in the cache.	Valid contexts: http Default value: -
fastcgi_param	Sets a parameter and its value to be passed to the FastCGI server. If the parameter should only be passed when the value is non-empty, the additional if_not_empty parameter should be set.	Valid contexts: http Default value: -
fastcgi_pass	Specifies the FastCGI server to which the request is passed, either as an address:port combination or as unix:path for a UNIX-domain socket.	Valid contexts: loca location Default value: -
fastcgi_pass_header	Overrides the disabled headers set in fastcgi_hide_header, allowing them to be sent to the client.	Valid contexts: http Default value: -
fastcgi_read_timeout	Specifies the length of time that needs to elapse between two successive read operations from a FastCGI server before the connection is closed.	Valid contexts: http Default value: 60s
fastcgi_send_lowat	This is a FreeBSD directive. When non-zero, it will tell NGINX to use either the NOTE_LOWAT kqueue method or the SO_SNDLOWAT socket option with the specified size when communicating with an upstream	Valid contexts: http Default value: 0

	server. Ignored in Linux, Solaris, and Windows.	
fastcgi_send_timeout	The length of time that needs to elapse between two successive write operations to a FastCGI server before the connection is closed.	Valid contexts: http Default value: 60s
fastcgi_split_path_info	Defines a regular expression with two captures. The first capture will be the value of the $fastcgi_script_name variable. The second capture becomes the value of the $fastcgi_path_info variable.	Valid context: locat Default value: -
fastcgi_store	Enables storing responses retrieved from a FastCGI server as files on the disk. The on parameter will use the alias or root directive as the base path under which to store the file. A string may instead be given, to indicate an alternative location to store the files.	Valid contexts: http Default value: off
fastcgi_store_access	Sets file access permissions for the newly-created fastcgi_store files.	Valid contexts: http Default value: user:
fastcgi_temp_file_write_size	Limits the amount of data buffered to a temporary file at one time, so that NGINX will not be blocked for too long on a single request.	Valid contexts: http Default value: 8k|16 dependent)
	A directory where temporary files may be buffered as they are proxied from the FastCGI server, optionally multilevel deep. If a second, third, or	Valid contexts: http

`fastcgi_temp_path`	fourth parameter is given, these specify a subdirectory heirarchy with the parameter value as the number of characters in the subdirectory name.	Default value: `fastc`
`flv`	Activates the `flv` module for this `location`.	Valid context: `locat` Default value: -
`geo`	Defines a new context, in which a variable is set to a specified value, dependent on the IP address found in another variable. If no other variable is specified, `$remote_addr` is used to determine the IP address. The format of the context definition is: `geo [$address-variable] $variable-to-be-set { … }` The following parameters are recognized within the context: • `delete`: Deletes the specified network • `default`: The variable will be set to this value if no IP address matches • `include`: Includes a file of address-to-value mappings • `proxy`: Defines an address or network of a direct connection from which the IP address will be taken from the `X-Forwarded-For` header • `proxy_recursive`: Works with `proxy` to specify that the last address in a multi-valued `X-Forwarded-For` header will	Valid context: `http` Default value: -

	be used • `ranges`: When defined, indicates that the following addresses are specified as ranges	
`geoip_city`	The path to a GeoIP database file containing IP address-to-city mappings. The following variables then become available: • `$geoip_city_country_code`: Two-letter country code • `$geoip_city_country_code3`: Three-letter country code • `$geoip_city_country_name`: Country name • `$geoip_region`: Country region name • `$geoip_city`: City name • `$geoip_postal_code`: Postal code	valid context: `http` Default value: -
`geoip_country`	The path to a GeoIP database file containing the IP address-to-country mappings. The following variables then become available: • `$geoip_country_code`: Two-letter country code • `$geoip_country_code3`: Three-letter country code • `$geoip_country_name`: Country name	Valid context: `http` Default value: -
`geoip_org`	The path to a GeoIP database file containing the IP address-to-organization mappings. The following variable then becomes available:	Valid context: `http`. Default value: -

	• $geoip_org: Organization name	
geoip_proxy	Defines an address or network of a direct connection from which the IP address will be taken from the X-Forwarded-For header.	Valid context: http Default value: -
geoip_proxy_recursive	Works with geoip_proxy, to specify that the last address in a multivalued X-Forwarded-For header will be used.	Valid context: http Default value: off.
gunzip	Enables the decompression of gzipped files when the client doesn't support gzip.	Valid contexts: http Default value: off
gunzip buffers	Specifies the number and size of buffers used for decompressing a response.	Valid contexts: http Default value: 32 4k dependent)
gzip	Enables or disables the compression of responses.	Valid contexts: http location, if in lo Default value: off
gzip_buffers	Specifies the number and size of buffers used for compressing a response.	Valid contexts: http Default value: 32 4k dependent)
gzip_comp_level	The gzip compression level (1-9).	Valid contexts: http Default value: 1

gzip_disable	A regular expression of User-Agents that shouldn't receive a compressed response. The special value msie6 is a shortcut for MSIE [4-6]\., excluding MSIE 6.0; ... SV1.	Valid contexts: http Default value: -
gzip_http_version	The minimum HTTP version of a request before compression is considered.	Valid contexts: http Default value: 1.1
gzip_min_length	The minimum length of a response before compression is considered, determined by the Content-Length header.	Valid contexts: http Default value: 20
gzip_proxied	Refer to the *Gzip module directives* table in the *Compressing* section in Chapter 5, *Reverse Proxy Advanced Topics*.	Valid contexts: http Default value: off
gzip_static	Enables checking for precompressed files, to be delivered directly to clients which support gzip compression.	Valid contexts: http Default value: off
gzip_types	The MIME types that should be compressed with gzip, in addition to the default text/html. It may be * to enable all MIME types.	Valid contexts: http Default value: text/
gzip_vary	Enables or disables the response header Vary: Accept-Encoding if gzip or gzip_static is active.	Valid contexts: http Default value: off
http	Sets up a configuration context in which HTTP server directives are	Valid context: main Default value: -

	specified.	
`if`	Refer to the *Rewrite module directives* table in the *Introducing the rewrite module* section in [Appendix B](), *Rewrite Rule Guide*.	Valid contexts: `serv` Default value: -
`if_modified_since`	Controls how the modification time of a response is compared to the value of the `If-Modified-Since` request header: • `off`: The `If-Modified-Since` header is ignored • `exact`: An exact match is made (default) • `before`: The modification time of the response is less than or equal to the value of the `If-Modified-Since` header	Valid contexts: `http` Default value: `exact`
`ignore_invalid_headers`	Disables ignoring headers with invalid names. A valid name is composed of ASCII letters, numbers, the hyphen, and possibly the underscore (controlled by the `underscores_in_headers` directive).	Valid contexts: `http` Default value: `on`
`image_filter`	Refer to the *Image filter directives* table in the *Generating images* section in [Chapter 7](), *NGINX for the Developer*.	Valid context: `locat` Default value: -
`image_filter_buffer`	The size of the buffer used to process images. If more memory is needed, the server will return a 415 error (`Unsupported Media Type`).	Valid contexts: `http` Default value: `1M`

image_filter_jpeg_quality	The quality of the resulting JPEG image, after processing. Not recommended to exceed 95.	Valid contexts: http Default value: 75
image_filter_sharpen	Increases the sharpness of a processed image by this percentage.	Valid contexts: http Default value: 0
image_filter_transparency	Disables preserving transparency of transformed GIF and PNG images. The default on preserves transparency.	Valid contexts: http Default value: on
imap_auth	Sets the supported client authentication mechanism. It can be one or more of login, plain, or cram-md5.	Valid contexts: mail Default value: plain
imap_capabilities	Indicates which IMAP4 capabilities are supported by the backend server.	Valid contexts: mail Default value: IMAP4 UIDPLUS
imap_client_buffer	Sets the size of the read buffer for IMAP commands.	Valid contexts: mail Default value: 4k|8k dependent)
include	The path to a file containing additional configuration directives. It may be specified as a glob to include multiple files.	Valid context: any Default value: -
index	Defines which file will be served to the client when a URI ending with / is received. It may be multivalued.	Valid contexts: http Default value: index

internal	Specifies a location that can only be used for internal requests (redirects defined in other directives, rewrite requests, and similar request processing directives).	Valid context: locat Default value: -
ip_hash	Ensures the distribution of clients evenly over all server by hashing the IP address, keying on its class C network.	Valid context: upstr Default value: -
keepalive	The number of connections to upstream servers that are cached per worker process. When used with HTTP connections, proxy_http_version should be set to 1.1 and proxy_set_header to Connection.	Valid context: upstr Default value: -
keepalive_disable	Disables keep-alive requests for certain browser types.	Valid contexts: http Default value: msie6
keepalive_requests	Defines how many requests may be made over one keepalive connection before it is closed.	Valid contexts: http Default value: 100
keepalive_timeout	Specifies how long a keep-alive connection will stay open. A second parameter may be given, to set a Keep-Alive header in the response.	Valid contexts: http Default value: 75s
large_client_header_buffers	Defines the maximum number and size of a large client request header.	Valid contexts: http Default value: 4 8k

least_conn	Activates the load-balancing algorithm where the server with the least number of active connections is chosen for the next new connection.	Valid context: upstr Default value: -
limit_conn	Specifies a shared memory zone (configured with limit_conn_zone) and the maximum number of connections that are allowed per key value.	Valid contexts: http Default value: -
limit_conn_log_level	When NGINX limits a connection due to the limit_conn directive, this directive specifies at which log level that limitation is reported.	Valid contexts: http Default value: error
limit_conn_zone	Specifies the key to be limited in limit_conn as the first parameter. The second parameter, zone, indicates the name of the shared memory zone used to store the key and current number of connections per key and the size of that zone (name:size).	Valid context: http Default value: -
limit_except	Will limit a location to the specified HTTP verb(s) (GET also includes HEAD).	Valid context: locat Default value: -
limit_rate	Limits the rate (in bytes per second) at which clients can download content. The rate limit works on a connection level, meaning that a single client could increase their throughput by opening multiple	Valid context: http, if in location Default value: 0

	connections.	
limit_rate_after	Starts the limit_rate after this number of bytes have been transferred.	Valid contexts: http location, if in lo Default value: 0
limit_req	Sets a limit with bursting capability on the number of requests for a specific key in a shared memory store (configured with limit_req_zone). The burst may be specified with the second parameter. If there shouldn't be a delay in between requests up to the burst, a third parameter nodelay needs to be configured.	Valid context: http, Default value: -
limit_req_log_level	When NGINX limits the number of requests due to the limit_req directive, this directive specifies at which log level that limitation is reported. A delay is logged at a level one less than the one indicated here.	Valid contexts: http Default value: -
limit_req_zone	Specifies the key to be limited in limit_req as the first parameter. The second parameter, zone, indicates the name of the shared memory zone used to store the key and current number of requests per key and the size of that zone (name:size). The third parameter, rate, configures the number of requests per second (r/s) or per minute (r/m) before the limit is imposed.	Valid context: http Default value: -

limit_zone	Deprecated. Use limit_conn_zone instead.	Valid context: http Default value: -
lingering_close	This directive specifies how a client connection will be kept open for more data.	Valid contexts: http Default value: on
lingering_time	In connection with the lingering_close directive, this directive will specify how long a client connection will be kept open for processing more data.	Valid contexts: http Default value: 30s
lingering_timeout	Also in conjunction with lingering_close, this directive indicates how long NGINX will wait for additional data before closing the client connection.	Valid contexts: http default value: 5s
listen (http)	Refer to the *listen parameters* table in the section named *The virtual server section* in Chapter 2, *A Configuration Guide*.	Valid context: serve Default value: *:80
listen (mail)	The listen directive uniquely identifies a socket binding under NGINX. It takes the following parameter: • bind: make a separate bind() call for this address:port pair.	Valid context: serve Default value: -
location	Defines a new context based on the request URI.	Valid context: serve Default value: -

lock_file	The prefix name for lock files. Depending on the platform, a lock file may be needed to implement accept_mutex and shared memory access serialization.	Valid context: main Default value: logs/
log_format	Specifies which fields should appear in the log file and what format they should take.	Valid context: http Default value: comb - $remote_user [$t "$request" $status $body_bytes_sent, "$http_referer""$h
log_not_found	Disables reporting of 404 errors in the error log.	Valid contexts: http Default value: on
log_subrequest	Enables logging of subrequests in the access log.	Valid contexts: http Default value: off
mail	Sets up a configuration context in which mail server directives are specified.	Valid context: main Default value: -
	Defines a new context, in which a variable is set to a specified value, dependent on the value of a source variable. The format of the context definition is: map $source-variable $variable-to-be-set { … } The string or strings to be mapped may also be regular expressions.	

map	The following parameters are recognized within the context: - default: Sets a default value for the variable if the value of the source variable didn't match any of the strings or regular expressions specified - hostnames: Indicates that source values may be hostnames with a prefix or suffix glob - include: Includes a file with string-to-value mappings	Valid context: http Default value: -
map_hash_bucket_size	The bucket size used to hold the map hash tables.	Valid context: http Default value: 32|64
map_hash_max_size	The maximum size of the map hash tables.	Valid context: http Default value: 2048
master_process	Determines whether or not to start worker processes.	Valid context: main Default value: on
max_ranges	Sets the maximum number of ranges allowed in a byte-range request. Specifying 0 disables byte-range support.	Valid contexts: http Default value: -
memcached_bind	Specifies which address should be used for outgoing connections to a memcached server.	Valid contexts: http Default value: -
memcached_buffer_size	The size of the buffer for the response from memcached. This	Valid contexts: http

	response is then sent synchronously to the client.	Default value: `4k|8k`
`memcached_connect_timeout`	The maximum length of time NGINX will wait for its connection to be accepted when making a request to a memcached server.	Valid contexts: `http` Default value: `60s`
`memcached_gzip_flag`	Specifies a value, when found in the response from a memcached server, which will set the `Content-Encoding` header to `gzip`.	Valid contexts: `http` Default value: -
`memcached_next_upstream`	Refer to the *Memcached module directives* table in the *Caching in the database* section in Chapter 7, *NGINX for the Developer*.	Valid contexts: `http` Default value: error
`memcached_pass`	Specifies the name or address of a memcached server and its port. It may also be a `server` group, as declared in an `upstream` context.	Valid contexts: `loca` `location` Default value: -
`memcached_read_timeout`	Specifies the length of time that needs to elapse between two successive read operations from a memcached server before the connection is closed.	Valid contexts: `http` Default value: `60s`
`memcached_send_timeout`	The length of time that needs to elapse between two successive write operations to a memcached server before the connection is closed.	Valid contexts: `http` Default value: `60s`
`merge_slashes`	Disables the removal of multiple slashes. The default value of `on`	Valid contexts: `http`

	means that NGINX will compress two or more / characters into one.	Default value: on
min_delete_depth	Allows the WebDAV DELETE method to remove files when at least this number of elements is present in the request path.	Valid contexts: http Default value: 0
modern_browser	Specifies a browser and version parameter, which together will indicate that the browser is considered modern by setting the $modern_browser variable to modern_browser_value. The browser parameter may take one of the following values: msie, gecko, opera, safari, or konqueror. An alternative parameter unlisted may be specified to indicate that any browser not found in ancient_browser nor in modern_browser or has a missing User-Agent header is considered modern.	Valid contexts: http Default value: -
modern_browser_value	The value to which the $modern_browser variable will be set.	Valid contexts: http Default value: 1
mp4	Activates the mp4 module for this location.	Valid context: locat Default value: -
mp4_buffer_size	Sets the initial buffer size for delivering MP4 files.	Valid contexts: http Default value: 512K
	Sets the maximum size of the buffer	Valid contexts: http

mp4_max_buffer_size	used to process MP4 metadata.	Default value: 10M
msie_padding	Enables the disabling of adding comments to responses with a status greater than 400 for MSIE clients, in order to pad the response size to 512 bytes.	Valid contexts: http Default value: on
msie_refresh	This directive enables the sending of a refresh instead of a redirect for MSIE clients.	Valid contexts: http Default value: off
multi_accept	Instructs a worker process to accept all new connections at once. Disregarded if the kqueue event method is used because kqueue reports the number of new connections waiting to be accepted.	Valid context: event Default value: off
open_file_cache	Configures a cache that can store open file descriptors, directory lookups, and file lookup errors.	Valid contexts: http Default value: off
open_file_cache_errors	Enables the caching of the file lookup errors by the open_file_cache directive.	Valid contexts: http Default value: off
open_file_cache_min_uses	Configures the minimum number of uses for a file within the inactive parameter to open_file_cache for that file descriptor to remain open in the cache.	Valid contexts: http Default value: 1
open_file_cache_valid	Specifies the time interval between the validity checks for the items in the open_file_cache directive.	Valid contexts: http Default value: 60s

open_log_file_cache	Refer to the *HTTP logging directives* table in the *Logging* section in Chapter 6, *The NGINX HTTP Server*.	Valid contexts: http Default value: off
optimize_server_names	This is deprecated. Use the server_name_in_redirect directive instead.	Valid contexts: http Default value: off
override_charset	Indicates whether the charset specified in the Content-Type header of a response received from a proxy_pass or fastcgi_pass request should be converted or not. If the response comes as a result of a subrequest, conversion to the main request's charset will always be performed.	Valid contexts: http location, if in lo Default value: off
pcre_jit	Enables just-in-time compilation of Perl-compatible regular expressions known at configuration time. JIT support needs to be enabled in the PCRE library to make use of this speedup.	Valid context: main Default value: off
perl	Activates a Perl handler for this location. The argument is the name of the handler or a string describing a full subroutine.	Valid contexts: loca limit_except Default value: -
perl_modules	Specifies an additional search path for Perl modules.	Valid context: http Default value: -

perl_require	Indicates a Perl module that will be loaded at each NGINX reconfiguration. It may be specified multiple times for separate modules.	Valid context: http Default value: -
perl_set	Installs a Perl handler to set the value of a variable. The argument is the name of the handler or a string describing a full subroutine.	Valid context: http Default value: -
pid	This is the file where the process ID of the main process will be written, overwriting the compiled-in default.	Valid context: main Default value: nginx
pop3_auth	Sets the supported client authentication mechanism. It can be one or more of plain, apop, or cram-md5.	Valid contexts: mail Default value: plain
pop3_capabilities	Indicates which POP3 capabilities are supported by the backend server.	Valid contexts: mail Default value: TOP U
port_in_redirect	Determines whether or not the port will be specified in a redirect method issued by NGINX.	Valid contexts: http Default value: on
postpone_output	Specifies the minimum size of data for NGINX to send to the client. If possible, no data will be sent until this value is reached.	Valid contexts: http Default value: 1460
protocol	Indicates which protocol is supported by this mail server context. It may be one of imap, pop3, or smtp.	Valid context: serve Default value: -

proxy	Enables or disables mail proxying.	Valid context: serve Default value: -
proxy_bind	Specifies which address should be used for outgoing connections to a proxied server.	Valid contexts: http Default value: -
proxy_buffer	Allows setting the size of the buffer used for the mail proxy connection beyond the default of one page.	Valid contexts: mail Default value: 4k|8k dependent)
proxy_buffer_size	The size of the buffer used for the first part of the response from the upstream server, in which the response headers are found.	Valid contexts: http Default value: 4k|8k dependent)
proxy_buffering	Activates buffering of proxied content; when switched off, responses are sent synchronously to the client as soon as they are received.	Valid contexts: http Default value: on
proxy_buffers	The number and size of buffers used for responses from upstream servers.	Valid contexts: http Default value: 8 4k| dependent)
proxy_busy_buffers_size	The total size of buffer space allocated to sending the response to the client while still being read from the upstream server. This is typically set to two proxy_buffers.	Valid contexts: http Default value: 8k|16 dependent)
proxy_cache	Defines a shared memory zone to	Valid contexts: http

	be used for caching.	Default value: off
proxy_cache_bypass	One or more string variables, which when non-empty or non-zero, will cause the response to be taken from the upstream server instead of the cache.	Valid contexts: http Default value: -
proxy_cache_key	A string used as the key for storing and retrieving cache values.	Valid contexts: http Default value: $scheme$proxy_host
proxy_cache_lock	Enabling this directive will prevent multiple requests from making an entry into the same cache key.	Valid contexts: http Default value: off
proxy_cache_lock_timeout	The length of time a request will wait for an entry to appear in the cache or for the proxy_cache_lock directive to be released.	Valid contexts: http Default value: 5s
proxy_cache_min_uses	The number of requests for a certain key needed before a response is cached.	Valid contexts: http Default value: 1
proxy_cache_path	Refer to the *Proxy module caching directives* table in the *Caching* section in Chapter 5, *Reverse Proxy Advanced Topics*.	Valid context: http Default value: -
proxy_cache_use_stale	The cases under which it is acceptable to serve stale cached data when an error occurs when accessing the upstream server. The updating parameter indicates the case when fresh data are being	Valid contexts: http Default value: off

	loaded.	
proxy_cache_valid	Indicates the length of time for which a cached response with response code 200, 301, or 302 is valid. If an optional response code is given before the time parameter, that time is only for that response code. The special parameter any indicates that any response code should be cached for that length of time.	Valid contexts: http Default value: -
proxy_connect_timeout	The maximum amount of time NGINX will wait for its connection to be accepted when making a request to an upstream server.	Valid contexts: http Default value: 60s
proxy_cookie_domain	Replaces the domain attribute of the Set-Cookie header from the upstream server; the domain to be replaced can either be a string or a regular expression, or reference a variable.	Valid contexts: http Default value: off
proxy_cookie_path	Replaces the path attribute of the Set-Cookie header from the upstream server; the path to be replaced can either be a string or a regular expression, or reference a variable.	Valid contexts: http Default value: off
proxy_header_hash_bucket_size	The bucket size used to hold proxy header names (one name cannot be longer than the value of this directive).	Valid contexts: http location, if Default value: 64
	The total size of headers received	Valid contexts: http

proxy_header_hash_max_size	from the upstream server.	Default value: 512
proxy_hide_header	A list of header fields that should not be passed on to the client.	Valid contexts: http Default value: -
proxy_http_version	The HTTP protocol version used to communicate with upstream servers (use 1.1 for keepalive connections).	Valid contexts: http Default value: 1.0
proxy_ignore_client_abort	If set to on, NGINX will not abort the connection to an upstream server if the client aborts the connection.	Valid contexts: http Default value: off
proxy_ignore_headers	Sets which headers may be disregarded when processing the response from the upstream server.	Valid contexts: http Default value: -
proxy_intercept_errors	If enabled, NGINX will display a configured error_page instead of the response directly from the upstream server.	Valid contexts: http Default value: off
proxy_max_temp_file_size	The maximum size of the overflow file, written when the response doesn't fit into memory buffers.	Valid contexts: http Default value: 1024m
	Indicates the conditions under which the next upstream server will be selected for the response. This won't be used if the client has already been sent something. The conditions are specified using the following parameters:	

proxy_next_upstream	- error: An error occurred while communicating with the upstream server - timeout: A timeout occurred while communicating with the upstream server - invalid_header: The upstream server returned an empty or otherwise invalid response - http_500: The upstream server responded with a 500 error code - http_503: The upstream server responded with a 503 error code - http_504: The upstream server responded with a 504 error code - http_404: The upstream server responded with a 404 error code - off: Disables passing the request to the next upstream server when an error occurs	Valid contexts: http Default value: error
proxy_no_cache	Defines the conditions under which the response will not be saved to the cache. The parameters are string variables, which evaluate to something non-empty and non-zero to not cache.	Valid contexts: http Default value: -
proxy_pass	Specifies the upstream server to which the request is passed, in the form of a URL.	Valid contexts: loca location, limit_ex Default value: -
proxy_pass_error_message	Useful in situations where the backend authentication process	Valid contexts: mail

	emits a useful error message to the client.	Default value: off
proxy_pass_header	Overrides the disabled headers set in proxy_hide_header, allowing them to be sent to the client.	Valid contexts: http Default value: -
proxy_pass_request_body	Prevents sending the body of the request to the upstream server if set to off.	Valid contexts: http Default value: on
proxy_pass_request_headers	Prevents sending the headers of the request to the upstream server if set to off.	Valid contexts: http Default value: on
proxy_read_timeout	Specifies the length of time that needs to elapse between two successive read operations from an upstream server before the connection is closed.	Valid contexts: http Default value: 60s
proxy_redirect	Rewrites the Location and Refresh headers received from the upstream servers; useful for working around assumptions made by an application framework.	Valid contexts: http Default value: defau
proxy_send_lowat	If non-zero, NGINX will try to minimize the number of send operations on outgoing connections to a proxied server. It is ignored in Linux, Solaris, and Windows.	Valid contexts: http Default value: 0
proxy_send_timeout	The length of time that needs to elapse between two successive write operations to an upstream server before the connection is	Valid contexts: http Default value: 60s

	closed.	
proxy_set_body	The body of a request sent to an upstream server may be altered by setting this directive.	Valid contexts: http Default value: -
proxy_set_header	Rewrites the contents of the headers sent to an upstream server; may also be used to not send certain headers by setting its value to the empty string.	Valid contexts: http Default value: Host Connection close
proxy_ssl_session_reuse	Sets whether or not SSL sessions may be reused when proxying.	Valid contexts: http Default value: on
proxy_store	Enables storing responses retrieved from an upstream server as files on disk. The on parameter will use the alias or root directive as the base path under which to store the file. A string may instead be given, to indicate an alternative location to store the files.	Valid contexts: http Default value: off
proxy_store_access	Sets file access permissions for the newly-created proxy_store files.	Valid contexts: http Default value: user:
proxy_temp_file_write_size	Limits the amount of data buffered to a temporary file at one time, so that NGINX will not be blocked for too long on a single request.	Valid contexts: http Default value: 8k|16 dependent)
	A directory where temporary files may be buffered as they are proxied from the upstream server, optionally	

proxy_temp_path	multilevel deep. If a second, third, or fourth parameter is given, these specify a subdirectory hierarchy with the parameter value as the number of characters in the subdirectory name.	Valid contexts: http Default value: proxy
proxy_timeout	If a timeout beyond the default of 24 hours is required, this directive can be used.	Valid contexts: mail Default value: 24h
random_index	Activates randomly choosing a file to be served to the client when a URI ending with / is received.	Valid context: locat Default value: off
read_ahead	If possible, the kernel will preread files up to the size parameter. Supported on current FreeBSD and Linux (the size parameter is ignored on Linux).	Valid contexts: http Default value: 0
real_ip_header	Sets the header whose value is used as the client IP address when set_real_ip_from matches the connecting IP.	Valid contexts: http Default value: X-Rea
real_ip_recursive	Works with set_real_ip_from, to specify that the last address in a multi-valued real_ip_header header will be used.	Valid contexts: http Default value: off
recursive_error_pages	Enables doing more than one redirect using the error_page directive (default is off).	Valid contexts: http Default value: off
referer_hash_bucket_size	The bucket size of the valid referers	Valid contexts: serv

	hash tables.	Default value: 64
referer_hash_max_size	The maximum size of the valid referers hash tables.	Valid contexts: serv Default value: 2048
request_pool_size	Fine tunes per-request memory allocation.	Valid contexts: http Default value: 4k
reset_timedout_connection	With this directive enabled, connections that have been timed out will immediately be reset, freeing all associated memory. The default is to leave the socket in the FIN_WAIT1 state, which will always be the case for the keepalive connections.	Valid contexts: http Default value: off
resolver	Configures one or more name servers to be used to resolve upstream server names into IP addresses. An optional valid parameter overrides the TTL of the domain name record.	Valid contexts: http Default value: -
resolver_timeout	Sets the timeout for name resolution.	Valid contexts: http Default value: 30s
return	Stops processing and returns the specified code to the client. The non-standard code 444 will close the connection without sending any response headers. If a code additionally has text accompanying it, the text will be placed in the response body. If instead, a URL is	Valid contexts: serv Default value: -

	given after the code, that URL will be the value of the `Location` header. A URL without a code is treated as a code 302.	
`rewrite`	Refer to the *Rewrite module directives* table in the *Introducing the rewrite module* section in Appendix B, *Rewrite Rule Guide*.	Valid contexts: `serv` Default value: -
`rewrite_log`	Activates `notice` level logging of `rewrites` to the `error_log`.	Valid contexts: `http` `server`, `location`, `i` Default value: `off`
`root`	Sets the path to the document root. Files are found by appending the URI to the value of this directive.	Valid contexts: `http` `location`, `if in lo` Default value: `html`
`satisfy`	Allows access if `all` or `any` of the `access` or `auth_basic` directives grant access. The default value `all` indicates that a user must come from a specific network address and enter the correct password.	Valid contexts: `http` Default value: `all`
`satisfy_any`	This is deprecated. Use the `any` parameter of the `satisfy` directive.	Valid contexts: `http` Default value: `off`
`secure_link_secret`	A salt used to compute the MD5 hash of a URI.	Valid context: `locat` Default value: -
	If non-zero, NGINX will try to minimize the number of send	Valid contexts: `http`

send_lowat	operations on client sockets. Ignored in Linux, Solaris, and Windows.	Default value: 0
send_timeout	This directive sets a timeout between two successive write operations for a client receiving a response.	Valid contexts: http Default value: 60s
sendfile	Enable using sendfile(2) to directly copy data from one file descriptor to another.	Valid contexts: http location, if in lo Default value: off
sendfile_max_chunk	Sets the maximum size of data to copy in one sendfile(2) call to prevent a worker from seizing.	Valid contexts: http Default value: 0
server (http)	Creates a new configuration context, defining a virtual host. The listen directive specifies the IP address(es) and port(s); the server_name directive lists the Host header values that this context matches.	Valid context: http Default value: -
server (upstream)	Refer to the *Upstream modules directives* table in the *The upstream module* section in Chapter 4, *NGINX as a Reverse Proxy*.	Valid context: upstr Default value: -
server (mail)	Creates a new configuration context, defining a mail server. The listen directive specifies the IP address(es) and port(s); the server_name directive sets the name of the server.	Valid context: mail Default value: -

`server_name` (`http`)	Configures the names that a virtual host may respond to.	Valid context: `serve` Default value: ""
`server_name` (`mail`)	Sets the name of the server, which is used in the following ways: • The POP3/SMTP server greeting • The salt for SASL CRAM-MD5 authentication • The EHLO name when using `xclient` to talk to an SMTP backend	Valid contexts: `mail` Default value: `hostn`
`server_name_in_redirect`	Activates using the first value of the `server_name` directive in any redirect issued by NGINX within this context.	Valid contexts: `http` Default value: `off`
`server_names_hash_bucket_size`	The bucket size used to hold the `server_name` hash tables.	Valid context: `http` Default value: `32|64` dependent)
`server_names_hash_max_size`	The maximum size of the `server_name` hash tables.	Valid context: `http` Default value: `512`
`server_tokens`	Disables sending the NGINX version string in error messages and the `Server` response header (default value is `on`).	Valid contexts: `http` Default value: `on`
`set`	Sets a given variable to a specific value.	Valid context: `serve` Default value: -

set_real_ip_from	Defines the connecting address(es) from which the client IP will be extracted from the real_ip_header directive. The value unix: means that all connections from UNIX-domain sockets will be treated this way.	Valid contexts: http Default value: -
smtp_auth	Sets the supported SASL client authentication mechanism. It can be one or more of login, plain, or cram-md5.	Valid contexts: mail Default value: login
smtp_capabilities	Indicates which SMTP capabilities are supported by the backend server.	Valid contexts: mail Default value: -
so_keepalive	Sets the TCP keepalive parameter on the socket connection to the proxied server.	Valid contexts: mail Default value: off
source_charset	Defines the charset of a response. If it is different from the defined charset, a conversion is performed.	Valid contexts: http location, if in lo Default value: -
split_clients	Creates a context in which variables appropriate to A/B (or split) testing are set. The string specified in the first parameter is hashed using MurmurHash2. The variable specified in the second parameter is then set to a value based on how the string falls within the range of hash values. The match is specified as either a percentage or * to place weights on the values.	valid context(s): http default value: -

ssi	Enables the processing of SSI files.	Valid contexts: http location, if in lo Default value: off
ssi_min_file_chunk	Sets the minimum size of a file above which it should be sent using sendfile(2).	Valid contexts: http Default value: 1k
ssi_silent_errors	Suppresses the error message normally output when an error occurs during SSI processing.	Valid contexts: http Default value: off
ssi_types	Lists the MIME types of a response in addition to text/html in which SSI commands are processed. It may be * to enable all MIME types.	Valid contexts: http Default value: text/
ssi_value_length	Sets the maximum length of values for parameters used in Server Side Includes.	Valid contexts: http Default value: 256
ssl (http)	Enables the HTTPS protocol for this virtual server.	Valid contexts: http Default value: off
ssl (mail)	Indicates if this context should support SSL/TLS transactions.	Valid contexts: mail Default value: off
ssl_certificate (http)	The path to the file containing the SSL certificate for this server_name in PEM format. If intermediate certificates are required, they need to be added in order after the certificate corresponding to the	Valid contexts: http Default value: -

	server_name directive, up to the root, if necessary.	
ssl_certificate (mail)	The path to the PEM-encoded SSL certificate(s) for this virtual server.	Valid contexts: mail Default value: -
ssl_certificate_key (http)	The path to the file containing the SSL certificate's secret key.	Valid contexts: http Default value: -
ssl_certificate_key (mail)	The path to the PEM-encoded SSL secret key for this virtual server.	Valid contexts: mail Default value: -
ssl_ciphers	The ciphers that should be supported in this virtual server context (OpenSSL format).	Valid contexts: http Default value: HIGH:
ssl_client_certificate	The path to the file containing the PEM-encoded public CA certificate(s) of the certificate authorities used to sign client certificates.	Valid contexts: http Default value: -
ssl_crl	The path to the file containing the PEM-encoded **certificate revocation list** (**CRL**) for the client certificates that are to be verified.	Valid contexts: http Default value: -
ssl_dhparam	The path to a file containing DH parameters, used for EDH ciphers.	Valid contexts: http Default value: -
ssl_engine	Specifies a hardware SSL accelerator.	Valid context: main

		Default value: -
`ssl_prefer_server_ciphers` (`http`)	Indicates that the server ciphers are to be preferred over the client's ciphers when using the SSLv3 and TLS protocols.	Valid contexts: `http` Default value: `off`
`ssl_prefer_server_ciphers` (`mail`)	Indicates that SSLv3 and TLSv1 server ciphers are preferred over the client's ciphers.	Valid contexts: `mail` Default value: `off`
`ssl_protocols` (`http`)	Indicates which SSL protocols should be enabled.	Valid contexts: `http` Default value: `SSLv3 TLSv1.2`
`ssl_protocols` (`mail`)	Indicates which SSL protocols should be enabled.	Valid contexts: `mail` Default value: `SSLv3 TLSv1.2`
`ssl_session_cache` (`http`)	Sets the type and size of the SSL cache to store session parameters. A cache can be one of the following types: • `off`: Clients are told that sessions won't be reused at all • `none`: Clients are told that sessions are reused, but they aren't really • `builtin`: An OpenSSL builtin cache used by only one worker with a size specified in sessions • `shared`: A cache shared by all worker processes, given a name and session size	Valid contexts: `http` Default value: `none`

	specified in megabytes	
ssl_session_cache (mail)	Sets the type and size of the SSL cache to store session parameters. A cache can be one of the following types: • off: Clients are told that sessions won't be reused at all • none: Clients are told that sessions are reused, but they aren't really • builtin: An OpenSSL builtin cache used by only one worker with a size specified in sessions • shared: A cache shared by all worker processes, given a name and session size specified in megabytes	Valid contexts: mail Default value: none
ssl_session_timeout (http)	How long the client can use the same SSL parameters, provided they are stored in the cache.	Valid contexts: http Default value: 5m
ssl_session_timeout (mail)	How long the client can use the same SSL parameters, provided they are stored in the cache.	Valid contexts: mail Default value: 5m
ssl_stapling	Enables stapling of OCSP responses. The CA certificate of the server's issuer should be contained in the file specified by ssl_trusted_certificate. A resolver should also be specified to be able to resolve the OCSP responder hostname.	Valid contexts: http Default value: off

ssl_stapling_file	The path to a DER-formatted file containing the stapled OCSP response.	Valid contexts: http Default value: -
ssl_stapling_responder	A URL specifying the OCSP responder. Only URLs beginning with http:// are currently supported.	Valid contexts: http Default value: -
ssl_stapling_verify	Enables verification of OCSP responses.	Valid contexts: http Default value: -
ssl_trusted_certificate	The path to a file containing PEM-formatted SSL certificates of the CA's signing client certificates and OCSP responses when ssl_stapling is enabled.	Valid contexts: http Default value: -
ssl_verify_client	Enables verification of SSL client certificates. If the optional parameter is specified, a client certificate will be requested and if present, verified. If the optional_no_ca parameter is specified, a client certificate is requested, but doesn't require it to be signed by a trusted CA certificate.	Valid contexts: http Default value: off
ssl_verify_depth	Sets how many signers will be checked before declaring the certificate invalid.	Valid contexts: http Default value: 1
starttls	Indicates whether or not STLS/STARTTLS are supported and/or required for further communication with this server.	Valid contexts: mail Default value: off

sub_filter	Sets the string to be matched without regards to case and the string to be substituted into that match. The substitution string may contain variables.	Valid contexts: http Default value: -
sub_filter_once	Setting to off will cause the match in sub_filter to be made as many times as the string is found.	Valid contexts: http Default value: on
sub_filter_types	Lists the MIME types of a response in addition to text/html in which a substitution will be made. It may be * to enable all MIME types.	Valid contexts: http Default value: text/
tcp_nodelay	Enables or disables the TCP_NODELAY option for the keep-alive connections.	Valid contexts: http Default value: on
tcp_nopush	Relevant only when the sendfile directive is used. Enables NGINX to attempt to send response headers in one packet, as well as sending a file in full packets.	Valid contexts: http Default value: off
timeout	The amount of time NGINX will wait before a connection to the backend server is finalized.	Valid contexts: mail Default value: 60s
timer_resolution	Specifies how often gettimeofday() is called instead of each time a kernel event is received.	Valid context: main Default value: -
	Tests the existence of files given as parameters. If none of the previous	Valid contexts: serv

try_files	files are found, the last entry is used as a fallback, so ensure that this path or named location exists.	Default value: -
types	Sets up a map of MIME types to filename extensions. NGINX ships with a conf/mime.types file that contains most MIME type mappings. Using include to load this file should be sufficient for most purposes.	Valid contexts: http Default value: text/ht image/g image/j
types_hash_bucket_size	The bucket size used to hold the types hash tables.	Valid contexts: http Default value: 32|64 dependent)
types_hash_max_size	The maximum size of the types hash tables.	Valid contexts: http Default value: 1024
underscores_in_headers	Enables the use of the underscore character in client request headers. If left at the default value off, evaluation of such headers is subject to the value of the ignore_invalid_headers directive.	Valid contexts: http Default value: off
uninitialized_variable_warn	Controls whether or not warnings about uninitialized variables are logged.	Valid contexts: http location, if Default value: on
upstream	Sets up a named context in which a group of servers is defined.	Valid context: http Default value: -
	The use directive indicates which	

use	connection processing method should be used. This will overwrite the compiled-in default, and must be contained in an events context, if used. It is especially useful when the compiled-in default is found to produce errors over time.	Valid context: event Default value: -
user	The user and group under which the worker processes will run is configured using this parameter. If the group is omitted, a group name equal to that of the user will be used.	Valid context: main Default value: nobod
userid	Activates the module according to the following parameters: • on: Sets Version 2 cookies and logs those received • v1: Sets Version 1 cookies and logs those received • log: Disables setting of cookies, but enables logging them • off: Disables both the setting of cookies and the logging of them	Valid contexts: http Default value: off
userid_domain	Configures a domain to be set in the cookie.	Valid contexts: http Default value: none
userid_expires	Sets the age of the cookie. If the keyword max is used, this translates to 31 Dec 2037 23:55:55 GMT.	Valid contexts: http Default value: -
userid_mark	Sets the first character of the tail of the userid_name cookie's base64	Valid contexts: http

	representation.	Default value: off
userid_name	Sets the name of the cookie.	Valid contexts: http Default value: uid
userid_p3p	Configures the P3P header.	Valid contexts: http Default value: -
userid_path	Defines the path set in the cookie.	Valid contexts: http Default value: /
userid_service	Identity of the service that set the cookie. For example, the default value for Version 2 cookies is the IP address of the server that set the cookie.	Valid contexts: http Default value: IP ad
valid_referers	Defines which values of the Referer header will cause the $invalid_referer variable to be set to an empty string. Otherwise it will be set to 1. The parameters can be one or more of the following: • none: There is no Referer header • blocked: The Referer header is present, but empty or lacking a scheme • server_names: The Referer value is one of the server_names • arbitrary string: the value of the Referer header is a server name with or without URI prefixes and * at the beginning or end	Valid context: serve Default value: -

	• regular expression: matches the text after the scheme in the `Referer` header's value	
`variables_hash_bucket_size`	The bucket size used to hold the remaining variables.	Valid context: `http` Default value: `64`
`variables_hash_max_size`	The maximum size of the hash that holds the remaining variables.	Valid context: `http` Default value: `512`
`worker_aio_requests`	The number of open asynchronous I/O operations for a single worker process when using `aio` with `epoll`.	Valid context: `event` Default value: `32`
`worker_connections`	This directive configures the maximum number of simultaneous connections that a worker process may have open. This includes, but is not limited to, client connections and connections to upstream servers.	Valid context: `event` Default value: `512`
`worker_cpu_affinity`	Binds worker processes to CPU sets, as specified by a bitmask. Only available on FreeBSD and Linux.	Valid context: `main` Default value: -
`worker_priority`	Sets the scheduling priority for worker processes. Works like the nice command, with a negative number being a higher priority.	Valid context: `main` Default value: `0`
`worker_processes`	This is the number of worker processes that will be started. These will handle all connections made by clients. Choosing the right	Valid context: `main`

	number is a complex process, a good rule of thumb is to set this equal to the number of CPU cores.	Default value: `1`
`worker_rlimit_core`	Changes the limit on core file size of a running process.	Valid context: `main` Default value: -
`worker_rlimit_nofile`	Changes the limit on the number of open files of a running process.	Valid context: `main` Default value: -
`worker_rlimit_sigpending`	Changes the limit on the number of pending signals of a running process when using the `rtsig` connection processing method.	Valid context: `main` Default value: -
`working_directory`	The current working directory for worker processes. It should be writable by the worker to produce core files.	Valid context: `main` Default value: -
`xclient`	The SMTP protocol allows checking based on `IP/HELO/LOGIN` parameters, which are passed via the `XCLIENT` command. This directive enables NGINX to communicate this information.	Valid contexts: `mail` Default value: `on`
`xml_entities`	The path to the DTD that declares the character entities referenced in the XML to be processed.	Valid contexts: `http` default value: -
`xslt_param`	Parameters passed to the stylesheets, whose values are XPath expressions.	Valid contexts: `http` Default value: -

`xslt_string_param`	Parameters passed to the stylesheets, whose values are strings.	Valid contexts: `http` Default value: -
`xslt_stylesheet`	The path to an XSLT stylesheet used to transform an XML response. Parameters may be passed as a series of key/value pairs.	Valid context: `locat` Default value: -
`xslt_types`	Lists the MIME types of a response in addition to `text/xml`, in which a substitution will be made. It may be `*` to enable all MIME types. If the transformation results in an HTML response, the MIME type will be changed to `text/html`.	Valid contexts: `http` Default value: `text/`

Appendix B. Rewrite Rule Guide

This appendix is meant to introduce the `rewrite` module in NGINX and serve as a guide for creating new rules as well as translating legacy Apache rewrite rules into NGINX's format. In this appendix, we will discuss the following:

- Introducing the rewrite module
- Creating new rewrite rules
- Translating from Apache

Introducing the rewrite module

NGINX's rewrite module is a simple regular expression matcher combined with a virtual stack machine. The first part of any rewrite rule is a regular expression. As such, it is possible to use parentheses to define certain parts as "captures", which can later be referenced by positional variables. A positional variable is one in which its value depends on the order of the capture in the regular expression. They are labeled by number, so positional variable `$1` references what is matched by the first set of parentheses, `$2` the second set, and so on. For example, refer to the following regular expression:

```
^/images/([a-z]{2})/([a-z0-9]{5})/(.*)\.(png|jpg|gif)$
```

The first positional variable, `$1`, references a two-letter string which comes immediately after the string `/images/` at the beginning of the URI. The second positional variable, `$2`, refers to a five character string composed of lowercase letters and the numbers from 0 to 9. The third positional variable, `$3`, is presumably the name of a file. And the last variable to be extracted from this regular expression, `$4`, is one of `png`, `jpg`, or `gif`, which appears at the very end of the URI.

The second part of a `rewrite` rule is the URI to which the request is rewritten. The URI may contain any positional variable captured in the regular expression indicated by the first argument, or any other variable valid at this level of NGINX's configuration:

```
/data?file=$3.$4
```

If this URI does not match any of the other locations in the NGINX configuration, then it is returned to the client in the `Location` header with either a 301 (Moved Permanently) or a 302 (Found) HTTP status code indicating the type of redirect that is to be performed. This status code may be specified explicitly if `permanent` or `redirect` is the third parameter.

This third parameter to the rewrite rule may also be either `last` or `break`, indicating that no further rewrite module directives will be processed. Using the last flag will cause NGINX to search for another location matching the rewritten URI.

```
rewrite '^/images/([a-z]{2})/([a-z0-9]{5})/(.*)\.(png|jpg|gif)$'
/data?file=$3.$4 last;
```

The break parameter may also be used as a directive on its own, to stop rewrite module directive processing within an if block or other context in which the rewrite module is active. The following snippet presumes that some external method is used to set the $bwhog variable to a non-empty and non-zero value when a client has used too much bandwidth. The limit_rate directive will then enforce a lower transfer rate. break is used here because we entered the rewrite module with if, and we don't want to process any further such directives:

```
if ($bwhog) {

    limit_rate 300k;

    break;

}
```

Another way to stop the processing of the rewrite module directives is to return control to the main http module processing the request. This may mean that NGINX returns information directly to the client, but return is often combined with an error_page to either present a formatted HTML page to the client or activate a different module to finish processing the request. The return directive may indicate a status code, a status code with some text, or a status code with a URI. If a bare URI is the sole parameter, then the status code is understood to be a 302. When the text is placed after the status code, that text becomes the body of the response. If a URI is used instead, then that URI becomes the value of the Location header, to which the client will then be redirected.

As an example, we want to set a short text as the output for a file not found error in a particular location. We specify the location with an equals sign (=) to exactly match just this URI:

```
location = /image404.html {

    return 404 "image not found\n";

}
```

Any call to this URI would then be answered with an HTTP code of 404, and the text **image not found\n**. So, we can use /image404.html at the end of a try_files directive or as an error page for image files.

In addition to directives relating to the act of rewriting a URI, the `rewrite` module also includes the `set` directive to create new variables and set their values. This is useful in a number of ways, from creating flags when certain conditions are present, to passing named arguments on to other `locations` and logging what was done.

The following example demonstrates some of these concepts and the usage of the corresponding directives:

```
http {

    # a special log format referencing variables we'll define later
    log_format imagelog '[$time_local] ' $image_file ' '
$image_type ' ' $body_bytes_sent ' ' $status;

    # we want to enable rewrite-rule debugging to see if our rule
does
    #  what we intend
    rewrite_log on;

    server {

        root /home/www;

        location / {

            # we specify which logfile should receive the rewrite-
ruledebug
            #  messages
            error_log logs/rewrite.log notice;

            # our rewrite rule, utilizing captures and positional
variables
            #  note the quotes around the regular expression -
theseare
            #  required because we used {} within the expression
itself
            rewrite '^/images/([a-z]{2})/([a-z0-9]{5})/(.*)\.
(png|jpg|gif)$' /data?file=$3.$4;

            # note that we didn't use the 'last' parameter above;
if we had,
            #  the variables below would not be set because NGINX
would
            #  have ended rewrite module processing

            # here we set the variables that are used in the custom
log
            #   format 'imagelog'
            set $image_file $3;

            set $image_type $4;

        }

        location /data {
```

```
            # we want to log all images to this specially-formatted
logfile
            #  to make parsing the type and size easier
            access_log logs/images.log imagelog;

            root /data/images;

            # we could also have used the $image-variables we
defined
            #  earlier, but referencing the argument is more
readable
            try_files /$arg_file /image404.html;

        }

        location = /image404.html {

            # our special error message for images that don't exist
            return 404 "image not found\n";

        }

}
```

The following table summarizes the `rewrite` module directives we discussed in this section:

Table: Rewrite module directives

Directive	Explanation
`break`	Ends the processing of the `rewrite` module directives found within the same context.
`if`	Evaluates a condition, and if true follows the `rewrite` module directives specified within the context set up using the following format: `if (condition) { … }` The condition may be any of the following: • a variable name: `false` if empty or any string starting with `0` • string comparison: using the `=` and `!=` operators

	• regular expression matching: using the `~` (case-sensitive) and the `~*` (case-insensitive) positive operators and their negative counterparts `!~` and `!~*` • file existence: using the `-f` and `! -f` operators • directory existence: using the `-d` and `! -d` operators • file, directory, or symbolic link existence: using the `-e` and `! -e` operators • file executability: using the `-x` and `! -x` operators
`return`	Stops processing and returns the specified code to the client. The non-standard code 444 will close the connection without sending any response headers. If a code additionally has text accompanying it, the text will be placed in the response body. If instead, a URL is given after the code, that URL will be the value of the `Location` header. A URL without a code is treated as a code 302.
`rewrite`	Changes the URI from one matched by the regular expression in the first parameter to the string in the second parameter. If a third parameter is given, it is one of the following flags: • `last`: stops processing the `rewrite` module directives and searches for a location matched by the changed URI • `break`: stops processing the `rewrite` module directives • `redirect`: returns a temporary redirect (code 302), used when the URI does not begin with a scheme • `permanent`: returns a permanent redirect (code 301)
`rewrite_log`	Activates the `notice` level logging of `rewrite` to `error_log`.
`set`	Sets a given variable to a specific value.
`unitialized_variable_warn`	Controls whether or not warnings about uninitialized variables are logged.

Creating new rewrite rules

When creating new rules from scratch, just as with any configuration block, plan out exactly what needs to be done. Some questions to ask yourself are as follows:

- What pattern(s) do I have in my URLs?
- Is there more than one way to reach a particular page?
- Do I want to capture any parts of the URL into variables?
- Am I redirecting to a site not on this server, or could my rule be seen again?
- Do I want to replace the query string arguments?

In examining the layout of your website or application, it should be clear what patterns you have in your URLs. If there is more than one way to reach a certain page, create a rewrite rule to send a permanent redirect back to the client. Using this knowledge, you can construct a canonical representation of your website or application. This not only makes for cleaner URLs, but also helps your site to be found more easily.

For example, if you have a `home` controller to handle default traffic, but can also reach that controller through an index page, you could have users getting to the same information using the following URIs:

```
/
/home
/home/
/home/index
/home/index/
/index
/index.php
/index.php/
```

It would be more efficient to direct requests containing the name of the controller and/or the index page back to the root:

```
rewrite ^/(home(/index)?|index(\.php)?)/?$ $scheme://$host/
permanent;
```

We specified the `$scheme` and `$host` variables because we're making a permanent redirect (code 301) and want NGINX to construct the URL using the same parameters that reached this configuration line in the first place.

If you would like to be able to log individual parts of the URL separately, you can use captures on the URI in the regular expression. Then, assign the positional variables to named variables, which are then part of a `log_format` definition. We saw an example of this in the previous section. The components are essentially as follows:

```
log_format imagelog '[$time_local] ' $image_file ' ' $image_type '
' $body_bytes_sent ' ' $status;

rewrite '^/images/([a-z]{2})/([a-z0-9]{5})/(.*)\.(png|jpg|gif)$'
/data?file=$3.$4;

set $image_file $3;

set $image_type $4;

access_log logs/images.log imagelog;
```

When your rewrite rule leads to an internal redirect or instructs the client to call a location in which the rule itself is defined, special care must be taken to avoid a rewrite loop. For example, a rule may be defined in the server context with the `last` flag, but must use the `break` flag when defined within the location it references.

```
server {

    rewrite ^(/images)/(.*)\.(png|jpg|gif)$ $1/$3/$2.$3 last;
    location /images/ {

        rewrite ^(/images)/(.*)\.(png|jpg|gif)$ $1/$3/$2.$3 break;

    }

}
```

Passing new query string arguments as part of a rewrite rule is one of the objectives of using rewrite rules. However, when the initial query string arguments should be discarded, and only the ones defined in the rule should be used, a `?` character needs to be placed at the end of the list of new arguments.

```
rewrite ^/images/(.*)_(\d+)x(\d+)\.(png|jpg|gif)$ /resizer/$1.$4?
width=$2&height=$3? last;
```

Translating from Apache

There is a long history of writing rewrite rules for Apache's powerful `mod_rewrite` module, and most resources on the Internet are focused on these. When encountering rewrite rules in Apache's format, they can be translated into a form that NGINX can parse by following a few simple rules.

Rule #1: Replace directory and file existence checks with try_files

When encountering an Apache rewrite rule of the following form:

```
RewriteCond %{REQUEST_FILENAME} !-f

RewriteCond %{REQUEST_FILENAME} !-d

RewriteRule ^(.*)$ index.php?q=$1 [L]
```

This can best be translated into an NGINX configuration as follows:

```
try_files $uri $uri/ /index.php?q=$uri;
```

These rules state that when the filename specified in the URI is neither a file nor a directory on disk, the request should be passed to the `index.php` file lying in the current context's root and given the argument `q` with a value matching the original URI.

Before NGINX had the `try_files` directive, there would be no choice but to use `if` to test for the existence of the URI:

```
if (!-e $request_filename) {

    rewrite ^/(.*)$ /index.php?q=$1 last;

}
```

Don't do this. You may see configurations on the Internet that recommend you do exactly this, but they are outdated or are copies of an outdated configuration. While not strictly a rewrite rule, because `try_files` belongs to the core `http` module, the `try_files` directive is much more efficient at performing this task and this is exactly what it was created for.

Rule #2: Replace matches against REQUEST_URI with a location

Many Apache rewrite rules are made to be placed into `.htaccess` files because, historically, users would most likely have access to these files themselves. A typical shared hoster would not enable their users direct access to the virtual host configuration context responsible for their website, but would instead offer the ability to place nearly any kind of configuration into an `.htaccess` file. This led to the situation we have today, with a proliferation of .htaccess-file-specific rewrite rules.

While Apache also has a `Location` directive, it is rarely used to solve the problem of matching against the URI because it may only be used in either the main server configuration or the configuration of a virtual host. So, instead we will see a proliferation of rewrite rules that match against `REQUEST_URI`:

```
RewriteCond %{REQUEST_URI} ^/niceurl

RewriteRule ^(.*)$ /index.php?q=$1 [L]
```

This is best handled in NGINX by using a location:

```
location /niceurl {

    include fastcgi_params;

    fastcgi_index index.php;

    fastcgi_pass 127.0.0.1:9000;

}
```

Of course, what is inside the `location` context is dependent upon your setup, but the principle remains the same; matches against the URI are best served by a `location`.

This principle also applies to `RewriteRules` that have an implicit `REQUEST_URI`. These are typically bare `RewriteRules` that transform the URI from an older format to a newer one. In the following example, we see that the `show.do` is no longer necessary:

```
RewriteRule ^/controller/show.do$ http://example.com/controller
[L,R=301]
```

This translates to an NGINX configuration as follows:

```
location = /controller/show.do {

    rewrite ^ http://example.com/controller permanent;

}
```

Not to get too carried away with creating locations whenever we see a `RewriteRule`, we should keep in mind that regular expressions translate directly.

Rule #3: Replace matches against HTTP_HOST with a server

Related closely to *Rule #2*, this rule takes configurations into account that try to either remove or add a `www` onto a domain name. These types of rewrite rules are often found in `.htaccess` files or in virtual hosts with overloaded `ServerAliases`:

```
RewriteCond %{HTTP_HOST} !^www

RewriteRule ^(.*)$ http://www.example.com/$1 [L,R=301]
```

Here, we translate the case where no `www` is found at the beginning of the `Host` part of the URL to the variant with a `www` there:

```
server {

    server_name example.com;

    rewrite ^ http://www.example.com$request_uri permanent;

}
```

In the opposite case, where no `www` is desired, we enter the following rule:

```
RewriteCond %{HTTP_HOST} ^www

RewriteRule ^(.*)$ http://example.com/$1 [L,R=301]
```

This translates to the following NGINX configuration:

```
server {

    server_name www.example.com;

    rewrite ^ http://example.com$request_uri permanent;

}
```

What is not shown is the `server` context for the variant that has been redirected. This has been left out because it's not relevant to the rewriting itself.

This same principle applies to more than just matching a `www` or lack of one. It can be used in dealing with any `RewriteCond` that uses `%{HTTP_HOST}`. These rewrites are best done in NGINX by using multiple `server` contexts, one each to match the desired condition.

For example, we have the following multisite configuration in Apache:

```
RewriteCond %{HTTP_HOST} ^site1

RewriteRule ^(.*)$ /site1/$1 [L]

RewriteCond %{HTTP_HOST} ^site2

RewriteRule ^(.*)$ /site2/$1 [L]

RewriteCond %{HTTP_HOST} ^site3

RewriteRule ^(.*)$ /site3/$1 [L]
```

This basically translates to a configuration that matches on hostname and has a different `root` configuration per host.

```
server {

    server_name site1.example.com;
    root /home/www/site1;

}

server {

    server_name site2.example.com;

    root /home/www/site2;

}

server {

    server_name site3.example.com;

    root /home/www/site3;

}
```

These are essentially different virtual hosts, so it is best to treat them as such in the configuration as well.

Rule #4: Replace RewriteCond with if for variable checks

This rule applies only after having applied rules 1 to 3. If there are any remaining conditions not covered by those rules, then `if` may be applied to test the values of variables. Any HTTP variable may be used by prefixing the lowercased name of the variable with `$http_`. If there are hyphens (-) in the name, these are translated into underscores (_).

The following example (taken from Apache's documentation on the `mod_rewrite` module at http://httpd.apache.org/docs/2.2/mod/mod_rewrite.html) is used to decide which page should be delivered to a client based on the `User-Agent` header:

```
RewriteCond  %{HTTP_USER_AGENT}  ^Mozilla

RewriteRule  ^/$                 /homepage.max.html  [L]

RewriteCond  %{HTTP_USER_AGENT}  ^Lynx
RewriteRule  ^/$                 /homepage.min.html  [L]

RewriteRule  ^/$                 /homepage.std.html  [L]
```

This can be translated to an NGINX configuration as follows:

```
if ($http_user_agent ~* ^Mozilla) {

    rewrite ^/$ /homepage.max.html break;

}

if ($http_user_agent ~* ^Lynx) {

    rewrite ^/$ /homepage.min.html break;

}

index homepage.std.html;
```

If there are any special variables that are available only under Apache's `mod_rewrite`, then these of course can't be checked in NGINX.

Summary

We explored NGINX's `rewrite` module in this appendix. There are only a few directives associated with the module, but these can be used to create some complex configurations. Taking the process of creating new rewrite rules step-by-step has hopefully demonstrated how rewrite rules can be made easily. An understanding of regular expressions, how to read and construct them, is needed before creating rewrite rules of any complexity. We rounded this appendix off by examining how to translate Apache-style rewrite rules into a configuration that NGINX can parse. In doing so, we discovered that quite a few Apache rewrite rule scenarios can be solved differently in NGINX.

Appendix C. The NGINX Community

NGINX is not only supported by a vibrant community, but also has a company to back it now, too. Igor Sysoev, the original author of NGINX, co-founded NGINX, Inc. in 2011 to offer professional support to companies using NGINX. He and the other NGINX developers are still available to the community, though. This appendix provides a brief overview of community resources available online.

Topics covered in this appendix include the following:

- Mailing list
- IRC channel
- Web resources
- Writing a proper bug report

Mailing list

The mailing list at `nginx@nginx.org` has been active since 2005. Subscribing to the list and seeing what kind of questions are asked and how they are answered is the best way to get an idea of how to get help from the list. Before asking a question, search online for an answer first. There is also an FAQ at http://wiki.nginx.org/Faq. See if someone has already asked the question recently by searching the archives at http://mailman.nginx.org/pipermail/nginx/. It's not only embarrassing for you if the same question has been asked recently, but it's also annoying to the readers of the list.

IRC channel

The IRC channel `#nginx` at `irc.freenode.net` is a real-time resource for those interested in getting to know the developers and having helpful responses to short queries. Please do follow IRC etiquette though when visiting the channel. Larger blocks of text such as configuration files or compilation output should go into a Pastebin and only the URL copied into the channel. More details about the channel can be found at http://wiki.nginx.org/IRC.

Web resources

The wiki at http://wiki.nginx.org has been a useful resource for a number of years. Here you will find a complete directive reference, a module listing, and a number of configuration examples. Keep in mind though, that this is a wiki, and the information found on it is not guaranteed to be accurate, up-to-date, or to fit your needs exactly. As we have seen throughout this book, it is always important to think about what you want to accomplish before setting out to derive the solution.

NGINX, Inc. maintains the official reference documentation located at http://nginx.org/en/docs/. There are some documents introducing NGINX, as well as How-to's and pages describing each module and directive.

Writing a good bug report

When searching for help online, it is useful to be able to write a good bug report. You will find that an answer is much more easily forthcoming if you can formulate the problem in a clear, reproducible way. This section will help you do just that.

The most difficult part of a bug report is actually defining the problem itself. It will help you to first think about what it is you are trying to accomplish. State your goal in a clear, concise manner as follows:

```
I need all requests to subdomain.example.com to be served from
server1.
```

Avoid writing reports in the following manner:

```
I'm getting requests served from the local filesystem instead of
proxying them to server1 when I call subdomain.example.com.
```

Do you see the difference between these two statements? In the first case, you can clearly see that there is a specific goal in mind. The second case describes more the result of the problem than the goal itself.

Once the problem has been defined, the next step is describing how that problem can be reproduced:

```
Calling http://subdomain.example.com/serverstatus yields a "404
File Not Found".
```

This will help whoever is looking at this problem to try to solve it. It ensures that there is a non-working case that can be shown to be working once the problem is solved.

Next, it is helpful to describe the environment in which this problem was observed. Some bugs only surface in certain operating systems or with a particular version of a dependent library.

Any configuration files necessary to reproduce the problem should be included in the report. If a file is found in the software archive, then a reference to that file is enough.

Read your bug report before sending it off. Often, you will find that some information has been left out. Sometimes, you will find that you have even solved the problem yourself, just by defining it clearly!

Summary

In this appendix, we learned a bit about the community behind NGINX. We saw who the major players are and what resources are available online. We also got an in-depth look at writing a bug report that should be helpful in finding a solution to a problem.

Appendix D. Persisting Solaris Network Tunings

In Chapter 8, *Troubleshooting Techniques*, we saw how to change different network tuning parameters for different operating systems. This appendix details what is necessary to persist these changes under Solaris 10 and above.

The following script is what is actually run by the **Service Management Framework** (**SMF**) to set the network parameters with ndd. Save it as `/lib/svc/method/network-tuning.sh` and make it executable, so that it can be run at any time on the command line to test:

```
# vi /lib/svc/method/network-tuning.sh
```

The following snippet is the content of the `/lib/svc/method/network-tuning.sh` file:

```
#!/sbin/sh
# Set the following values as desired
ndd -set /dev/tcp tcp_max_buf 16777216
ndd -set /dev/tcp tcp_smallest_anon_port 1024
ndd -set /dev/tcp tcp_largest_anon_port 65535
ndd -set /dev/tcp tcp_conn_req_max_q 1024
ndd -set /dev/tcp tcp_conn_req_max_q0 4096
ndd -set /dev/tcp tcp_xmit_hiwat 1048576
ndd -set /dev/tcp tcp_recv_hiwat 1048576
# chmod 755 /lib/svc/method/network-tuning.sh
```

The following manifest serves to define the network-tuning service and will run the script at boot time. Note that we specify a duration of *transient* to let SMF know that this is a run-once script and not a persistent daemon.

Place it in `/var/svc/manifest/site/network-tuning.xml` and import with the following command:

```
# svccfg import /var/svc/manifest/site/network-tuning.xml
```

You should see the following output:

```
<?xml version="1.0"?>
<!DOCTYPE service_bundle SYSTEM
"/usr/share/lib/xml/dtd/service_bundle.dtd.1">

<service_bundle type='manifest' name='SUNW:network_tuning'>

<service
      name='site/network_tuning'
```

```
        type='service'
        version='1'>

        <create_default_instance enabled='true' />

        <single_instance />

        <dependency
                name='usr'
                type='service'
                grouping='require_all'
                restart_on='none'>
                <service_fmri value='svc:/system/filesystem/minimal'
/>
        </dependency>

<!-- Run ndd commands after network/physical is plumbed. -->
        <dependency
                name='network-physical'
                grouping='require_all'
                restart_on='none'
                type='service'>
                <service_fmri value='svc:/network/physical' />
        </dependency>

<!-- but run the commands before network/initial -->
        <dependent
                name='ndd_network-initial'
                grouping='optional_all'
                restart_on='none'>
                <service_fmri value='svc:/network/initial' />
        </dependent>

        <exec_method
                type='method'
                name='start'
                exec='/lib/svc/method/network-tuning.sh'
                timeout_seconds='60' />

        <exec_method
                type='method'
                name='stop'
                exec=':true'
                timeout_seconds='60' />

        <property_group name='startd' type='framework'>
                <propval name='duration' type='astring'
value='transient' />
        </property_group>

        <stability value='Unstable' />

        <template>
                <common_name>
                        <loctext xml:lang='C'>
                                Network Tunings
                        </loctext>
                </common_name>
```

```
_

        </template>
    </service>

    </service_bundle>
```

This service is intentionally kept simple, for demonstration purposes. The interested reader can explore SMF in the Solaris man pages and online resources.

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