



Manage Security Enhanced Linux (SELinux)



Unit objectives

After completing this unit, you should be able to:

- Understand SELinux
- Change SELinux Enforcement Mode
- Controlling SELinux File Contexts

Understand SELinux

File Permissions / ACLs

- Control user or group access to file and directory
- File / Directory Level
- Control how file is access, not the content

SELinux Settings

- Control processes or set of programs access to file and directory
- Granular Level – can control content
- Set of policies – determine actions and accesses right
- Place labels
- Policies applies to binaries, executable, configuration, app's data, and network port used by application

SELinux Mode

Enforcing

- SELinux enforces access control rules. Enabled by default.

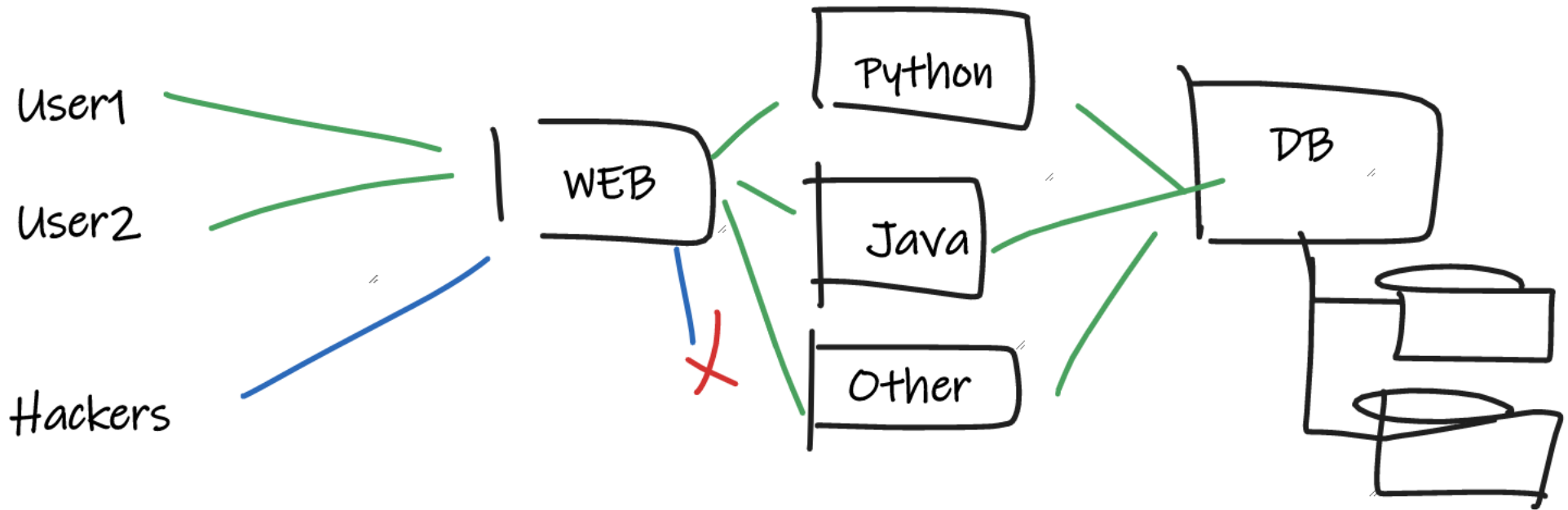
Permissive

- SELinux is active but records warnings of rules violated. Used for testing and troubleshooting

Disabled

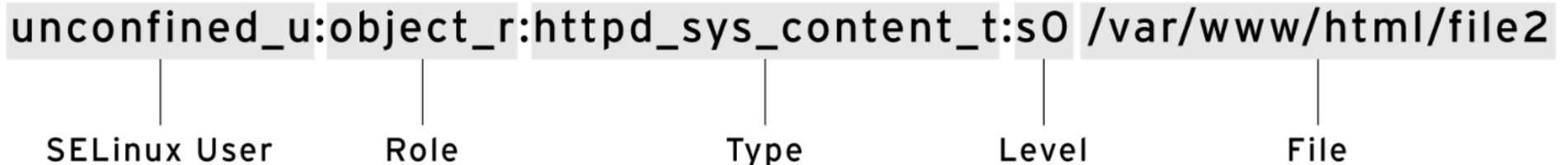
- SELinux is turned off entirely. Violations are allowed and not recording whatsoever. Discouraged!

Why use SELinux



Basic SELinux security concepts

- Is a layer built on top of other security layer
- Protect user data from system services that have been compromised
 - mitigate against discretionary access control weakness
- Context - Set of rules determining which process can access file, directories and application ports
- Context – user, role, type ,sensitivity
- Default, implicit denied rule is imposed

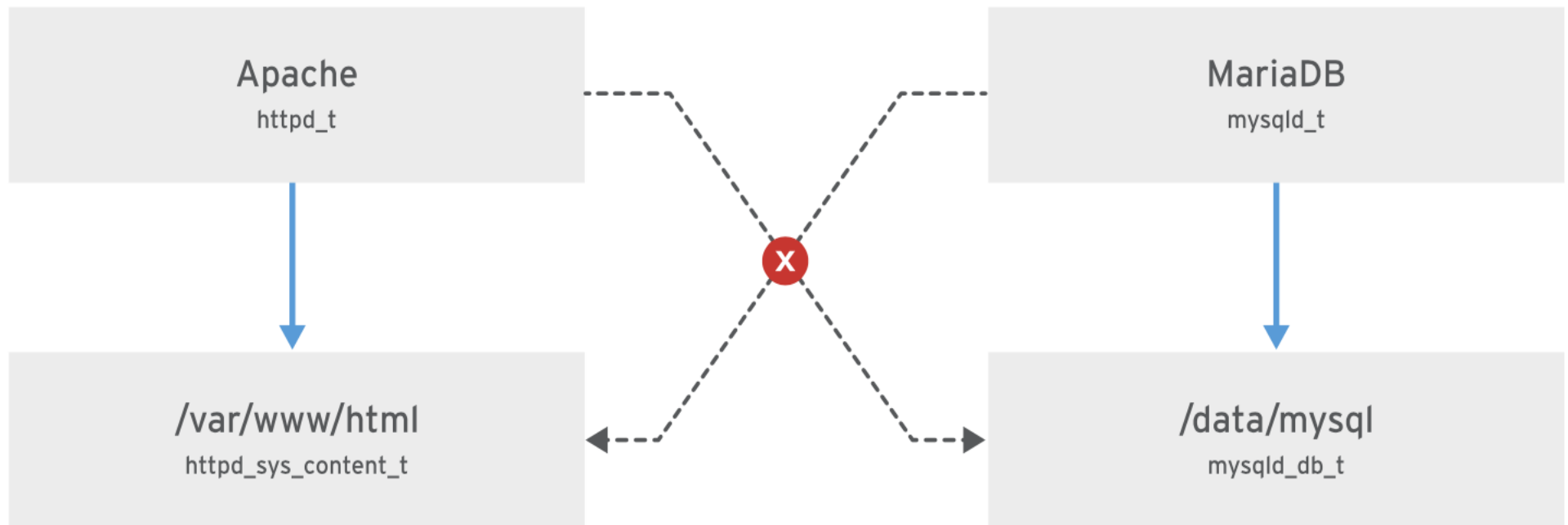


The diagram illustrates the components of an SELinux context. It shows a sequence of five components separated by colons: 'unconfined_u', 'object_r', 'httpd_sys_content_t', 's0', and '/var/www/html/file2'. Each component is highlighted with a light gray background. Below each component, a vertical line connects it to a label: 'SELinux User' for 'unconfined_u', 'Role' for 'object_r', 'Type' for 'httpd_sys_content_t', 'Level' for 's0', and 'File' for '/var/www/html/file2'.

SELinux User	Role	Type	Level	File
unconfined_u	object_r	httpd_sys_content_t	s0	/var/www/html/file2

Basic SELinux security concepts

- **MariaDB** server has context **mysqld_t** and has access to **/data/mysql** with **mysqld_db_t** type context.
- **Apache** server has context **httpd_t** and has access to **/var/www/html** with **httpd_sys_content_t** type context.
- Each data file access by own services but disables access by other services



Reveal SELinux contexts

```
[root@host ~]# ps axZ
```

LABEL	PID	TTY	STAT	TIME	COMMAND
system_u:system_r:init_t:s0	1	?	Ss	0:09	/usr/lib/systemd/...
system_u:system_r:kernel_t:s0	2	?	S	0:00	[kthreadd]
system_u:system_r:kernel_t:s0	3	?	S	0:00	[ksoftirqd/0]

...output omitted...

```
[root@host ~]# systemctl start httpd
```

```
[root@host ~]# ps -ZC httpd
```

LABEL	PID	TTY	TIME	CMD
system_u:system_r:httpd_t:s0	1608	?	00:00:05	httpd
system_u:system_r:httpd_t:s0	1609	?	00:00:00	httpd

...output omitted...

```
[root@host ~]# ls -Z /home
```

drwx-----.	root	root	system_u:object_r:lost_found_t:s0	lost+found
drwx-----.	student	student	unconfined_u:object_r:user_home_dir_t:s0	student
drwx-----.	visitor	visitor	unconfined_u:object_r:user_home_dir_t:s0	visitor

```
[root@host ~]# ls -Z /var/www
```

drwxr-xr-x.	root	root	system_u:object_r:httpd_sys_script_exec_t:s0	cgi-bin
drwxr-xr-x.	root	root	system_u:object_r:httpd_sys_content_t:s0	error
drwxr-xr-x.	root	root	system_u:object_r:httpd_sys_content_t:s0	html
drwxr-xr-x.	root	root	system_u:object_r:httpd_sys_content_t:s0	icons

Changing SELinux mode - temporarily

- `getenforce` # get mode
- `sefenceforce` # switch mode
- `setenforce 0` # disable completely
- `setenforce 1` # same as enforcing

```
[user@host ~]# getenforce
Enforcing
[user@host ~]# setenforce
usage:  setenforce [ Enforcing | Permissive | 1 | 0 ]
[user@host ~]# setenforce 0
[user@host ~]# getenforce
Permissive
[user@host ~]# setenforce Enforcing
[user@host ~]# getenforce
Enforcing
```

Changing SELinux mode - persistent

- Using /etc/selinux/config
- targetted type # Object access is controlled by SELinux, not by discretionary ccess control. Default
- minimum type # SELlinux only protect selected process
- mls # SELinux provide multi level security protection

```
# This file controls the state of SELinux on the system.
# SELINUX= can take one of these three values:
#     enforcing - SELinux security policy is enforced.
#     permissive - SELinux prints warnings instead of enforcing.
#     disabled - No SELinux policy is loaded.
SELINUX=enforcing
# SELINUXTYPE= can take one of these two values:
#     targeted - Targeted processes are protected,
#     minimum - Modification of targeted policy. Only selected processes
#               are protected.
#     mls - Multi Level Security protection.
SELINUXTYPE=targeted
```

Initial SELinux Context

- Label represents security relevant information
- All processes and files are labelled
- New files inherit context from parent directory
- Inheritancy compromise security

Example: Inherency compromise security

The **ls -Z** command displays the SELinux context of a file. Note the label of the file.

```
[root@host ~]# ls -Z /var/www/html/index.html
-rw-r--r--. root root unconfined_u:object_r:httpd_sys_content_t:s0 /var/www/html/
index.html
```

And the **ls -Zd** command displays the SELinux context of a directory:

```
[root@host ~]# ls -Zd /var/www/html/
drwxr-xr-x. root root system_u:object_r:httpd_sys_content_t:s0 /var/www/html/
```

Note that the **/var/www/html/index.html** has the same label as the parent directory **/var/www/html/**. Now, create files outside of the **/var/www/html** directory and note their file context:

Example: Inherency compromise security

- /tmp has **unconfined_u:object_r:user_tmp_t:s0** context

```
[root@host ~]# touch /tmp/file1 /tmp/file2
[root@host ~]# ls -Z /tmp/file*
unconfined_u:object_r:user_tmp_t:s0 /tmp/file1
unconfined_u:object_r:user_tmp_t:s0 /tmp/file2
```

Move one of these files to the **/var/www/html** directory, copy another, and note the label of each:

```
[root@host ~]# mv /tmp/file1 /var/www/html/
[root@host ~]# cp /tmp/file2 /var/www/html/
```

```
[root@host ~]# ls -Z /var/www/html/file*
unconfined_u:object_r:user_tmp_t:s0 /var/www/html/file1
unconfined_u:object_r:httpd_sys_content_t:s0 /var/www/html/file2
```

The moved file maintains its original label while the copied file inherits the label from the **/var/www/html** directory. **unconfined_u:** is the user, **object_r:** denotes the role, and **s0** is the level. A sensitivity level of 0 is the lowest possible sensitivity level.

Changing SELinux context of file

- includes semanage fcontext, restorecon, and chcon
- chcon – discouraged. Changes does not survived thru restorecon or file system relabeled process
- Example: chcon does not survived restorecon

```
[root@host ~]# mkdir /virtual
[root@host ~]# ls -Zd /virtual
drwxr-xr-x. root root unconfined_u:object_r:default_t:s0 /virtual
[root@host ~]# chcon -t httpd_sys_content_t /virtual
[root@host ~]# ls -Zd /virtual
drwxr-xr-x. root root unconfined_u:object_r:httpd_sys_content_t:s0 /virtual
[root@host ~]# restorecon -v /virtual
Relabeled /virtual from unconfined_u:object_r:httpd_sys_content_t:s0 to
unconfined_u:object_r:default_t:s0
[root@host ~]# ls -Zd /virtual
drwxr-xr-x. root root unconfined_u:object_r:default_t:s0 /virtual
```

Basic File Context Operations

semanage fcontext commands

option	description
-a, --add	Add a record of the specified object type
-d, --delete	Delete a record of the specified object type
-l, --list	List records of the specified object type

```
[root@host ~]# ls -Z /var/www/html/file*
unconfined_u:object_r:user_tmp_t:s0 /var/www/html/file1
unconfined_u:object_r:httpd_sys_content_t:s0 /var/www/html/file2
```

```
[root@host ~]# semanage fcontext -l
...output omitted...
/var/www(/.*)?          all files      system_u:object_r:httpd_sys_content_t:s0
...output omitted...
```

Basic File Context Operations

```
[root@host; ~]# restorecon -Rv /var/www/
Relabeled /var/www/html/file1 from unconfined_u:object_r:user_tmp_t:s0 to
unconfined_u:object_r:httpd_sys_content_t:s0
[root@host ~]# ls -Z /var/www/html/file*
unconfined_u:object_r:httpd_sys_content_t:s0 /var/www/html/file1
unconfined_u:object_r:httpd_sys_content_t:s0 /var/www/html/file2

[root@host ~]# mkdir /virtual
[root@host ~]# touch /virtual/index.html
[root@host ~]# ls -Zd /virtual/
drwxr-xr-x. root root unconfined_u:object_r:default_t:s0 /virtual/

[root@host ~]# ls -Z /virtual/
-rw-r--r--. root root unconfined_u:object_r:default_t:s0 index.html
[root@host ~]# semanage fcontext -a -t httpd_sys_content_t '/virtual(/.*)?'
[root@host ~]# restorecon -RFvv /virtual
[root@host ~]# ls -Zd /virtual/
drwxr-xr-x. root root system_u:object_r:httpd_sys_content_t:s0 /virtual/
[root@host ~]# ls -Z /virtual/
-rw-r--r--. root root system_u:object_r:httpd_sys_content_t:s0 index.html
```


Adjusting SELinux Policy with Booleans

- Switches that change behavior of policy
- Can be enabled or disabled only
- Get documentations
 - # dnf -y install selinux-policy-doc selinux-policy-devel
 - # man -k '_selinux'
- Manage thru **setsebool**, **getsebool**, **semanage boolean**

Example: Manage SELinux Boolean

```
[user@host ~]$ getsebool -a
abrt_anon_write --> off
abrt_handle_event --> off
abrt_upload_watch_anon_write --> on
antivirus_can_scan_system --> off
antivirus_use_jit --> off
...output omitted...
[user@host ~]$ getsebool httpd_enable_homedirs
httpd_enable_homedirs --> off

[user@host ~]$ setsebool httpd_enable_homedirs on
Could not change active booleans. Please try as root: Permission denied
[user@host ~]$ sudo setsebool httpd_enable_homedirs on
[user@host ~]$ sudo semanage boolean -l | grep httpd_enable_homedirs
httpd_enable_homedirs          (on , off) Allow httpd to enable homedirs
[user@host ~]$ getsebool httpd_enable_homedirs
httpd_enable_homedirs --> on
[user@host ~]$ setsebool -P httpd_enable_homedirs on
[user@host ~]$ sudo semanage boolean -l | grep httpd_enable_homedirs
httpd_enable_homedirs          (on , on) Allow httpd to enable homedirs
```

Example: Manage SELinux Boolean

- List booleans which current state differs from default configuration

```
[user@host ~]$ sudo semanage boolean -l -C
SELinux boolean          State  Default Description
cron_can_relabel         (off  ,   on) Allow cron to can relabel
```

Investigate and Resolving SELinux Issues

- Important: To prevent unauthorized access to files.
- Intentional
 1. Before thinking of making any adjustments, consider that SELinux may be doing its job correctly by prohibiting the attempted access. If a web server tries to access files in **/home**, this could signal a compromise of the service if web content is not published by users. If access should have been granted, then additional steps need to be taken to solve the problem.
- Missconfigured
 2. The most common SELinux issue is an incorrect file context. This can occur when a file is created in a location with one file context and moved into a place where a different context is expected. In most cases, running **restorecon** will correct the issue. Correcting issues in this way has a very narrow impact on the security of the rest of the system.
- Overly restrictive
 3. Another remedy for overly restrictive access could be the adjustment of a Boolean. For example, the **ftpd_anon_write** boolean controls whether anonymous FTP users can upload files. You must turn this boolean on to permit anonymous FTP users to upload files to a server. Adjusting booleans requires more care because they can have a broad impact on system security.

Investigate and Resolving SELinux Issues

- Important: To prevent unauthorized access to files.
 - Bug
4. It is possible that the SELinux policy has a bug that prevents a legitimate access. Since SELinux has matured, this is a rare occurrence. When it is clear that a policy bug has been identified, contact Red Hat support to report the bug so it can be resolved.

Monitor SELinux for any violations

- Install setroubleshoot-server package
- Listen for audit messages in /var/log/audit/audit.log
- Send short message /var/log/messages
 - Look for *UUID* : unique identifiers for violations to SELinux
- sealert -l *UUID*
- sealert -a /var/log/audit/audit.log
- Next slide for sample sequence commands on standard Apache web server.

Diagnose SELinux on standard Apache web server.

```
[root@host ~]# touch /root/file3
[root@host ~]# mv /root/file3 /var/www/html
[root@host ~]# systemctl start httpd
[root@host ~]# curl http://localhost/file3
<!DOCTYPE HTML PUBLIC "-//IETF//DTD HTML 2.0//EN">
<html><head>
<title>403 Forbidden</title>
</head><body>
<h1>Forbidden</h1>
<p>You don't have permission to access /file3
on this server.</p>
</body></html>
```

When getting web page , it shows permission denied. Time to find out why

Check on the logs

```
[root@host ~]# tail /var/log/audit/audit.log
...output omitted...
type=AVC msg=audit(1392944135.482:429): avc: denied { getattr } for
  pid=1609 comm="httpd" path="/var/www/html/file3" dev="vda1" ino=8980981
  scontext=system_u:system_r:httpd_t:s0
  tcontext=unconfined_u:object_r:admin_home_t:s0 tclass=file
...output omitted...
[root@host ~]# tail /var/log/messages
...output omitted...
Feb 20 19:55:42 host setroubleshoot: SELinux is preventing /usr/sbin/httpd
  from getattr access on the file . For complete SELinux messages. run
  sealert -l 613ca624-248d-48a2-a7d9-d28f5bbe2763
```

Further check, SELinux is preventing access

sealert -l UUID (gather from log)

```
[root@host ~]# sealert -l 613ca624-248d-48a2-a7d9-d28f5bbe2763
SELinux is preventing /usr/sbin/httpd from getattr access on the file .

***** Plugin catchall (100. confidence) suggests *****

If you believe that httpd should be allowed getattr access on the
file by default.
Then you should report this as a bug.
You can generate a local policy module to allow this access.
Do
allow this access for now by executing:
# grep httpd /var/log/audit/audit.log | audit2allow -M mypol
# semodule -i mypol.pp

Additional Information:
Source Context           system_u:system_r:httpd_t:s0
Target Context           unconfined_u:object_r:admin_home_t:s0
Target Objects           [ file ]
Source                   httpd
Source Path              /usr/sbin/httpd
Port                    <Unknown>
Host                    servera
Source RPM Packages      httpd-2.4.6-14.el7.x86_64
```

Look for main problem

sealert -l UUID (gather from log)

Raw Audit Messages

```
type=AVC msg=audit(1392944135.482:429): avc: denied { getattr } for
pid=1609 comm="httpd" path="/var/www/html/file3" dev="vda1" ino=8980981
scontext=system_u:system_r:httpd_t:s0
tcontext=unconfined_u:object_r:admin_home_t:s0 tclass=file
```

```
type=SYSCALL msg=audit(1392944135.482:429): arch=x86_64 syscall=lstat
success=no exit=EACCES a0=7f9fed0edea8 a1=7fff7bffc770 a2=7fff7bffc770
a3=0 items=0 ppid=1608 pid=1609 auid=4294967295 uid=48 gid=48 euid=48
suid=48 fsuid=48 egid=48 sgid=48 fsgid=48 tty=(none) ses=4294967295
comm=httpd exe=/usr/sbin/httpd subj=system_u:system_r:httpd_t:s0 key=(null)
```

```
Hash: httpd,httpd_t,admin_home_t,file,getattr
```

Audit messages reveals target file is the main problem.
/var/www/html/file3 does not look like belongs to web server.

Search for recent logs in raw audit messages

```
[root@host ~]# ausearch -m AVC -ts recent
----
time->Tue Apr  9 13:13:07 2019
type=PROCTITLE msg=audit(1554808387.778:4002):
  proctitle=2F7573722F7362696E2F6874747064002D44464F524547524F554E44
type=SYSCALL msg=audit(1554808387.778:4002): arch=c000003e syscall=49
  success=no exit=-13 a0=3 a1=55620b8c9280 a2=10 a3=7ffed967661c items=0
  ppid=1 pid=9340 auid=4294967295 uid=0 gid=0 euid=0 suid=0 fsuid=0 egid=0
  sgid=0 fsgid=0 tty=(none) ses=4294967295 comm="httpd" exe="/usr/sbin/httpd"
  subj=system_u:system_r:httpd_t:s0 key=(null)
type=AVC msg=audit(1554808387.778:4002): avc:  denied  { name_bind }
  for  pid=9340 comm="httpd" src=82 scontext=system_u:system_r:httpd_t:s0
  tcontext=system_u:object_r:reserved_port_t:s0 tclass=tcp_socket permissive=0
```

This raw audit further confirms the problem

The solution

- Simply copy security context using parent directory

```
# restorecon -Rv /var/www/html/
```

- Confirm the rectification

```
# ls -lZ /var/www/html/file3
```

```
# curl http://localhost/file3
```

- Check the default file context of /var/www/html

```
# semanage fcontext -l | grep httpd | grep /var/www/html
```

Checkpoint

1. How do you verify if SELinux is enabled?
 - a) `getenforce 1`
 - b) `setenforce 0`
 - c) `getenforce`
 - d) `setenforce 1`

2. How do you quickly enable SELinux now?
 - a) `getenforce 1`
 - b) `setenforce 0`
 - c) `getenforce`
 - d) `setenforce 1`

3. How do you configure SELinux to permissive mode on every reboot?
 - a) Modify `/etc/security/selinux`, by changing `SELINUX=permissive`
 - b) Modify `/etc/security/selinux`, by changing `SELINUX=enforcing`
 - c) Modify `/etc/selinux/config`, by changing `SELINUX=permissive`
 - d) Modify `/etc/selinux/config`, by changing `SELINUX=enforcing`

4. True or False: Best practice is to disable SELinux as DAC has enough security strength

Checkpoint

1. How do you verify if SELinux is enabled?
 - a) `getenforce 1`
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 - a) Modify `/etc/security/selinux`, by changing `SELINUX=permissive`
 - b) Modify `/etc/security/selinux`, by changing `SELINUX=enforcing`
 - c) Modify `/etc/selinux/config`, by changing `SELINUX=permissive`
 - d) Modify `/etc/selinux/config`, by changing `SELINUX=enforcing`

4. True or False: Best practice is to disable SELinux as DAC has enough security strength

Guided Exercise

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Adjusting SELinux with Booleans	114	10
Investigate and Resolve SELinux Issues	121	10
Manage SELinux Security	125	25



Unit summary

Having completed this unit, you should be able to:

- Understand SELinux
- Change SELinux Enforcement Mode