



# Red Hat Enterprise Linux 9

## Deploying web servers and reverse proxies

Setting up and configuring web servers and reverse proxies in Red Hat Enterprise Linux 9



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## Abstract

Configure and run the Apache HTTP web server, the NGINX web server, or the Squid caching proxy server on Red Hat Enterprise Linux 9. Configure TLS encryption. Configure Kerberos authentication for the Apache HTTP web server. Set up NGINX as a reverse proxy for the HTTP traffic or as an HTTP load balancer. Configure Squid as a caching proxy without authentication, with LDAP authentication, or with Kerberos authentication.

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# CHAPTER 1. SETTING UP THE APACHE HTTP WEB SERVER

## 1.1. INTRODUCTION TO THE APACHE HTTP WEB SERVER

A *web server* is a network service that serves content to a client over the web. This typically means web pages, but any other documents can be served as well. Web servers are also known as HTTP servers, as they use the *hypertext transport protocol* (**HTTP**).

The **Apache HTTP Server**, **httpd**, is an open source web server developed by the [Apache Software Foundation](#).

If you are upgrading from a previous release of Red Hat Enterprise Linux, you have to update the **httpd** service configuration accordingly. This section reviews some of the newly added features, and guides you through the update of prior configuration files.

## 1.2. NOTABLE CHANGES IN THE APACHE HTTP SERVER

RHEL 9 provides version 2.4.62 of the Apache HTTP Server. Notable changes over version 2.4.37 distributed with RHEL 8 include:

- Apache HTTP Server Control Interface (**apachectl**):
  - The **systemctl** pager is now disabled for **apachectl status** output.
  - The **apachectl** command now fails instead of giving a warning if you pass additional arguments.
  - The **apachectl graceful-stop** command now returns immediately.
  - The **apachectl configtest** command now executes the **httpd -t** command without changing the SELinux context.
  - The **apachectl(8)** man page in RHEL now fully documents differences from upstream **apachectl**.
- Apache eXtenSion tool (**apxs**):
  - The **/usr/bin/apxs** command no longer uses or exposes compiler optimisation flags as applied when building the **httpd** package. You can now use the **/usr/lib64/httpd/build/vendor-apxs** command to apply the same compiler flags as used to build **httpd**. To use the **vendor-apxs** command, you must install the **redhat-rpm-config** package first.
- Apache modules:
  - The **mod\_lua** module is now provided in a separate package.
  - The **mod\_php** module provided with PHP for use with the Apache HTTP Server has been removed. Since RHEL 8, PHP scripts are run using the FastCGI Process Manager (**php-fpm**) by default. For more information, see [Using PHP with the Apache HTTP Server](#).
- Configuration syntax changes:
  - In the deprecated **Allow** directive provided by the **mod\_access\_compat** module, a comment (the **#** character) now triggers a syntax error instead of being silently ignored.



- Other changes:
  - Kernel thread IDs are now used directly in error log messages, making them both accurate and more concise.
  - Many minor enhancements and bug fixes.
  - Several new interfaces are available to module authors.

There are no backwards-incompatible changes to the **httpd** module API since RHEL 8.

Apache HTTP Server 2.4 is the initial version of this Application Stream, which you can install easily as an RPM package.

### 1.3. THE APACHE CONFIGURATION FILES

The **httpd**, by default, reads the configuration files after start. You can see the list of the locations of configuration files in the table below.

**Table 1.1. The httpd service configuration files**

Path	Description
<b>/etc/httpd/conf/httpd.conf</b>	The main configuration file.
<b>/etc/httpd/conf.d/</b>	An auxiliary directory for configuration files that are included in the main configuration file.
<b>/etc/httpd/conf.modules.d/</b>	An auxiliary directory for configuration files which load installed dynamic modules packaged in Red Hat Enterprise Linux. In the default configuration, these configuration files are processed first.

Although the default configuration is suitable for most situations, you can use also other configuration options. For any changes to take effect, restart the web server first.

To check the configuration for possible errors, type the following at a shell prompt:

```
# apachectl configtest
Syntax OK
```

To make the recovery from mistakes easier, make a copy of the original file before editing it.

### 1.4. MANAGING THE HTTPD SERVICE

This section describes how to start, stop, and restart the **httpd** service.

#### Prerequisites

- The Apache HTTP Server is installed.

#### Procedure

- To start the **httpd** service, enter:

```
# systemctl start httpd
```

- To stop the **httpd** service, enter:

```
# systemctl stop httpd
```

- To restart the **httpd** service, enter:

```
# systemctl restart httpd
```

## 1.5. SETTING UP A SINGLE-INSTANCE APACHE HTTP SERVER

You can set up a single-instance Apache HTTP Server to serve static HTML content.

Follow the procedure if the web server should provide the same content for all domains associated with the server. If you want to provide different content for different domains, set up name-based virtual hosts. For details, see [Configuring Apache name-based virtual hosts](#).

### Procedure

1. Install the **httpd** package:

```
# dnf install httpd
```

2. If you use **firewalld**, open the TCP port **80** in the local firewall:

```
# firewall-cmd --permanent --add-port=80/tcp  
# firewall-cmd --reload
```

3. Enable and start the **httpd** service:

```
# systemctl enable --now httpd
```

4. Optional: Add HTML files to the **/var/www/html/** directory.



### NOTE

When adding content to **/var/www/html/**, files and directories must be readable by the user under which **httpd** runs by default. The content owner can be either the **root** user and **root** user group, or another user or group of the administrator's choice. If the content owner is the **root** user and **root** user group, the files must be readable by other users. The SELinux context for all the files and directories must be **httpd\_sys\_content\_t**, which is applied by default to all content within the **/var/www** directory.

### Verification

- Connect with a web browser to **http://server\_IP\_or\_host\_name/**.  
If the **/var/www/html/** directory is empty or does not contain an **index.html** or **index.htm** file, Apache displays the **Red Hat Enterprise Linux Test Page**. If **/var/www/html/** contains HTML

files with a different name, you can load them by entering the URL to that file, such as **`http://server_IP_or_host_name/example.html`**.

### Additional resources

- Apache manual: [Installing the Apache HTTP server manual](#).
- See the **`httpd.service(8)`** man page on your system.

## 1.6. CONFIGURING APACHE NAME-BASED VIRTUAL HOSTS

Name-based virtual hosts enable Apache to serve different content for different domains that resolve to the IP address of the server.

You can set up a virtual host for both the **`example.com`** and **`example.net`** domain with separate document root directories. Both virtual hosts serve static HTML content.

### Prerequisites

- Clients and the web server resolve the **`example.com`** and **`example.net`** domain to the IP address of the web server.  
Note that you must manually add these entries to your DNS server.

### Procedure

1. Install the **`httpd`** package:

```
# dnf install httpd
```

2. Edit the **`/etc/httpd/conf/httpd.conf`** file:

- a. Append the following virtual host configuration for the **`example.com`** domain:

```
<VirtualHost *:80>
    DocumentRoot "/var/www/example.com/"
    ServerName example.com
    CustomLog /var/log/httpd/example.com_access.log combined
    ErrorLog /var/log/httpd/example.com_error.log
</VirtualHost>
```

These settings configure the following:

- All settings in the **`<VirtualHost *:80>`** directive are specific for this virtual host.
- **`DocumentRoot`** sets the path to the web content of the virtual host.
- **`ServerName`** sets the domains for which this virtual host serves content.  
To set multiple domains, add the **`ServerAlias`** parameter to the configuration and specify the additional domains separated with a space in this parameter.
- **`CustomLog`** sets the path to the access log of the virtual host.
- **`ErrorLog`** sets the path to the error log of the virtual host.

**NOTE**

Apache uses the first virtual host found in the configuration also for requests that do not match any domain set in the **ServerName** and **ServerAlias** parameters. This also includes requests sent to the IP address of the server.

3. Append a similar virtual host configuration for the **example.net** domain:

```
<VirtualHost *:80>
  DocumentRoot "/var/www/example.net/"
  ServerName example.net
  CustomLog /var/log/httpd/example.net_access.log combined
  ErrorLog /var/log/httpd/example.net_error.log
</VirtualHost>
```

4. Create the document roots for both virtual hosts:

```
# mkdir /var/www/example.com/
# mkdir /var/www/example.net/
```

5. If you set paths in the **DocumentRoot** parameters that are not within **/var/www/**, set the **httpd\_sys\_content\_t** context on both document roots:

```
# semanage fcontext -a -t httpd_sys_content_t "/srv/example.com(/.*)?"
# restorecon -Rv /srv/example.com/
# semanage fcontext -a -t httpd_sys_content_t "/srv/example.net(/.*)?"
# restorecon -Rv /srv/example.net/
```

These commands set the **httpd\_sys\_content\_t** context on the **/srv/example.com/** and **/srv/example.net/** directory.

Note that you must install the **polycycoreutils-python-utils** package to run the **restorecon** command.

6. If you use **firewalld**, open port **80** in the local firewall:

```
# firewall-cmd --permanent --add-port=80/tcp
# firewall-cmd --reload
```

7. Enable and start the **httpd** service:

```
# systemctl enable --now httpd
```

**Verification**

1. Create a different example file in each virtual host's document root:

```
# echo "vHost example.com" > /var/www/example.com/index.html
# echo "vHost example.net" > /var/www/example.net/index.html
```

2. Use a browser and connect to **http://example.com**. The web server shows the example file from the **example.com** virtual host.

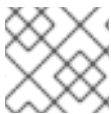
3. Use a browser and connect to **http://example.net**. The web server shows the example file from the **example.net** virtual host.

### Additional resources

- [Installing the Apache HTTP Server manual - Virtual Hosts](#)

## 1.7. CONFIGURING KERBEROS AUTHENTICATION FOR THE APACHE HTTP WEB SERVER

To perform Kerberos authentication in the Apache HTTP web server, RHEL 9 uses the **mod\_auth\_gssapi** Apache module. The Generic Security Services API ( **GSSAPI**) is an interface for applications that make requests to use security libraries, such as Kerberos. The **gssproxy** service allows to implement privilege separation for the **httpd** server, which optimizes this process from the security point of view.



### NOTE

The **mod\_auth\_gssapi** module replaces the removed **mod\_auth\_kerb** module.

### Prerequisites

- The **httpd**, **mod\_auth\_gssapi** and **gssproxy** packages are installed.
- The Apache web server is set up and the **httpd** service is running.

### 1.7.1. Setting up GSS-Proxy in an IdM environment

This procedure describes how to set up **GSS-Proxy** to perform Kerberos authentication in the Apache HTTP web server.

### Procedure

1. Enable access to the **keytab** file of HTTP/<SERVER\_NAME>@realm principal by creating the service principal:

```
# ipa service-add HTTP/<SERVER_NAME>
```

2. Retrieve the **keytab** for the principal stored in the **/etc/gssproxy/http.keytab** file:

```
# ipa-getkeytab -s $(awk '/^server =/ {print $3}' /etc/ipa/default.conf) -k
/etc/gssproxy/http.keytab -p HTTP/$(hostname -f)
```

This step sets permissions to 400, thus only the **root** user has access to the **keytab** file. The **apache** user does not.

3. Create the **/etc/gssproxy/80-httpd.conf** file with the following content:

```
[service/HTTP]
mechs = krb5
cred_store = keytab:/etc/gssproxy/http.keytab
cred_store = ccache:/var/lib/gssproxy/clients/krb5cc_%U
euid = apache
```

4. Restart and enable the **gssproxy** service:

```
# systemctl restart gssproxy.service
# systemctl enable gssproxy.service
```

#### Additional resources

- **gssproxy(8)** man pages on your system
- **gssproxy-mech(8)** man pages on your system
- **gssproxy.conf(5)** man pages on your system

### 1.7.2. Configuring Kerberos authentication for a directory shared by the Apache HTTP web server

This procedure describes how to configure Kerberos authentication for the **/var/www/html/private/** directory.

#### Prerequisites

- The **gssproxy** service is configured and running.

#### Procedure

1. Configure the **mod\_auth\_gssapi** module to protect the **/var/www/html/private/** directory:

```
<Location /var/www/html/private>
  AuthType GSSAPI
  AuthName "GSSAPI Login"
  Require valid-user
</Location>
```

2. Create system unit configuration drop-in file:

```
# systemctl edit httpd.service
```

3. Add the following parameter to the system drop-in file:

```
[Service]
Environment=GSS_USE_PROXY=1
```

4. Reload the **systemd** configuration:

```
# systemctl daemon-reload
```

5. Restart the **httpd** service:

```
# systemctl restart httpd.service
```

#### Verification

1. Obtain a Kerberos ticket:

```
# kinit
```

2. Open the URL to the protected directory in a browser.

## 1.8. CONFIGURING TLS ENCRYPTION ON AN APACHE HTTP SERVER

By default, Apache provides content to clients using an unencrypted HTTP connection. This section describes how to enable TLS encryption and configure frequently used encryption-related settings on an Apache HTTP Server.

### Prerequisites

- The Apache HTTP Server is installed and running.

### 1.8.1. Adding TLS encryption to an Apache HTTP Server

You can enable TLS encryption on an Apache HTTP Server for the **example.com** domain.

### Prerequisites

- The Apache HTTP Server is installed and running.
- The private key is stored in the **/etc/pki/tls/private/example.com.key** file.  
For details about creating a private key and certificate signing request (CSR), as well as how to request a certificate from a certificate authority (CA), see your CA's documentation. Alternatively, if your CA supports the ACME protocol, you can use the **mod\_md** module to automate retrieving and provisioning TLS certificates.
- The TLS certificate is stored in the **/etc/pki/tls/certs/example.com.crt** file. If you use a different path, adapt the corresponding steps of the procedure.
- The CA certificate is stored in the **/etc/pki/tls/certs/ca.crt** file. If you use a different path, adapt the corresponding steps of the procedure.
- Clients and the web server resolve the host name of the server to the IP address of the web server.
- If the server runs RHEL 9.2 or later and the FIPS mode is enabled, clients must either support the Extended Master Secret (EMS) extension or use TLS 1.3. TLS 1.2 connections without EMS fail. For more information, see the Red Hat Knowledgebase solution [TLS extension "Extended Master Secret" enforced](#).

### Procedure

1. Install the **mod\_ssl** package:

```
# dnf install mod_ssl
```

2. Edit the **/etc/httpd/conf.d/ssl.conf** file and add the following settings to the **<VirtualHost \_default\_:443>** directive:
  - a. Set the server name:

**ServerName** *example.com*

The server name must match the entry set in the **Common Name** field of the certificate.

- a. Optional: If the certificate contains additional host names in the **Subject Alt Names** (SAN) field, you can configure **mod\_ssl** to provide TLS encryption also for these host names. To configure this, add the **ServerAliases** parameter with corresponding names:

**ServerAlias** *www.example.com server.example.com*

- b. Set the paths to the private key, the server certificate, and the CA certificate:

```
SSLCertificateKeyFile "/etc/pki/tls/private/example.com.key"
SSLCertificateFile "/etc/pki/tls/certs/example.com.crt"
SSLCACertificateFile "/etc/pki/tls/certs/ca.crt"
```

1. For security reasons, configure that only the **root** user can access the private key file:

```
# chown root:root /etc/pki/tls/private/example.com.key
# chmod 600 /etc/pki/tls/private/example.com.key
```

**WARNING**

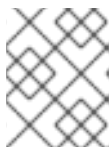
If the private key was accessed by unauthorized users, revoke the certificate, create a new private key, and request a new certificate. Otherwise, the TLS connection is no longer secure.

2. If you use **firewalld**, open port **443** in the local firewall:

```
# firewall-cmd --permanent --add-port=443/tcp
# firewall-cmd --reload
```

3. Restart the **httpd** service:

```
# systemctl restart httpd
```

**NOTE**

If you protected the private key file with a password, you must enter this password each time when the **httpd** service starts.

**Verification**

- Use a browser and connect to **https://example.com**.

**Additional resources**



- [SSL/TLS Encryption](#)
- [Security considerations for TLS in RHEL 9](#)

### 1.8.2. Setting the supported TLS protocol versions on an Apache HTTP Server

By default, the Apache HTTP Server on RHEL uses the system-wide crypto policy that defines safe default values, which are also compatible with recent browsers. For example, the **DEFAULT** policy defines that only the **TLSv1.2** and **TLSv1.3** protocol versions are enabled in apache.

You can manually configure which TLS protocol versions your Apache HTTP Server supports. Follow the procedure if your environment requires to enable only specific TLS protocol versions, for example:

- If your environment requires that clients can also use the weak **TLS1** (TLSv1.0) or **TLS1.1** protocol.
- If you want to configure that Apache only supports the **TLSv1.2** or **TLSv1.3** protocol.

#### Prerequisites

- TLS encryption is enabled on the server as described in [Adding TLS encryption to an Apache HTTP server](#).
- If the server runs RHEL 9.2 or later and the FIPS mode is enabled, clients must either support the Extended Master Secret (EMS) extension or use TLS 1.3. TLS 1.2 connections without EMS fail. For more information, see the Red Hat Knowledgebase solution [TLS extension "Extended Master Secret" enforced](#).

#### Procedure

1. Edit the `/etc/httpd/conf/httpd.conf` file, and add the following setting to the `<VirtualHost>` directive for which you want to set the TLS protocol version. For example, to enable only the **TLSv1.3** protocol:

```
SSLProtocol -All TLSv1.3
```

2. Restart the **httpd** service:

```
# systemctl restart httpd
```

#### Verification

1. Use the following command to verify that the server supports **TLSv1.3**:

```
# openssl s_client -connect example.com:443 -tls1_3
```

2. Use the following command to verify that the server does not support **TLSv1.2**:

```
# openssl s_client -connect example.com:443 -tls1_2
```

If the server does not support the protocol, the command returns an error:

```
140111600609088:error:1409442E:SSL routines:ssl3_read_bytes:tls1 alert protocol
version:ssl/record/rec_layer_s3.c:1543:SSL alert number 70
```

- 
- 3. Optional: Repeat the command for other TLS protocol versions.

### Additional resources

- **update-crypto-policies(8)** man page on your system
- [Using system-wide cryptographic policies](#).
- For further details about the **SSLProtocol** parameter, refer to the **mod\_ssl** documentation in the Apache manual: [Installing the Apache HTTP server manual](#).

### 1.8.3. Setting the supported ciphers on an Apache HTTP Server

By default, the Apache HTTP Server uses the system-wide crypto policy that defines safe default values, which are also compatible with recent browsers. For the list of ciphers the system-wide crypto allows, see the **/etc/crypto-policies/back-ends/openssl.config** file.

You can manually configure which ciphers your Apache HTTP Server supports. Follow the procedure if your environment requires specific ciphers.

#### Prerequisites

- TLS encryption is enabled on the server as described in [Adding TLS encryption to an Apache HTTP server](#).

#### Procedure

1. Edit the **/etc/httpd/conf/httpd.conf** file, and add the **SSLCipherSuite** parameter to the **<VirtualHost>** directive for which you want to set the TLS ciphers:

```
SSLCipherSuite  
"EECDH+AESGCM:EDH+AESGCM:AES256+EECDH:AES256+EDH:!SHA1:!SHA256"
```

This example enables only the **EECDH+AESGCM**, **EDH+AESGCM**, **AES256+EECDH**, and **AES256+EDH** ciphers and disables all ciphers which use the **SHA1** and **SHA256** message authentication code (MAC).

2. Restart the **httpd** service:

```
# systemctl restart httpd
```

#### Verification

1. To display the list of ciphers the Apache HTTP Server supports:
  - a. Install the **nmap** package:

```
# dnf install nmap
```

- b. Use the **nmap** utility to display the supported ciphers:

```
# nmap --script ssl-enum-ciphers -p 443 example.com  
...
```

```

PORT      STATE SERVICE
443/tcp   open  https
| ssl-enum-ciphers:
|   TLSv1.2:
|     ciphers:
|       TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384 (ecdh_x25519) - A
|       TLS_DHE_RSA_WITH_AES_256_GCM_SHA384 (dh 2048) - A
|       TLS_ECDHE_RSA_WITH_CHACHA20_POLY1305_SHA256 (ecdh_x25519) - A
|
...

```

#### Additional resources

- **update-crypto-policies(8)** man page on your system
- [Using system-wide cryptographic policies](#).
- [SSLCipherSuite](#)

## 1.9. CONFIGURING TLS CLIENT CERTIFICATE AUTHENTICATION

Client certificate authentication enables administrators to allow only users who authenticate using a certificate to access resources on the web server. You can configure client certificate authentication for the **/var/www/html/Example/** directory.

If the Apache HTTP Server uses the TLS 1.3 protocol, certain clients require additional configuration. For example, in Firefox, set the **security.tls.enable\_post\_handshake\_auth** parameter in the **about:config** menu to **true**.

#### Prerequisites

- TLS encryption is enabled on the server as described in [Adding TLS encryption to an Apache HTTP server](#).

#### Procedure

1. Edit the **/etc/httpd/conf/httpd.conf** file and add the following settings to the **<VirtualHost>** directive for which you want to configure client authentication:

```

<Directory "/var/www/html/Example/">
    SSLVerifyClient require
</Directory>

```

The **SSLVerifyClient require** setting defines that the server must successfully validate the client certificate before the client can access the content in the **/var/www/html/Example/** directory.

2. Restart the **httpd** service:

```
# systemctl restart httpd
```

#### Verification

1. Use the **curl** utility to access the **https://example.com/Example/** URL without client authentication:

```
$ curl https://example.com/Example/
curl: (56) OpenSSL SSL_read: error:1409445C:SSL routines:ssl3_read_bytes:tlsv13 alert
certificate required, errno 0
```

The error indicates that the web server requires a client certificate authentication.

2. Pass the client private key and certificate, as well as the CA certificate to **curl** to access the same URL with client authentication:

```
$ curl --cacert ca.crt --key client.key --cert client.crt https://example.com/Example/
```

If the request succeeds, **curl** displays the **index.html** file stored in the **/var/www/html/Example/** directory.

### Additional resources

- [mod\\_ssl configuration](#)

## 1.10. SECURING WEB APPLICATIONS ON A WEB SERVER USING MODSECURITY

ModSecurity is an open source web application firewall (WAF) supported by various web servers such as Apache, Nginx, and IIS, which reduces security risks in web applications. ModSecurity provides customizable rule sets for configuring your server.

The **mod\_security-crs** package contains the core rule set (CRS) with rules against cross-website scripting, bad user agents, SQL injection, Trojans, session hijacking, and other exploits.

### 1.10.1. Deploying the ModSecurity web-based application firewall for Apache

To reduce risks related to running web-based applications on your web server by deploying ModSecurity, install the **mod\_security** and **mod\_security\_crs** packages for the Apache HTTP server. The **mod\_security\_crs** package provides the core rule set (CRS) for the ModSecurity web-based application firewall (WAF) module.

#### Procedure

1. Install the **mod\_security**, **mod\_security\_crs**, and **httpd** packages:

```
# dnf install -y mod_security mod_security_crs httpd
```

2. Start the **httpd** server:

```
# systemctl restart httpd
```

#### Verification

1. Verify that the ModSecurity web-based application firewall is enabled on your Apache HTTP server:

```
# httpd -M | grep security
security2_module (shared)
```

2. Check that the `/etc/httpd/modsecurity.d/activated_rules/` directory contains rules provided by `mod_security_crs`:

```
# ls /etc/httpd/modsecurity.d/activated_rules/
...
REQUEST-921-PROTOCOL-ATTACK.conf
REQUEST-930-APPLICATION-ATTACK-LFI.conf
...
```

### Additional resources

- [Red Hat JBoss Core Services ModSecurity Guide](#)
- [An introduction to web application firewalls for Linux sysadmins](#)

## 1.10.2. Adding a custom rule to ModSecurity

If the rules contained in the ModSecurity core rule set (CRS) do not fit your scenario and if you want to prevent additional possible attacks, you can add your custom rules to the rule set used by the ModSecurity web-based application firewall. The following example demonstrates the addition of a simple rule. For creating more complex rules, see the reference manual on the [ModSecurity Wiki](#) website.

### Prerequisites

- ModSecurity for Apache is installed and enabled.

### Procedure

1. Open the `/etc/httpd/conf.d/mod_security.conf` file in a text editor of your choice, for example:

```
# vi /etc/httpd/conf.d/mod_security.conf
```

2. Add the following example rule after the line starting with **SecRuleEngine On**:

```
SecRule ARGS:data "@contains evil" "deny,status:403,msg:'param data contains evil
data',id:1"
```

The previous rule forbids the use of resources to the user if the **data** parameter contains the **evil** string.

3. Save the changes, and quit the editor.
4. Restart the **httpd** server:

```
# systemctl restart httpd
```

### Verification

1. Create a **test.html** page:

```
# echo "mod_security test" > /var/www/html/test.html
```

- Restart the **httpd** server:

```
# systemctl restart httpd
```

- Request **test.html** without malicious data in the **GET** variable of the HTTP request:

```
$ curl http://localhost/test.html?data=good

mod_security test
```

- Request **test.html** with malicious data in the **GET** variable of the HTTP request:

```
$ curl localhost/test.html?data=xxxevilxxx

<!DOCTYPE HTML PUBLIC "-//IETF//DTD HTML 2.0//EN">
<html><head>
<title>403 Forbidden</title>
</head><body>
<h1>Forbidden</h1>
<p>You do not have permission to access this resource.</p>
</body></html>
```

- Check the **/var/log/httpd/error\_log** file, and locate the log entry about denying access with the **param data containing an evil data** message:

```
[Wed May 25 08:01:31.036297 2022] [:error] [pid 5839:tid 139874434791168] [client
::1:45658] [client ::1] ModSecurity: Access denied with code 403 (phase 2). String match
"evil" at ARGS:data. [file "/etc/httpd/conf.d/mod_security.conf"] [line "4"] [id "1"] [msg "param
data contains evil data"] [hostname "localhost"] [uri "/test.html"] [unique_id
"Yo4amwldsBG3yZqSzh2GuwAAAIY"]
```

## Additional resources

- [ModSecurity Wiki](#)

## 1.11. INSTALLING THE APACHE HTTP SERVER MANUAL

You can install the Apache HTTP Server manual. This manual provides a detailed documentation of, for example:

- Configuration parameters and directives
- Performance tuning
- Authentication settings
- Modules
- Content caching
- Security tips
- Configuring TLS encryption

After installing the manual, you can display it using a web browser.

### Prerequisites

- The Apache HTTP Server is installed and running.

### Procedure

1. Install the **httpd-manual** package:

```
# dnf install httpd-manual
```

2. Optional: By default, all clients connecting to the Apache HTTP Server can display the manual. To restrict access to a specific IP range, such as the **192.0.2.0/24** subnet, edit the **/etc/httpd/conf.d/manual.conf** file and add the **Require ip 192.0.2.0/24** setting to the **<Directory "/usr/share/httpd/manual">** directive:

```
<Directory "/usr/share/httpd/manual">
...
    Require ip 192.0.2.0/24
...
</Directory>
```

3. Restart the **httpd** service:

```
# systemctl restart httpd
```

### Verification

1. To display the Apache HTTP Server manual, connect with a web browser to **http://host\_name\_or\_IP\_address/manual/**

## 1.12. WORKING WITH APACHE MODULES

The **httpd** service is a modular application, and you can extend it with a number of *Dynamic Shared Objects* (**DSOs**). *Dynamic Shared Objects* are modules that you can dynamically load or unload at runtime as necessary. You can find these modules in the **/usr/lib64/httpd/modules/** directory.

### 1.12.1. Loading a DSO module

As an administrator, you can choose the functionality to include in the server by configuring which modules the server should load. To load a particular DSO module, use the **LoadModule** directive. Note that modules provided by a separate package often have their own configuration file in the **/etc/httpd/conf.modules.d/** directory.

### Prerequisites

- You have installed the **httpd** package.

### Procedure

1. Search for the module name in the configuration files in the **/etc/httpd/conf.modules.d/** directory:

```
# grep mod_ssl.so /etc/httpd/conf.modules.d/*
```

2. Edit the configuration file in which the module name was found, and uncomment the **LoadModule** directive of the module:

```
LoadModule ssl_module modules/mod_ssl.so
```

3. If the module was not found, for example, because a RHEL package does not provide the module, create a configuration file, such as **/etc/httpd/conf.modules.d/30-example.conf** with the following directive:

```
LoadModule ssl_module modules/<custom_module>.so
```

4. Restart the **httpd** service:

```
# systemctl restart httpd
```

### 1.12.2. Compiling a custom Apache module

You can create your own module and build it with the help of the **httpd-devel** package, which contains the include files, the header files, and the **APache eXtenSion (apxs)** utility required to compile a module.

#### Prerequisites

- You have the **httpd-devel** package installed.

#### Procedure

- Build a custom module with the following command:

```
# apxs -i -a -c module_name.c
```

#### Verification

- Load the module the same way as described in [Loading a DSO module](#).

## 1.13. EXPORTING A PRIVATE KEY AND CERTIFICATES FROM AN NSS DATABASE TO USE THEM IN AN APACHE WEB SERVER CONFIGURATION

Since RHEL 8 we no longer provide the **mod\_nss** module for the Apache web server, and Red Hat recommends using the **mod\_ssl** module. If you store your private key and certificates in a Network Security Services (NSS) database, follow this [procedure to extract the key and certificates in Privacy Enhanced Mail \(PEM\) format](#).

## 1.14. ADDITIONAL RESOURCES

- **httpd(8)**, **httpd.service(8)**, **httpd.conf(5)**, and **apachectl(8)** man pages on your system



- Kerberos authentication on an Apache HTTP server: [Using GSS-Proxy for Apache httpd operation](#). Using Kerberos is an alternative way to enforce client authorization on an Apache HTTP Server.
- [Configuring applications to use cryptographic hardware through PKCS #11](#) .

## CHAPTER 2. SETTING UP AND CONFIGURING NGINX

NGINX is a high performance and modular server that you can use, for example, as a:

- Web server
- Reverse proxy
- Load balancer

This section describes how to NGINX in these scenarios.

### 2.1. INSTALLING AND PREPARING NGINX

In Red Hat Enterprise Linux 9, different versions to NGINX are provided by Application Streams. By using the default configuration, NGINX runs as a web server on port **80** and provides content from the **/usr/share/nginx/html/** directory.

#### Prerequisites

- RHEL 9 is installed.
- The host is subscribed to the Red Hat Customer Portal.
- The **firewalld** service is enabled and started.

#### Procedure

1. Install the **nginx** package:

- To install NGINX 1.20 as the initial version of this Application Stream from an RPM package:

```
# dnf install nginx
```



#### NOTE

If you have previously enabled an NGINX module stream, this command installs the NGINX version from the enabled stream.

- To install an alternate later version of NGINX from a module stream:
  - a. Display the available NGINX module streams:

```
# dnf module list nginx
...
rhel-AppStream
Name      Stream    Profiles    Summary
nginx     1.22      common [d]  nginx webserver
...
Hint: [d]efault, [e]nabled, [x]disabled, [i]nstalled
```

- b. Enable the selected stream:

```
# dnf module enable nginx:stream_version
```

- c. Install the **nginx** package:

```
# dnf install nginx
```

2. Open the ports on which NGINX should provide its service in the firewall. For example, to open the default ports for HTTP (port 80) and HTTPS (port 443) in **firewalld**, enter:

```
# firewall-cmd --permanent --add-port={80/tcp,443/tcp}
# firewall-cmd --reload
```

3. Enable the **nginx** service to start automatically when the system boots:

```
# systemctl enable nginx
```

4. Optional: Start the **nginx** service:

```
# systemctl start nginx
```

If you do not want to use the default configuration, skip this step, and configure NGINX accordingly before you start the service.

## Verification

1. Use the **dnf** utility to verify that the **nginx** package is installed.

- In case of the NGINX 1.20 RPM package:

```
# dnf list installed nginx
Installed Packages
nginx.x86_64 1:1.20.1-4.el9 @rhel-AppStream
```

- In case of a selected NGINX module stream:

```
# dnf list installed nginx
Installed Packages
nginx.x86_64 1:1.22.1-3.module+el9.2.0+17617+2f289c6c @rhel-AppStream
```

2. Ensure that the ports on which NGINX should provide its service are opened in the firewall:

```
# firewall-cmd --list-ports
80/tcp 443/tcp
```

3. Verify that the **nginx** service is enabled:

```
# systemctl is-enabled nginx
enabled
```

## Additional resources

- [Securing networks](#)

## 2.2. CONFIGURING NGINX AS A WEB SERVER THAT PROVIDES DIFFERENT CONTENT FOR DIFFERENT DOMAINS

By default, NGINX acts as a web server that provides the same content to clients for all domain names associated with the IP addresses of the server. This procedure explains how to configure NGINX:

- To serve requests to the **example.com** domain with content from the **/var/www/example.com/** directory
- To serve requests to the **example.net** domain with content from the **/var/www/example.net/** directory
- To serve all other requests, for example, to the IP address of the server or to other domains associated with the IP address of the server, with content from the **/usr/share/nginx/html/** directory

### Prerequisites

- NGINX is installed
- Clients and the web server resolve the **example.com** and **example.net** domain to the IP address of the web server.  
Note that you must manually add these entries to your DNS server.

### Procedure

1. Edit the **/etc/nginx/nginx.conf** file:
  - a. By default, the **/etc/nginx/nginx.conf** file already contains a catch-all configuration. If you have deleted this part from the configuration, re-add the following **server** block to the **http** block in the **/etc/nginx/nginx.conf** file:

```
server {  
    listen      80 default_server;  
    listen      [::]:80 default_server;  
    server_name _;  
    root        /usr/share/nginx/html;  
}
```

These settings configure the following:

- The **listen** directive defines which IP address and ports the service listens. In this case, NGINX listens on port **80** on both all IPv4 and IPv6 addresses. The **default\_server** parameter indicates that NGINX uses this **server** block as the default for requests matching the IP addresses and ports.
  - The **server\_name** parameter defines the host names for which this **server** block is responsible. Setting **server\_name** to **\_** configures NGINX to accept any host name for this **server** block.
  - The **root** directive sets the path to the web content for this **server** block.
- b. Append a similar **server** block for the **example.com** domain to the **http** block:

```
server {
```

```
server_name example.com;
root    /var/www/example.com/;
access_log /var/log/nginx/example.com/access.log;
error_log /var/log/nginx/example.com/error.log;
}
```

- The **access\_log** directive defines a separate access log file for this domain.
- The **error\_log** directive defines a separate error log file for this domain.

c. Append a similar **server** block for the **example.net** domain to the **http** block:

```
server {
    server_name example.net;
    root    /var/www/example.net/;
    access_log /var/log/nginx/example.net/access.log;
    error_log /var/log/nginx/example.net/error.log;
}
```

2. Create the root directories for both domains:

```
# mkdir -p /var/www/example.com/
# mkdir -p /var/www/example.net/
```

3. Set the **httpd\_sys\_content\_t** context on both root directories:

```
# semanage fcontext -a -t httpd_sys_content_t "/var/www/example.com/(.*)?"
# restorecon -Rv /var/www/example.com/
# semanage fcontext -a -t httpd_sys_content_t "/var/www/example.net/(.*)?"
# restorecon -Rv /var/www/example.net/
```

These commands set the **httpd\_sys\_content\_t** context on the **/var/www/example.com/** and **/var/www/example.net/** directories.

Note that you must install the **policycoreutils-python-utils** package to run the **restorecon** commands.

4. Create the log directories for both domains:

```
# mkdir /var/log/nginx/example.com/
# mkdir /var/log/nginx/example.net/
```

5. Restart the **nginx** service:

```
# systemctl restart nginx
```

## Verification

1. Create a different example file in each virtual host's document root:

```
# echo "Content for example.com" > /var/www/example.com/index.html
# echo "Content for example.net" > /var/www/example.net/index.html
# echo "Catch All content" > /usr/share/nginx/html/index.html
```

2. Use a browser and connect to **http://example.com**. The web server shows the example content from the **/var/www/example.com/index.html** file.
3. Use a browser and connect to **http://example.net**. The web server shows the example content from the **/var/www/example.net/index.html** file.
4. Use a browser and connect to **http://IP\_address\_of\_the\_server**. The web server shows the example content from the **/usr/share/nginx/html/index.html** file.

## 2.3. ADDING TLS ENCRYPTION TO AN NGINX WEB SERVER

You can enable TLS encryption on an NGINX web server for the **example.com** domain.

### Prerequisites

- NGINX is installed.
- The private key is stored in the **/etc/pki/tls/private/example.com.key** file.  
For details about creating a private key and certificate signing request (CSR), as well as how to request a certificate from a certificate authority (CA), see your CA's documentation.
- The TLS certificate is stored in the **/etc/pki/tls/certs/example.com.crt** file. If you use a different path, adapt the corresponding steps of the procedure.
- The CA certificate has been appended to the TLS certificate file of the server.
- Clients and the web server resolve the host name of the server to the IP address of the web server.
- Port **443** is open in the local firewall.
- If the server runs RHEL 9.2 or later and the FIPS mode is enabled, clients must either support the Extended Master Secret (EMS) extension or use TLS 1.3. TLS 1.2 connections without EMS fail. For more information, see the Red Hat Knowledgebase solution [TLS extension "Extended Master Secret" enforced](#).

### Procedure

1. Edit the **/etc/nginx/nginx.conf** file, and add the following **server** block to the **http** block in the configuration:

```
server {  
    listen          443 ssl;  
    server_name     example.com;  
    root            /usr/share/nginx/html;  
    ssl_certificate  /etc/pki/tls/certs/example.com.crt;  
    ssl_certificate_key /etc/pki/tls/private/example.com.key;  
}
```

2. Optional: Starting with RHEL 9.3, you can use the **ssl\_pass\_phrase\_dialog** directive to configure an external program that is called at **nginx** start for each encrypted private key. Add one of the following lines to the **/etc/nginx/nginx.conf** file:
  - To call an external program for each encrypted private key file, enter:

```
ssl_pass_phrase_dialog exec:<path_to_program>;
```

NGINX calls this program with the following two arguments:

- The server name specified in the **server\_name** setting.
- One of the following algorithms: **RSA**, **DSA**, **EC**, **DH**, or **UNK** if a cryptographic algorithm cannot be recognized.
- If you want to manually enter a passphrase for each encrypted private key file, enter:

```
ssl_pass_phrase_dialog builtin;
```

This is the default behavior if **ssl\_pass\_phrase\_dialog** is not configured.



#### NOTE

The **nginx** service fails to start if you use this method but have at least one private key protected by a passphrase. In this case, use one of the other methods.

- If you want **systemd** to prompt for the passphrase for each encrypted private key when you start the **nginx** service by using the **systemctl** utility, enter:

```
ssl_pass_phrase_dialog exec:/usr/libexec/nginx-ssl-pass-dialog;
```

3. For security reasons, configure that only the **root** user can access the private key file:

```
# chown root:root /etc/pki/tls/private/example.com.key
# chmod 600 /etc/pki/tls/private/example.com.key
```



#### WARNING

If the private key was accessed by unauthorized users, revoke the certificate, create a new private key, and request a new certificate. Otherwise, the TLS connection is no longer secure.

4. Restart the **nginx** service:

```
# systemctl restart nginx
```

#### Verification

- Use a browser and connect to **https://example.com**

#### Additional resources

- [Security considerations for TLS in RHEL](#)

## 2.4. CONFIGURING NGINX AS A REVERSE PROXY FOR THE HTTP TRAFFIC

You can configure the NGINX web server to act as a reverse proxy for HTTP traffic. For example, you can use this functionality to forward requests to a specific subdirectory on a remote server. From the client perspective, the client loads the content from the host it accesses. However, NGINX loads the actual content from the remote server and forwards it to the client.

This procedure explains how to forward traffic to the **/example** directory on the web server to the URL **https://example.com**.

### Prerequisites

- NGINX is installed as described in [Installing and preparing NGINX](#).
- Optional: TLS encryption is enabled on the reverse proxy.

### Procedure

1. Edit the **/etc/nginx/nginx.conf** file and add the following settings to the **server** block that should provide the reverse proxy:

```
location /example {  
    proxy_pass https://example.com;  
}
```

The **location** block defines that NGINX passes all requests in the **/example** directory to **https://example.com**.

2. Set the **httpd\_can\_network\_connect** SELinux boolean parameter to **1** to configure that SELinux allows NGINX to forward traffic:

```
# setsebool -P httpd_can_network_connect 1
```

3. Restart the **nginx** service:

```
# systemctl restart nginx
```

### Verification

- Use a browser and connect to **http://host\_name/example** and the content of **https://example.com** is shown.

## 2.5. CONFIGURING NGINX AS AN HTTP LOAD BALANCER

You can use the NGINX reverse proxy feature to load-balance traffic. This procedure describes how to configure NGINX as an HTTP load balancer that sends requests to different servers, based on which of them has the least number of active connections. If both servers are not available, the procedure also defines a third host for fallback reasons.

### Prerequisites

- NGINX is installed as described in [Installing and preparing NGINX](#).



## Procedure

1. Edit the `/etc/nginx/nginx.conf` file and add the following settings:

```
http {
    upstream backend {
        least_conn;
        server server1.example.com;
        server server2.example.com;
        server server3.example.com backup;
    }

    server {
        location / {
            proxy_pass http://backend;
        }
    }
}
```

The **least\_conn** directive in the host group named **backend** defines that NGINX sends requests to **server1.example.com** or **server2.example.com**, depending on which host has the least number of active connections. NGINX uses **server3.example.com** only as a backup in case that the other two hosts are not available.

With the **proxy\_pass** directive set to **http://backend**, NGINX acts as a reverse proxy and uses the **backend** host group to distribute requests based on the settings of this group.

Instead of the **least\_conn** load balancing method, you can specify:

- No method to use round robin and distribute requests evenly across servers.
- **ip\_hash** to send requests from one client address to the same server based on a hash calculated from the first three octets of the IPv4 address or the whole IPv6 address of the client.
- **hash** to determine the server based on a user-defined key, which can be a string, a variable, or a combination of both. The **consistent** parameter configures that NGINX distributes requests across all servers based on the user-defined hashed key value.
- **random** to send requests to a randomly selected server.

2. Restart the **nginx** service:

```
# systemctl restart nginx
```

## 2.6. ADDITIONAL RESOURCES

- [Official NGINX documentation](#). Note that Red Hat does not maintain this documentation and that it might not work with the NGINX version you have installed.
- [Configuring applications to use cryptographic hardware through PKCS #11](#).

## CHAPTER 3. CONFIGURING THE SQUID CACHING PROXY SERVER

Squid is a proxy server that caches content to reduce bandwidth and load web pages more quickly. This chapter describes how to set up Squid as a proxy for the HTTP, HTTPS, and FTP protocol, as well as authentication and restricting access.

### 3.1. SETTING UP SQUID AS A CACHING PROXY WITHOUT AUTHENTICATION

You can configure Squid as a caching proxy without authentication. The procedure limits access to the proxy based on IP ranges.

#### Prerequisites

- The procedure assumes that the `/etc/squid/squid.conf` file is as provided by the **squid** package. If you edited this file before, remove the file and reinstall the package.

#### Procedure

1. Install the **squid** package:

```
# dnf install squid
```

2. Edit the `/etc/squid/squid.conf` file:

- a. Adapt the **localnet** access control lists (ACL) to match the IP ranges that should be allowed to use the proxy:

```
acl localnet src 192.0.2.0/24
acl localnet 2001:db8:1::/64
```

By default, the `/etc/squid/squid.conf` file contains the **http\_access allow localnet** rule that allows using the proxy from all IP ranges specified in **localnet** ACLs. Note that you must specify all **localnet** ACLs before the **http\_access allow localnet** rule.



#### IMPORTANT

Remove all existing **acl localnet** entries that do not match your environment.

- b. The following ACL exists in the default configuration and defines **443** as a port that uses the HTTPS protocol:

```
acl SSL_ports port 443
```

If users should be able to use the HTTPS protocol also on other ports, add an ACL for each of these port:

```
acl SSL_ports port port_number
```

- c. Update the list of **acl Safe\_ports** rules to configure to which ports Squid can establish a connection. For example, to configure that clients using the proxy can only access

resources on port 21 (FTP), 80 (HTTP), and 443 (HTTPS), keep only the following **acl Safe\_ports** statements in the configuration:

```
acl Safe_ports port 21
acl Safe_ports port 80
acl Safe_ports port 443
```

By default, the configuration contains the **http\_access deny !Safe\_ports** rule that defines access denial to ports that are not defined in **Safe\_ports** ACLs.

- d. Configure the cache type, the path to the cache directory, the cache size, and further cache type-specific settings in the **cache\_dir** parameter:

```
cache_dir ufs /var/spool/squid 10000 16 256
```

With these settings:

- Squid uses the **ufs** cache type.
  - Squid stores its cache in the **/var/spool/squid/** directory.
  - The cache grows up to **10000** MB.
  - Squid creates **16** level-1 sub-directories in the **/var/spool/squid/** directory.
  - Squid creates **256** sub-directories in each level-1 directory.
- If you do not set a **cache\_dir** directive, Squid stores the cache in memory.

3. If you set a different cache directory than **/var/spool/squid/** in the **cache\_dir** parameter:
  - a. Create the cache directory:

```
# mkdir -p path_to_cache_directory
```

- b. Configure the permissions for the cache directory:

```
# chown squid:squid path_to_cache_directory
```

- c. If you run SELinux in **enforcing** mode, set the **squid\_cache\_t** context for the cache directory:

```
# semanage fcontext -a -t squid_cache_t "path_to_cache_directory(/.*)?"
# restorecon -Rv path_to_cache_directory
```

If the **semanage** utility is not available on your system, install the **policycoreutils-python-utils** package.

4. Open the **3128** port in the firewall:

```
# firewall-cmd --permanent --add-port=3128/tcp
# firewall-cmd --reload
```

5. Enable and start the **squid** service:

```
# systemctl enable --now squid
```

■

## Verification

To verify that the proxy works correctly, download a web page using the **curl** utility:

```
# curl -O -L "https://www.redhat.com/index.html" -x "proxy.example.com:3128"
```

If **curl** does not display any error and the **index.html** file was downloaded to the current directory, the proxy works.

## 3.2. SETTING UP SQUID AS A CACHING PROXY WITH LDAP AUTHENTICATION

You can configure Squid as a caching proxy that uses LDAP to authenticate users. The procedure configures that only authenticated users can use the proxy.

### Prerequisites

- The procedure assumes that the **/etc/squid/squid.conf** file is as provided by the **squid** package. If you edited this file before, remove the file and reinstall the package.
- An service user, such as **uid=proxy\_user,cn=users,cn=accounts,dc=example,dc=com** exists in the LDAP directory. Squid uses this account only to search for the authenticating user. If the authenticating user exists, Squid binds as this user to the directory to verify the authentication.

### Procedure

1. Install the **squid** package:

```
# dnf install squid
```

2. Edit the **/etc/squid/squid.conf** file:

- a. To configure the **basic\_ldap\_auth** helper utility, add the following configuration entry to the top of **/etc/squid/squid.conf**:

```
auth_param basic program /usr/lib64/squid/basic_ldap_auth -b
"cn=users,cn=accounts,dc=example,dc=com" -D
"uid=proxy_user,cn=users,cn=accounts,dc=example,dc=com" -W
/etc/squid/ldap_password -f "(&(objectClass=person)(uid=%s))" -ZZ -H
ldap://ldap_server.example.com:389
```

The following describes the parameters passed to the **basic\_ldap\_auth** helper utility in the example above:

- **-b base\_DN** sets the LDAP search base.
- **-D proxy\_service\_user\_DN** sets the distinguished name (DN) of the account Squid uses to search for the authenticating user in the directory.
- **-W path\_to\_password\_file** sets the path to the file that contains the password of the proxy service user. Using a password file prevents that the password is visible in the operating system's process list.

- **-f LDAP\_filter** specifies the LDAP search filter. Squid replaces the **%s** variable with the user name provided by the authenticating user.  
The **(&(objectClass=person)(uid=%s))** filter in the example defines that the user name must match the value set in the **uid** attribute and that the directory entry contains the **person** object class.
  - **-ZZ** enforces a TLS-encrypted connection over the LDAP protocol using the **STARTTLS** command. Omit the **-ZZ** in the following situations:
    - The LDAP server does not support encrypted connections.
    - The port specified in the URL uses the LDAPS protocol.
  - The **-H LDAP\_URL** parameter specifies the protocol, the host name or IP address, and the port of the LDAP server in URL format.
- b. Add the following ACL and rule to configure that Squid allows only authenticated users to use the proxy:

```
acl ldap-auth proxy_auth REQUIRED  
http_access allow ldap-auth
```



#### IMPORTANT

Specify these settings before the **http\_access deny** all rule.

- c. Remove the following rule to disable bypassing the proxy authentication from IP ranges specified in **localnet** ACLs:

```
http_access allow localnet
```

- d. The following ACL exists in the default configuration and defines **443** as a port that uses the HTTPS protocol:

```
acl SSL_ports port 443
```

If users should be able to use the HTTPS protocol also on other ports, add an ACL for each of these port:

```
acl SSL_ports port port_number
```

- e. Update the list of **acl Safe\_ports** rules to configure to which ports Squid can establish a connection. For example, to configure that clients using the proxy can only access resources on port 21 (FTP), 80 (HTTP), and 443 (HTTPS), keep only the following **acl Safe\_ports** statements in the configuration:

```
acl Safe_ports port 21  
acl Safe_ports port 80  
acl Safe_ports port 443
```

By default, the configuration contains the **http\_access deny !Safe\_ports** rule that defines access denial to ports that are not defined in **Safe\_ports** ACLs.

- f. Configure the cache type, the path to the cache directory, the cache size, and further cache type-specific settings in the **cache\_dir** parameter:

```
cache_dir ufs /var/spool/squid 10000 16 256
```

With these settings:

- Squid uses the **ufs** cache type.
  - Squid stores its cache in the **/var/spool/squid/** directory.
  - The cache grows up to **10000** MB.
  - Squid creates **16** level-1 sub-directories in the **/var/spool/squid/** directory.
  - Squid creates **256** sub-directories in each level-1 directory.
- If you do not set a **cache\_dir** directive, Squid stores the cache in memory.

3. If you set a different cache directory than **/var/spool/squid/** in the **cache\_dir** parameter:

- a. Create the cache directory:

```
# mkdir -p path_to_cache_directory
```

- b. Configure the permissions for the cache directory:

```
# chown squid:squid path_to_cache_directory
```

- c. If you run SELinux in **enforcing** mode, set the **squid\_cache\_t** context for the cache directory:

```
# semanage fcontext -a -t squid_cache_t "path_to_cache_directory(/.*)?"  
# restorecon -Rv path_to_cache_directory
```

If the **semanage** utility is not available on your system, install the **policycoreutils-python-utils** package.

4. Store the password of the LDAP service user in the **/etc/squid/ldap\_password** file, and set appropriate permissions for the file:

```
# echo "password" > /etc/squid/ldap_password  
# chown root:squid /etc/squid/ldap_password  
# chmod 640 /etc/squid/ldap_password
```

5. Open the **3128** port in the firewall:

```
# firewall-cmd --permanent --add-port=3128/tcp  
# firewall-cmd --reload
```

6. Enable and start the **squid** service:

```
# systemctl enable --now squid
```

## Verification

To verify that the proxy works correctly, download a web page using the **curl** utility:

```
# curl -O -L "https://www.redhat.com/index.html" -x
"user_name:password@proxy.example.com:3128"
```

If curl does not display any error and the **index.html** file was downloaded to the current directory, the proxy works.

## Troubleshooting steps

To verify that the helper utility works correctly:

1. Manually start the helper utility with the same settings you used in the **auth\_param** parameter:

```
# /usr/lib64/squid/basic_ldap_auth -b "cn=users,cn=accounts,dc=example,dc=com" -D
"uid=proxy_user,cn=users,cn=accounts,dc=example,dc=com" -W
/etc/squid/ldap_password -f "(&(objectClass=person)(uid=%s))" -ZZ -H
ldap://ldap_server.example.com:389
```

2. Enter a valid user name and password, and press **Enter**:

```
user_name password
```

If the helper utility returns **OK**, authentication succeeded.

## 3.3. SETTING UP SQUID AS A CACHING PROXY WITH KERBEROS AUTHENTICATION

You can configure Squid as a caching proxy that authenticates users to an Active Directory (AD) using Kerberos. The procedure configures that only authenticated users can use the proxy.

### Prerequisites

- The procedure assumes that the **/etc/squid/squid.conf** file is as provided by the **squid** package. If you edited this file before, remove the file and reinstall the package.
- The server on which you want to install Squid is a member of the AD domain.

### Procedure

1. Install the following packages:

```
# dnf install squid krb5-workstation
```

2. Authenticate as the AD domain administrator:

```
# kinit administrator@AD.EXAMPLE.COM
```

3. Create a keytab for Squid, store it in the **/etc/squid/HTTP.keytab** file and add the **HTTP** service principal to the keytab:

```
# export KRB5_KTNAME=FILE:/etc/squid/HTTP.keytab
# net ads keytab CREATE -U administrator
# net ads keytab ADD HTTP -U administrator
```

4. Optional: If system is initially joined to the AD domain with realm (via **adcli**), use following instructions to add **HTTP** principal and create a keytab file for squid:

- a. Add the **HTTP** service principal to the default keytab file **/etc/krb5.keytab** and verify:

```
# adcli update -vvv --domain=ad.example.com --computer-name=PROXY --add-
service-principal="HTTP/proxy.ad.example.com" -C
# klist -kte /etc/krb5.keytab | grep -i HTTP
```

- b. Load the **/etc/krb5.keytab** file, remove all service principals except **HTTP**, and save the remaining principals into the **/etc/squid/HTTP.keytab** file:

```
# ktutil
ktutil: rkt /etc/krb5.keytab
ktutil: l -e
slot | KVNO | Principal
-----
1 | 2 | PROXY$@AD.EXAMPLE.COM (aes128-cts-hmac-sha1-96)
2 | 2 | PROXY$@AD.EXAMPLE.COM (aes256-cts-hmac-sha1-96)
3 | 2 | host/PROXY@AD.EXAMPLE.COM (aes128-cts-hmac-sha1-96)
4 | 2 | host/PROXY@AD.EXAMPLE.COM (aes256-cts-hmac-sha1-96)
5 | 2 | host/proxy.ad.example.com@AD.EXAMPLE.COM (aes128-cts-hmac-sha1-96)
6 | 2 | host/proxy.ad.example.com@AD.EXAMPLE.COM (aes256-cts-hmac-sha1-96)
7 | 2 | HTTP/proxy.ad.example.com@AD.EXAMPLE.COM (aes128-cts-hmac-sha1-96)
8 | 2 | HTTP/proxy.ad.example.com@AD.EXAMPLE.COM (aes256-cts-hmac-sha1-96)
```

In the interactive shell of **ktutil**, you can use the different options, until all unwanted principals are removed from keytab, for example:

```
ktutil: delent 1
```

```
ktutil: l -e
```

```
slot | KVNO | Principal
-----
```

```
1 | 2 | HTTP/proxy.ad.example.com@AD.EXAMPLE.COM (aes128-cts-hmac-sha1-96)
2 | 2 | HTTP/proxy.ad.example.com@AD.EXAMPLE.COM (aes256-cts-hmac-sha1-96)
```

```
ktutil: wkt /etc/squid/HTTP.keytab
```

```
ktutil: q
```



**WARNING**

The keys in **/etc/krb5.keytab** might get updated if SSSD or Samba/winbind will update the machine account password. After the update, the key in **/etc/squid/HTTP.keytab** will stop working, and you will need to perform the **ktutil** steps again to copy the new keys into the keytab.

5. Set the owner of the keytab file to the **squid** user:

```
# chown squid /etc/squid/HTTP.keytab
```

6. Optional: Verify that the keytab file contains the **HTTP** service principal for the fully-qualified domain name (FQDN) of the proxy server:

```
# klist -k /etc/squid/HTTP.keytab
Keytab name: FILE:/etc/squid/HTTP.keytab
KVNO Principal
-----
...
  2 HTTP/proxy.ad.example.com@AD.EXAMPLE.COM
...
```

7. Edit the **/etc/squid/squid.conf** file:

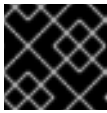
- a. To configure the **negotiate\_kerberos\_auth** helper utility, add the following configuration entry to the top of **/etc/squid/squid.conf**:

```
auth_param negotiate program /usr/lib64/squid/negotiate_kerberos_auth -k
/etc/squid/HTTP.keytab -s HTTP/proxy.ad.example.com@AD.EXAMPLE.COM
```

The following describes the parameters passed to the **negotiate\_kerberos\_auth** helper utility in the example above:

- **-k file** sets the path to the key tab file. Note that the squid user must have read permissions on this file.
  - **-s HTTP/host\_name@kerberos\_realm** sets the Kerberos principal that Squid uses. Optionally, you can enable logging by passing one or both of the following parameters to the helper utility:
  - **-i** logs informational messages, such as the authenticating user.
  - **-d** enables debug logging.  
Squid logs the debugging information from the helper utility to the **/var/log/squid/cache.log** file.
- b. Add the following ACL and rule to configure that Squid allows only authenticated users to use the proxy:

```
acl kerb-auth proxy_auth REQUIRED
http_access allow kerb-auth
```



### IMPORTANT

Specify these settings before the **http\_access deny all** rule.

- c. Remove the following rule to disable bypassing the proxy authentication from IP ranges specified in **localnet** ACLs:

```
http_access allow localnet
```

- d. The following ACL exists in the default configuration and defines **443** as a port that uses the HTTPS protocol:

```
acl SSL_ports port 443
```

If users should be able to use the HTTPS protocol also on other ports, add an ACL for each of these port:

```
acl SSL_ports port port_number
```

- e. Update the list of **acl Safe\_ports** rules to configure to which ports Squid can establish a connection. For example, to configure that clients using the proxy can only access resources on port 21 (FTP), 80 (HTTP), and 443 (HTTPS), keep only the following **acl Safe\_ports** statements in the configuration:

```
acl Safe_ports port 21
acl Safe_ports port 80
acl Safe_ports port 443
```

By default, the configuration contains the **http\_access deny !Safe\_ports** rule that defines access denial to ports that are not defined in **Safe\_ports** ACLs.

- f. Configure the cache type, the path to the cache directory, the cache size, and further cache type-specific settings in the **cache\_dir** parameter:

```
cache_dir ufs /var/spool/squid 10000 16 256
```

With these settings:

- Squid uses the **ufs** cache type.
- Squid stores its cache in the **/var/spool/squid/** directory.
- The cache grows up to **10000** MB.
- Squid creates **16** level-1 sub-directories in the **/var/spool/squid/** directory.
- Squid creates **256** sub-directories in each level-1 directory.  
If you do not set a **cache\_dir** directive, Squid stores the cache in memory.

8. If you set a different cache directory than **/var/spool/squid/** in the **cache\_dir** parameter:

- a. Create the cache directory:

```
# mkdir -p path_to_cache_directory
```

- b. Configure the permissions for the cache directory:

```
# chown squid: squid path_to_cache_directory
```

- c. If you run SELinux in **enforcing** mode, set the **squid\_cache\_t** context for the cache directory:

```
# semanage fcontext -a -t squid_cache_t "path_to_cache_directory(/.*)?"
# restorecon -Rv path_to_cache_directory
```

If the **semanage** utility is not available on your system, install the **policycoreutils-python-utils** package.

9. Open the **3128** port in the firewall:

```
# firewall-cmd --permanent --add-port=3128/tcp
# firewall-cmd --reload
```

10. Enable and start the **squid** service:

```
# systemctl enable --now squid
```

## Verification

- To verify that the proxy works correctly, download a web page using the **curl** utility:

```
# curl -O -L "https://www.redhat.com/index.html" --proxy-negotiate -u : -x
"proxy.ad.example.com:3128"
```

If **curl** does not display any error and the **index.html** file exists in the current directory, the proxy works.

## Troubleshooting steps

1. Obtain a Kerberos ticket for the AD account:

```
# kinit user@AD.EXAMPLE.COM
```

2. Optional: Display the ticket:

```
# klist
```

3. Use the **negotiate\_kerberos\_auth\_test** utility to test the authentication:

```
# /usr/lib64/squid/negotiate_kerberos_auth_test proxy.ad.example.com
```

If the helper utility returns a token, the authentication succeeded:

Token: YlIFtAYGKwYBBQUColIFqDC...

### 3.4. CONFIGURING A DOMAIN DENY LIST IN SQUID

Frequently, administrators want to block access to specific domains. This section describes how to configure a domain deny list in Squid.

#### Prerequisites

- Squid is configured, and users can use the proxy.

#### Procedure

1. Edit the **/etc/squid/squid.conf** file and add the following settings:

```
acl domain_deny_list dstdomain "/etc/squid/domain_deny_list.txt"
http_access deny all domain_deny_list
```

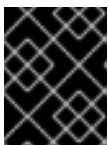


#### IMPORTANT

Add these entries before the first **http\_access allow** statement that allows access to users or clients.

2. Create the **/etc/squid/domain\_deny\_list.txt** file and add the domains you want to block. For example, to block access to **example.com** including subdomains and to block **example.net**, add:

```
.example.com
example.net
```



#### IMPORTANT

If you referred to the **/etc/squid/domain\_deny\_list.txt** file in the squid configuration, this file must not be empty. If the file is empty, Squid fails to start.

3. Restart the **squid** service:

```
# systemctl restart squid
```

### 3.5. CONFIGURING THE SQUID SERVICE TO LISTEN ON A SPECIFIC PORT OR IP ADDRESS

By default, the Squid proxy service listens on the **3128** port on all network interfaces. You can change the port and configuring Squid to listen on a specific IP address.

#### Prerequisites

- The **squid** package is installed.

#### Procedure

1. Edit the **/etc/squid/squid.conf** file:

- To set the port on which the Squid service listens, set the port number in the **http\_port** parameter. For example, to set the port to **8080**, set:

```
http_port 8080
```

- To configure on which IP address the Squid service listens, set the IP address and port number in the **http\_port** parameter. For example, to configure that Squid listens only on the **192.0.2.1** IP address on port **3128**, set:

```
http_port 192.0.2.1:3128
```

Add multiple **http\_port** parameters to the configuration file to configure that Squid listens on multiple ports and IP addresses:

```
http_port 192.0.2.1:3128  
http_port 192.0.2.1:8080
```

2. If you configured that Squid uses a different port as the default (**3128**):

a. Open the port in the firewall:

```
# firewall-cmd --permanent --add-port=port_number/tcp  
# firewall-cmd --reload
```

b. If you run SELinux in enforcing mode, assign the port to the **squid\_port\_t** port type definition:

```
# semanage port -a -t squid_port_t -p tcp port_number
```

If the **semanage** utility is not available on your system, install the **policycoreutils-python-utils** package.

3. Restart the **squid** service:

```
# systemctl restart squid
```

## 3.6. ADDITIONAL RESOURCES

- Configuration parameters **usr/share/doc/squid-<version>/squid.conf.documented**