

Concepts in System Security

Understanding SELinux

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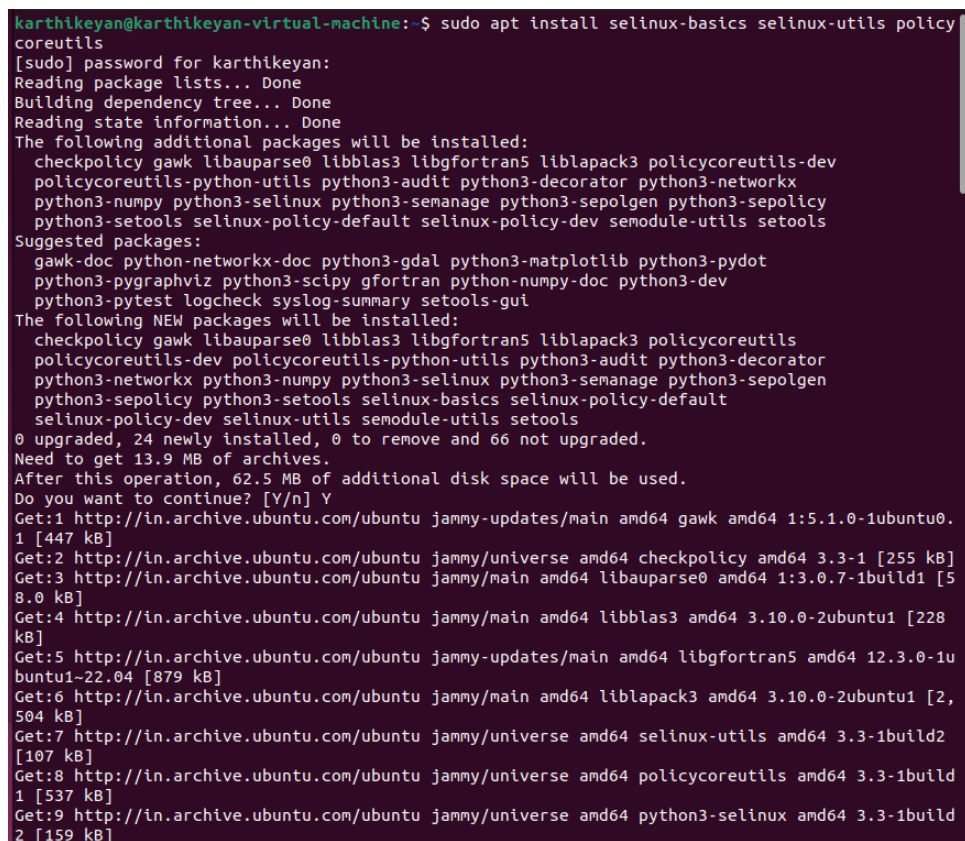
1 SELinux Setup

Security-Enhanced Linux (SELinux) is a security architecture for Linux systems that provides mandatory access control (MAC). It enforces security policies that restrict what actions users, programs, and processes can perform on a system.

To install SELinux, use the following command:

```
sudo apt install selinux-basics selinux-utils policycoreutils
```

This command installs the basic SELinux packages, utilities, and policy tools needed for managing SELinux.



```
karthikeyan@karthikeyan-virtual-machine:~$ sudo apt install selinux-basics selinux-utils policycoreutils
[sudo] password for karthikeyan:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  checkpolicy gawk libauparse0 libblas3 libgfortran5 liblapack3 policycoreutils-dev
  policycoreutils-python-utils python3-audit python3-decorator python3-networkx
  python3-numpy python3-selinux python3-semanage python3-sepolgen python3-sepolicy
  python3-setools selinux-policy-default selinux-policy-dev semodule-utils setools
Suggested packages:
  gawk-doc python-networkx-doc python3-gdal python3-matplotlib python3-pydot
  python3-pygraphviz python3-scipy gfortran python-numpy-doc python3-dev
  python3-pytest logcheck syslog-summary setools-gui
The following NEW packages will be installed:
  checkpolicy gawk libauparse0 libblas3 libgfortran5 liblapack3 policycoreutils
  policycoreutils-dev policycoreutils-python-utils python3-audit python3-decorator
  python3-networkx python3-numpy python3-selinux python3-semanage python3-sepolgen
  python3-sepolicy python3-setools selinux-basics selinux-policy-default
  selinux-policy-dev selinux-utils semodule-utils setools
0 upgraded, 24 newly installed, 0 to remove and 66 not upgraded.
Need to get 13.9 MB of archives.
After this operation, 62.5 MB of additional disk space will be used.
Do you want to continue? [Y/n] Y
Get:1 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 gawk amd64 1:5.1.0-1ubuntu0.1 [447 kB]
Get:2 http://in.archive.ubuntu.com/ubuntu jammy/universe amd64 checkpolicy amd64 3.3-1 [255 kB]
Get:3 http://in.archive.ubuntu.com/ubuntu jammy/main amd64 libauparse0 amd64 1:3.0.7-1build1 [58.0 kB]
Get:4 http://in.archive.ubuntu.com/ubuntu jammy/main amd64 libblas3 amd64 3.10.0-2ubuntu1 [228 kB]
Get:5 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libgfortran5 amd64 12.3.0-1ubuntu1~22.04 [879 kB]
Get:6 http://in.archive.ubuntu.com/ubuntu jammy/main amd64 liblapack3 amd64 3.10.0-2ubuntu1 [2,504 kB]
Get:7 http://in.archive.ubuntu.com/ubuntu jammy/universe amd64 selinux-utils amd64 3.3-1build2 [107 kB]
Get:8 http://in.archive.ubuntu.com/ubuntu jammy/universe amd64 policycoreutils amd64 3.3-1build1 [537 kB]
Get:9 http://in.archive.ubuntu.com/ubuntu jammy/universe amd64 python3-selinux amd64 3.3-1build2 [159 kB]
```

Figure 1: Installing SELinux

To activate SELinux, run the following command:

```
sudo selinux-activate
```

This command enables SELinux and prepares the system for enforcing policies.

```
karthikeyan@karthikeyan-virtual-machine:~$ sestatus
SELinux status: disabled
karthikeyan@karthikeyan-virtual-machine:~$ sudo selinux-activate
Activating SE Linux
Sourcing file '/etc/default/grub'
Sourcing file '/etc/default/grub.d/init-select.cfg'
Generating grub configuration file ...
Found linux image: /boot/vmlinuz-6.8.0-52-generic
Found initrd image: /boot/initrd.img-6.8.0-52-generic
Found linux image: /boot/vmlinuz-6.8.0-40-generic
Found initrd image: /boot/initrd.img-6.8.0-40-generic
Found memtest86+ image: /boot/memtest86+.elf
Found memtest86+ image: /boot/memtest86+.bin
Warning: os-prober will not be executed to detect other bootable partitions.
Systems on them will not be added to the GRUB boot configuration.
Check GRUB_DISABLE_OS_PROBER documentation entry.
done
SE Linux is activated. You may need to reboot now.
karthikeyan@karthikeyan-virtual-machine:~$
```

Figure 2: Activating SELinux

SELinux operates in different modes:

Permissive mode: SELinux loads the security policy but does not enforce it. Instead, it logs policy violations, making it useful for debugging and troubleshooting.

```
karthikeyan@karthikeyan-virtual-machine:~$ sestatus
SELinux status: enabled
SELinuxfs mount: /sys/fs/selinux
SELinux root directory: /etc/selinux
Loaded policy name: default
Current mode: permissive
Mode from config file: permissive
Policy MLS status: enabled
Policy deny_unknown status: allowed
Memory protection checking: actual (secure)
Max kernel policy version: 33
karthikeyan@karthikeyan-virtual-machine:~$
```

Figure 3: Permissive Mode in SELinux

Enforcing mode: SELinux actively enforces the security policy, blocking any unauthorized access attempts.

```
karthikeyan@karthikeyan-virtual-machine:~$ sudo selinux-config-enforcing
Configured enforcing mode in /etc/selinux/config for the next boot.
This can be overridden by "enforcing=0" on the kernel command line.
karthikeyan@karthikeyan-virtual-machine:~$
```

Figure 4: Enforcing Mode in SELinux

To list available SELinux object classes, use:

```
ls /sys/fs/selinux/class
```

Object classes define different types of objects that SELinux controls, such as files, directories, and network sockets.

```
karthikeyan@karthikeyan-virtual-machine:~$ ls /sys/fs/selinux/class
alg_socket          irda_socket        process
appletalk_socket    isdn_socket        process2
association          iucv_socket        qipcrt_socket
atmpvc_socket        kcm_socket         rawip_socket
atmsvc_socket        kernel_service     rds_socket
ax25_socket          key                rose_socket
binder               key_socket         rxrpc_socket
blk_file             llc_socket         sctp_socket
bluetooth_socket     lnk_file           security
bpf                  lockdown          sem
caif_socket          menprotect         service
can_socket           msg               shm
cap2_usersns         msgq              smc_socket
capability           netif             socket
capability2          netlink_audit_socket
cap_usersns          netlink_connector_socket
chr_file             netlink_crypto_socket
context              netlink_dnrt_socket
db_blob              netlink_fib_lookup_socket
db_column            netlink_generic_socket
db_database           netlink_iscsi_socket
db_datatype          netlink_kobject_uevent_socket
db_exception          netlink_netfilter_socket
db_language           netlink_nflog_socket
db_procedure          netlink_rdma_socket
db_schema             netlink_route_socket
db_sequence           netlink_scsitransport_socket
db_table              netlink_selinux_socket
db_tuple              netlink_socket
dbus                  netlink_tcpdiag_socket
db_view              netlink_xfrm_socket
dccp_socket           netrom_socket
decnet_socket         nfc_socket
dir                   node               x_font
fd                    nscd               x_gc
fifo_file             obsolete_netlink_firewall_socket
file                  obsolete_netlink_ip6fw_socket
x_keyboard
```

Figure 5: SELinux Object Classes

To show available permissions for the `file` class:

```
ls /sys/fs/selinux/class/file/perms
```

This command lists the actions allowed on files, such as read, write, and execute.

```
karthikeyan@karthikeyan-virtual-machine:~$ ls /sys/fs/selinux/class/file/perms
append      execmod          ioctl           mounton         relabelfrom    unlink          watch_sb
audit_access execute          link            open            relabelto      watch           watch_with_perm
create      execute_no_trans lock            quotaon        rename          watch_mount     write
entrypoint  getattr          map            read            setattr        watch_reads
```

Figure 6: File Permissions in SELinux

To display permissions for TCP sockets:

```
ls /sys/fs/selinux/class/tcp_socket/perms/
```

This command helps administrators manage network security by defining socket access rules.

```
karthikeyan@karthikeyan-virtual-machine:~$ ls /sys/fs/selinux/class/tcp_socket/perms
accept      connect          getopt          lock            name_connect    recvfrom        sendto          shutdown
append      create          ioctl           map            node_bind       relabelfrom     setattr         write
bind         getattr         listen          name_bind       read            relabelto       setopt
```

Figure 7: TCP Socket Permissions

To query the set of domains accessible to a role in SELinux:

```
seinfo -ruser_r -x
```

```

bind_t getdef_t listen_name_bind_t read_t relabel_t setopt
karthikeyan@karthikeyan-virtual-machine:~$ seinfo -ruser_r -x

Roles: 1
role user_r types { telepathy_gabble_t xscreensaver_t thunderbird_t xauth_t httpd_user_scrip
t_t telepathy_msn_t updpwd_t wireshark_t policykit_auth_t lpr_t pulseaudio_t evolution_t evolut
ion_alarm_t pppd_t user_mail_t telepathy_stream_engine_t gpg_pinentry_t dirmngr_t traceroute_t
gconfd_t sepgsql_trusted_proc_t gpg_agent_t telepathy_idle_t chfn_t shutdown_t user_userhelper_
t postfix_postqueue_t exim_t irc_t xscreensaver_helper_t ping_t pam_t telepathy_mission_control
_t sysadm_screen_t gpg_helper_t uml_t git_session_t user_t sepgsql_ranged_proc_t user_wm_t vmwa
re_t user_systemd_t user_crontab_t postfix_postdrop_t vlock_t sysadm_consolehelper_t gpg_t tele
pathy_salut_t user_dbusd_t xserver_t spamassassin_t chromium_t games_t chkpwd_t evolution_webca
l_t staff_screen_t telepathy_sofiasip_t mailman_mail_t bluetooth_helper_t cdrecord_t user_scree
n_t passwd_t loadkeys_t mencoder_t user_ssh_agent_t user_sudo_t telepathy_sunshine_t evolution_
exchange_t tvtime_t utempter_t chromium_sandbox_t qmail_inject_t sysadm_userhelper_t staff_user
helper_t ssh_t razor_t iceauth_t mplayer_t spamc_t mozilla_t staff_consolehelper_t auditadm_scr
een_t user_gkeyringd_t pyzor_t ddclient_t newrole_t telepathy_logger_t qmail_queue_t secadm_scr
een_t user_su_t java_t chromium_naclhelper_t evolution_server_t rssh_t chromium_renderer_t nscd
_t user_consolehelper_t mozilla_plugin_t mozilla_plugin_config_t };
karthikeyan@karthikeyan-virtual-machine:~$

```

Figure 8: SELinux User Information

The `seinfo` command provides an overview of SELinux policies, roles, and users.

To get details of a specific SELinux user (e.g., `staff_u`):

```
seinfo -ustaff_u -x
```

This command displays detailed information about the given SELinux user, including assigned roles and policies.

```

karthikeyan@karthikeyan-virtual-machine:~$ seinfo -ustaff_u -x

Users: 1
user staff_u roles { sysadm_r staff_r } level s0 range s0 - s0:c0.c1023;
karthikeyan@karthikeyan-virtual-machine:~$

```

Figure 9: SELinux User Information

Semanage Utility: The `semanage` command manages SELinux policies. To list all SELinux users, use:

```
sudo semanage user -l
```

This command shows defined SELinux users and their associated roles.

```

karthikeyan@karthikeyan-virtual-machine:~$ sudo semanage user -l

SELinux User      Labeling Prefix  MLS/ MCS Level  MLS/ MCS Range  SELinux Roles
root              sysadm          s0             s0-s0:c0.c1023  staff_r sysadm_r system_r
staff_u          staff           s0             s0-s0:c0.c1023  staff_r sysadm_r
sysadm_u         sysadm          s0             s0-s0:c0.c1023  sysadm_r
system_u          user            s0             s0-s0:c0.c1023  system_r
unconfined_u     unconfined      s0             s0-s0:c0.c1023  system_r unconfined_r
user_u            user            s0             s0               user_r
xdm               user            s0             s0               xdm_r
karthikeyan@karthikeyan-virtual-machine:~$

```

Figure 10: SELinux Users List

When analyzing SELinux contexts, the following example output shows two files with security contexts:

```
unconfined_u:object_r:user_home_t:s0
```

This indicates that both files belong to `unconfined_u`, meaning they are not restricted by strict SELinux policies. This is useful in security audits to detect potential policy violations.

```
karthikeyan@karthikeyan-virtual-machine:~$ ls /home
karthikeyan  linuxbrew
karthikeyan@karthikeyan-virtual-machine:~$ ls -l /home/karthikeyan/K1.txt /home/linuxbrew/K.txt
-rw-r--r--. 1 root root 0 Mar 23 21:36 /home/karthikeyan/K1.txt
-rw-r--r--. 1 root root 0 Mar 23 21:39 /home/linuxbrew/K.txt
karthikeyan@karthikeyan-virtual-machine:~$ ls -ldZ /home/karthikeyan/K1.txt /home/linuxbrew/K.txt
-rw-r--r--. 1 root root unconfined_u:object_r:user_home_t:s0 0 Mar 23 21:36 /home/karthikeyan/K1.txt
-rw-r--r--. 1 root root unconfined_u:object_r:home_root_t:s0 0 Mar 23 21:39 /home/linuxbrew/K.txt
karthikeyan@karthikeyan-virtual-machine:~$ sudo chcon unconfined_u:object_r:user_home_t:s0 /home/linuxbrew/K.txt
karthikeyan@karthikeyan-virtual-machine:~$ ls -ldZ /home/karthikeyan/K1.txt /home/linuxbrew/K.txt
-rw-r--r--. 1 root root unconfined_u:object_r:user_home_t:s0 0 Mar 23 21:36 /home/karthikeyan/K1.txt
-rw-r--r--. 1 root root unconfined_u:object_r:user_home_t:s0 0 Mar 23 21:39 /home/linuxbrew/K.txt
karthikeyan@karthikeyan-virtual-machine:~$
```

Figure 11: SELinux Context Analysis