Monthly Research

# A Re-Introduction to SELinux

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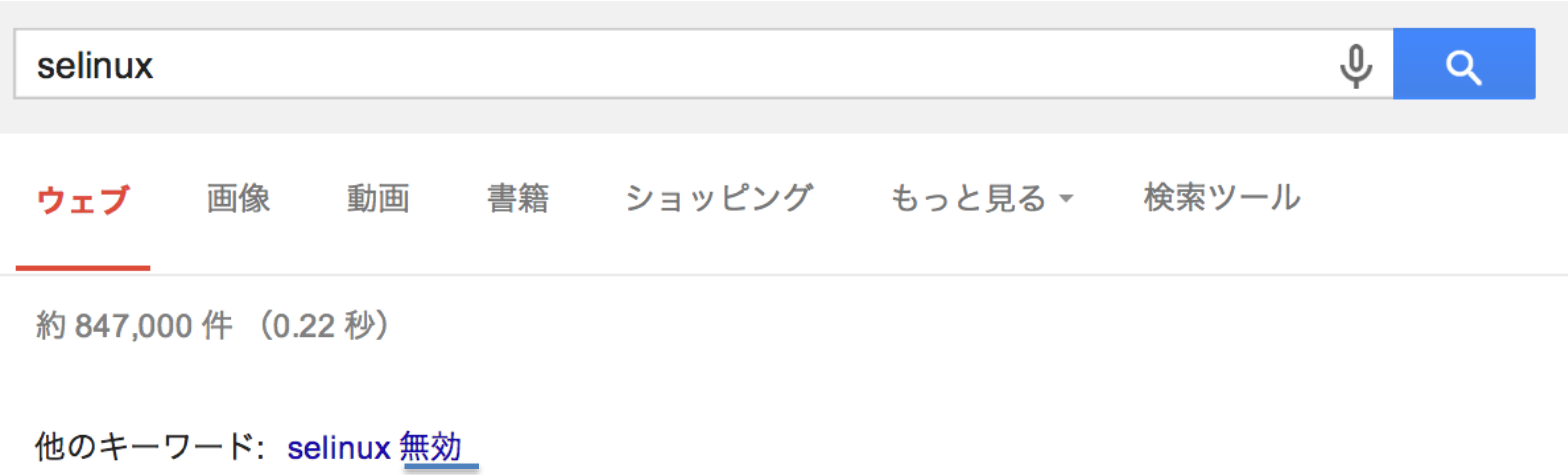
# Why a Re-Introduction?

- SELinux applies virtualization, container isolation and Android recently
- However, many server engineers have disabled SELinux up to now
- 

約 847,000 件 （0.22 秒）

他のキーワード: selinux 無効

It means “disable”

# Agenda

- SELinux Overview
- SELinux Access Control Model
  - Type Enforcement (TE)
  - Role-based Access Control (RBAC)
  - Multi-level Security (MLS) / Multi-category Security (MCS)
- SELinux Security Policy
  - Strict Policy (deprecated)
  - Targeted Policy
  - Minimum Policy
  - MLS/MCS Policy

A Re-Introduction to SELinux

# SELinux Overview

# What is SELinux?

- SELinux is a security extension for Linux kernel
  - Developed by NSA
  - Policy processing based on FLASK architecture
  - One of Linux security module implementation

- SELinux aims military level security

- Reference monitor(=linux kernel) forces restriction of application behavior

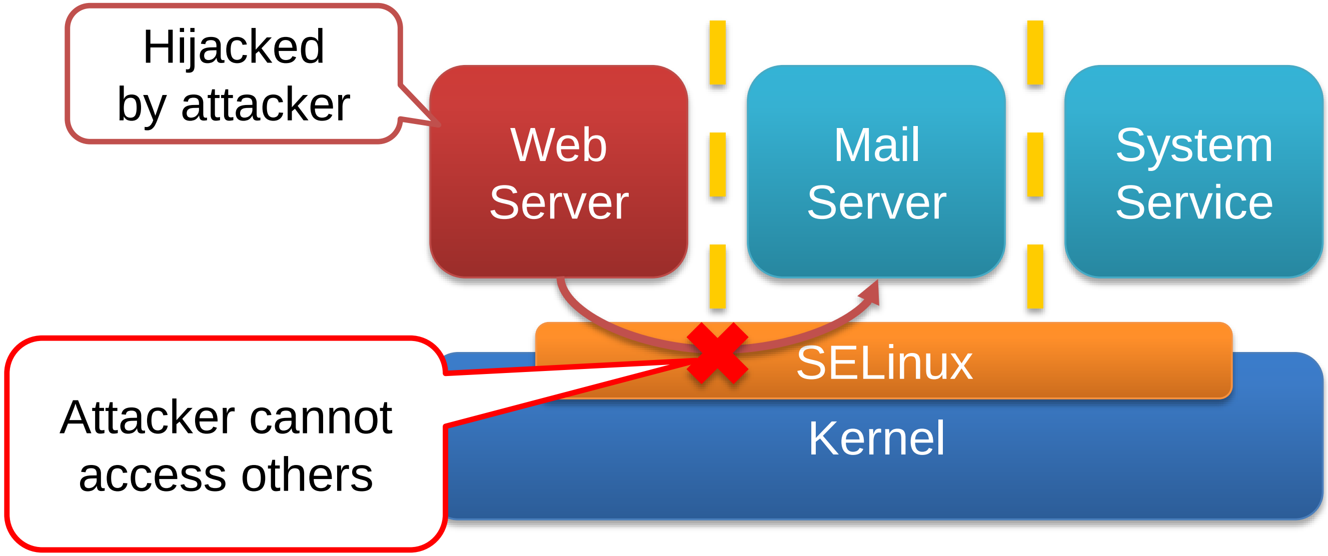
- Demolish *root privilege* for the principle of  least privilege

# MAC: Mandatory Access Control

- Giving SELinux context to all resources
- Linux security module hooks can mediate system calls completely
- SELinux cannot force application-internal access control
  - However, several application embedded SELinux hook into itself
    - X Window System (XACE)
    - PostgreSQL (SE-PostgreSQL)
    - Systemd
    - D-Bus

# Benefits

- Fine-grained(Process-level) access control
- Strong isolation
- Abolish root privilege



# SELinux is not

- Antivirus software
- Intrusion detection
- Memory protection

A Re-Introduction to SELinux

# SELinux Access Control Models

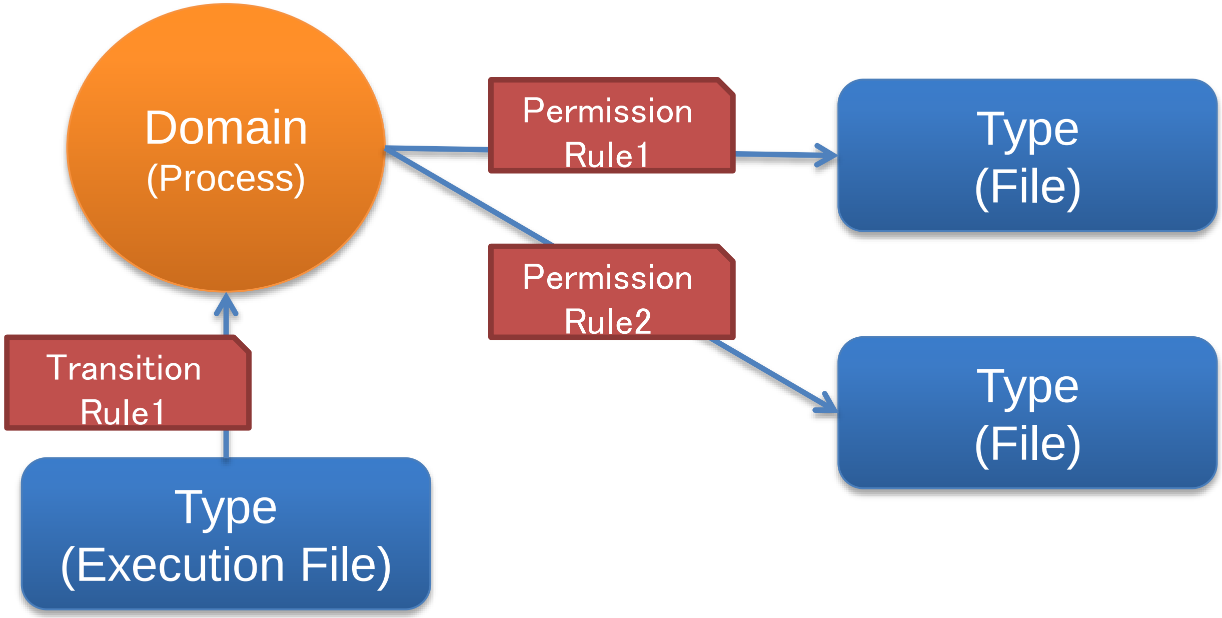
# SELinux Access Control Models

- TE: Type Enforcement
- RBAC: Role-based Access Control
- MLS/MCS: Multi-level Security/Multi-category Security

# Type Enforcement

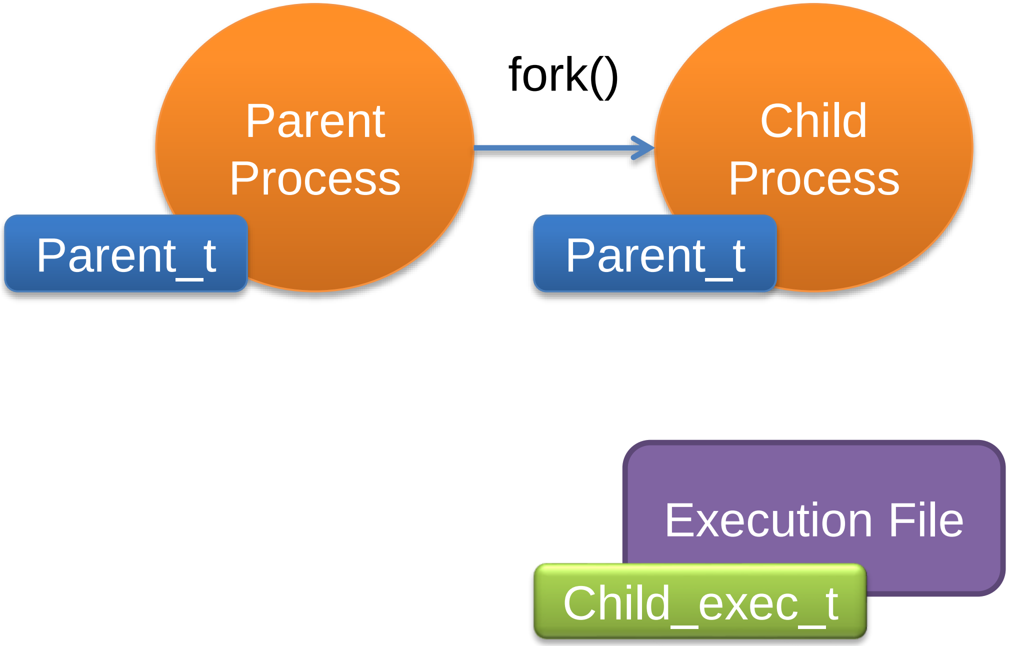
- The type defines a type for files
- The domain defines a type for processes

- The rule  defines permission between domain and type



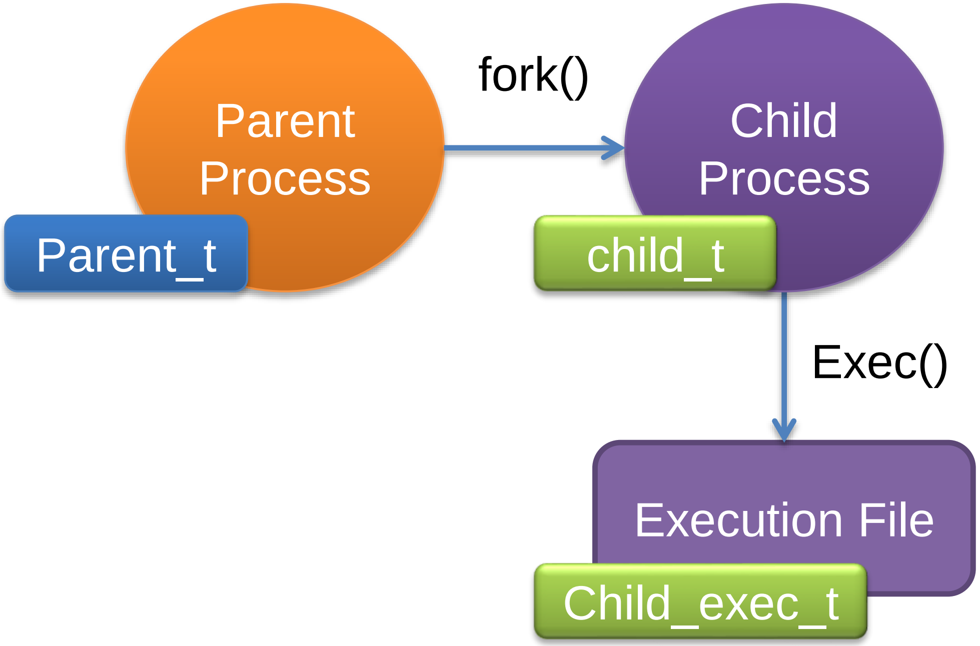
# Domain transition

- Child process inherits SELinux context from parent process normally when process forked



# Domain transition

- SELinux supports process domain transition when process execution using type of execution file



# Example1: myapp.te

```
# Type definition
type myapp_t;
type myapp_exec_t;

 #Declaring myapp_t
domain_type(myapp_t)

#Assigning myapp_t when process executes from myapp_exec_t file
domain_entry_file(myapp_t, myapp_exec_t)

#Type definition
type myapp_log_t

#Declaring interface
logging_log_file(myapp_log_t)

#myapp_t domain can read and append for myapp_log_t files
allow myapp_t myapp_log_t:file { read_file_perms append_file_perms };
```

# Describing Rule of Type Enforcement

- SELinux TE rule declaration is primitive
  - SELinux prepare some expressive macros, but···

- Strictness policy description is composed by huge TE rules
  - It is difficult to understand for user (incl. security administrator)

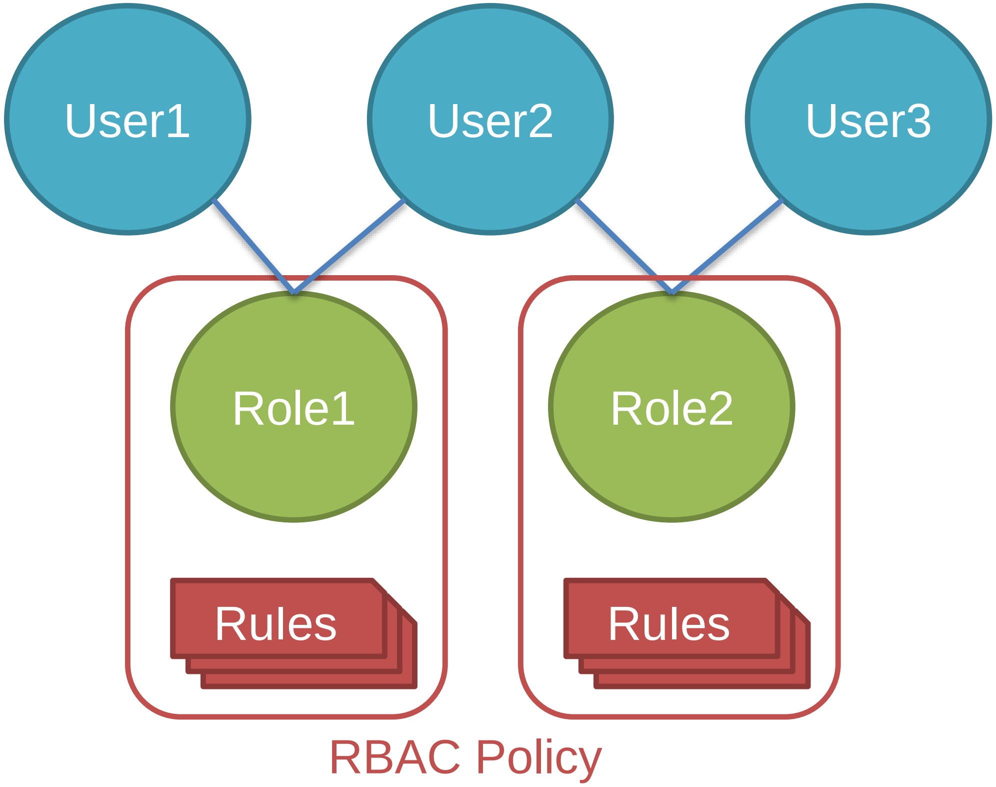
# SELinux Policy Module

- SELinux TE rule modularization system
- Can load each policy modules
  - Can defines interfaces of the module
  - Reusable utilities for security administrator

See also：
“Getting Started with Reference Policy”
http://oss.tresys.com/projects/refpolicy/wiki/GettingStarted

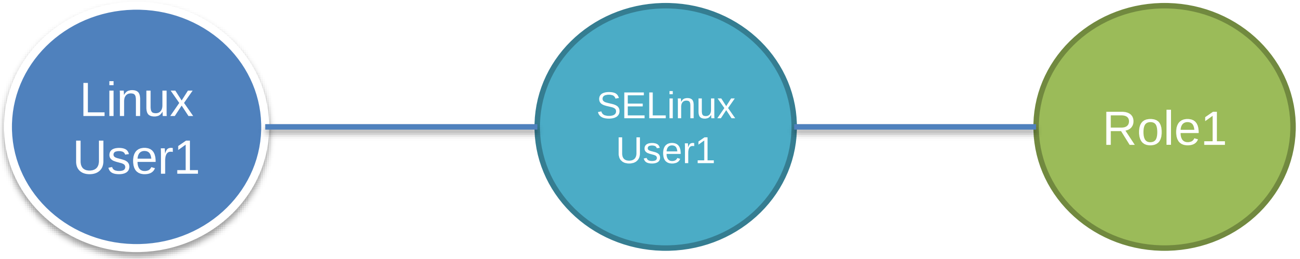
# RBAC (Role-based Access Control)

- A user is assigned to some roles
- Role is granted some permissions



# SELinux Users and roles

- SELinux maps Linux users on SELinux users
  - Moreover, maps SELinux users on SELinux roles
  - Because Linux user controls under discretionary access control its not mandatory



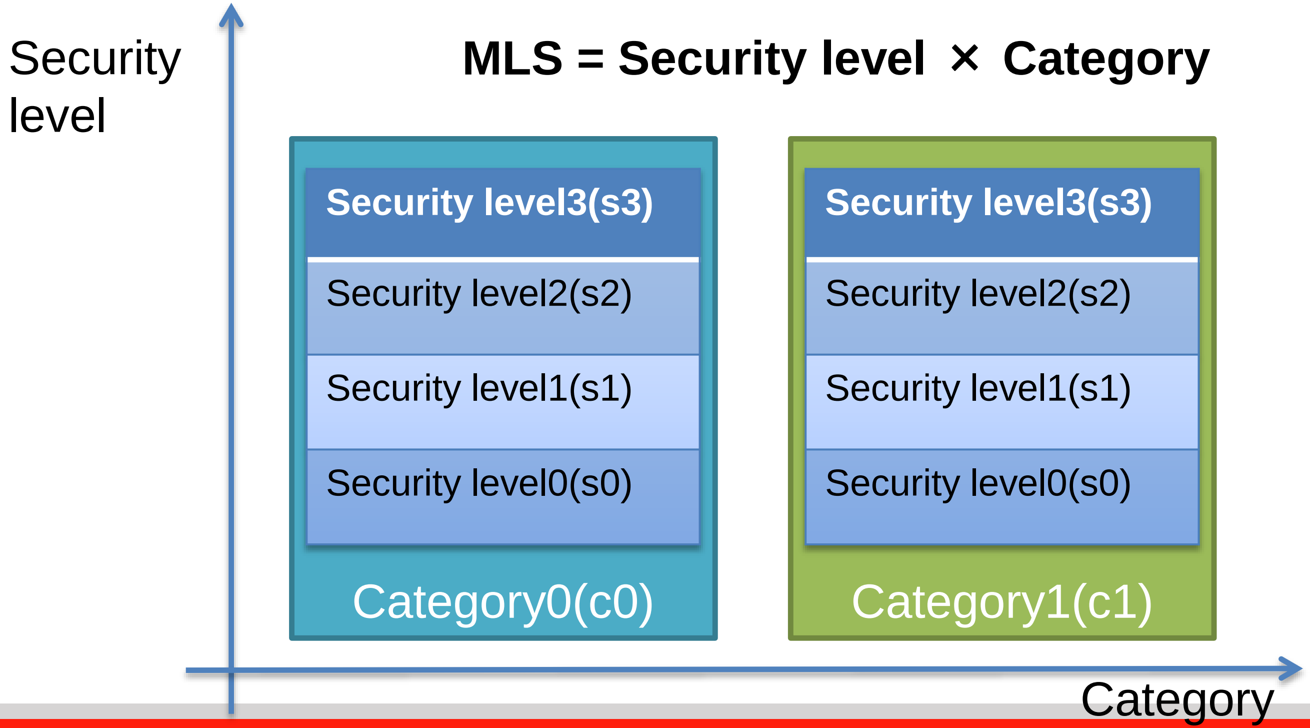
Major Linux users：
・user1
・root

SELinux users：
・user_u
・root
・staff_u
・system_u
・sysadm_u
・unconfined_u

Major roles：
・user_r
・staff_r
・system_r
・sysadm_r
・unconfined_r

# MLS/MCS (Multi-Level/Category Security)

- Multi level security is an access control using security level and category
  - Security level based on a rank of organization(like army)
  - Isolating access from other category



**MLS = Security level × Category**

Security level

Security level3(s3)

Security level2(s2)

Security level1(s1)

Security level0(s0)

Category0(c0)

Security level3(s3)

Security level2(s2)

Security level1(s1)

Security level0(s0)

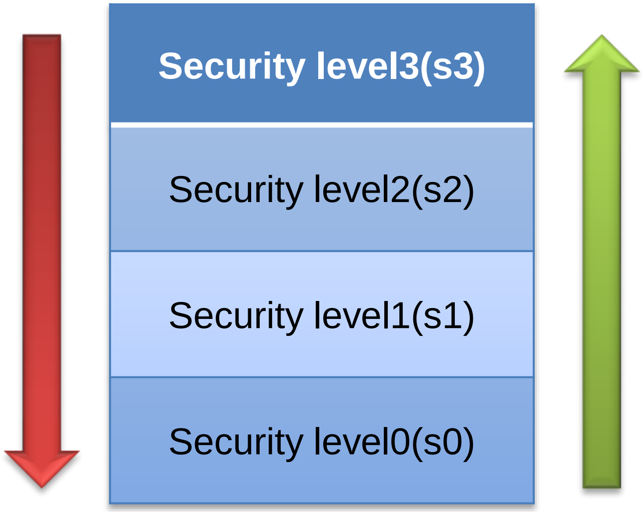
Category1(c1)

Category

# Bell-LaPadula Model

- Mathematical model of Multi level security
  - Main interests is information leakage prevention
- Users cannot read information from upper rank document
  - Users can write report to upper rank document
- User can read information from lower rank document
  - Users cannot write report to lower rank document

Users can read from lower(incl. same) rank document only



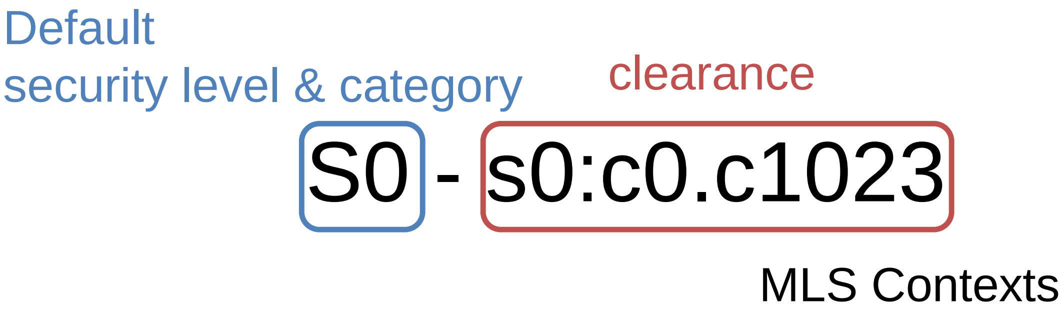
Users can write to upper(incl. same) rank document only

# Access Control using MLS/MCS

- Assigning default security level and category for all resources
  - In addition, users are assigned clearance

- MLS permissions follows in Bell-LaPadula Models

- Different category access requires clearance



Default
security level & category

clearance

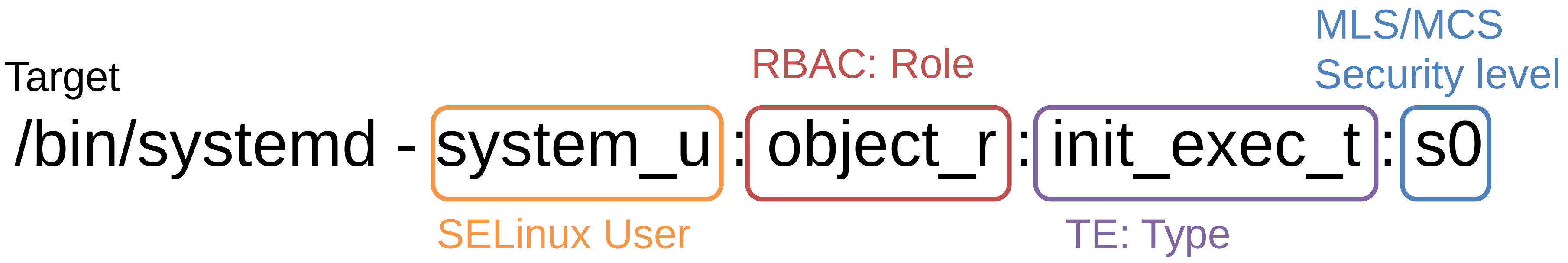
S0 - s0:c0.c1023

MLS Contexts

# File contexts（SELinux Contexts on Files)

- A file context enumerates the mapping between resource and SELinux context

- File contexts are stored xattr(or xattr like file system extension) by labeling scripts
  - SELinux requires labeling before enforcing access control



# SELinux Modes

- SELinux has three modes
  - Enforcing: Enabling SELinux access control
  - Permissive: Policy check only
  - Disabled: SELinux disabled

- Checking SELinux status on your host:
  - Run sestatus command

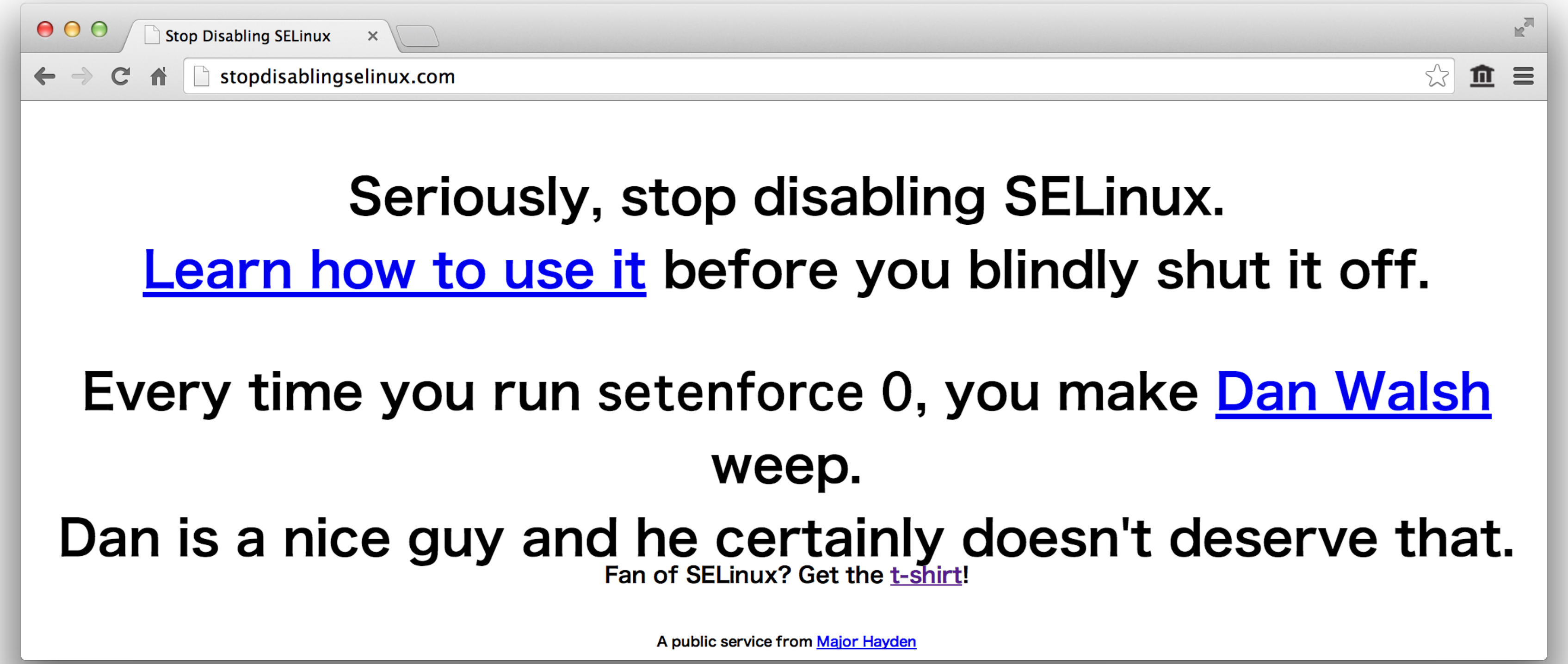
- If you want change the SELinux mode on boot time:
  - Edit SELINUX=enforcing/permissive in /etc/selinux/config

# sestatus

- Show current SELinux configurations

```
# sestatus
SELinux status:                 enabled
SELinuxfs mount:                /sys/fs/selinux
SELinux root directory:         /etc/selinux
Loaded policy name:             targeted
Current mode:                   enforcing
Mode from config file:          enforcing
Policy MLS status:              enabled
Policy deny_unknown status:     allowed
Max kernel policy version:      29
```

# See Also: stopdisablingselinux.com



Seriously, stop disabling SELinux.
Learn how to use it before you blindly shut it off.

Every time you run setenforce 0, you make Dan Walsh weep.
Dan is a nice guy and he certainly doesn't deserve that.

Fan of SELinux? Get the t-shirt!

A public service from Major Hayden

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# SELinux Security Policy

# Current SELinux Security Policies

- Type Enforcement(+RBAC)
  - Strict (deprecated)
  - Targeted
  - Minimum

- Multi Level/Category Security
  - MLS
  - MCS

Default policy is **Targeted + MCS** on Fedora, RHEL and RHEL-based distributions

# Strict policy (deprecated)

*“SELinux designed to be a strict policy.”* – Dan Walsh (2005)

- Restrict all processes completely
  - Using both TE and RBAC policies
- NSA and Red Hat encouraged strongly
  - However, SELinux operation cost is unsuitable for the security
- Everybody thought that SELinux operation using strict policy is impracticable
  - Red Hat integrates a part of strict policy into targeted policy

# Targeted Policy

- Restrict some process
  - Only Internet server(httpd, named···) and network service
  - Preparing against privilege escalation

- Permit to run **unconfined_t** type/domain with no limitation
  - Ex. Login shell execute with unconfined_t domain

- In Fedora20,  Red Hat prepared a lot of predefined policy modules
  - If you want to enforce with strict like policy, remove unconfined_t, unconfined_r
    - Ref. http://danwalsh.livejournal.com/27885.html

# Predefined Policy Modules in Targeted Policy on Fedora20

abrt.pp, accountsd.pp, acct.pp, afs.pp, aiccu.pp, aide.pp, ajaxterm.pp, alsa.pp, amanda.pp, amtu.pp, anaconda.pp, antivirus.pp, apache.pp, apcupsd.pp, apm.pp, application.pp, arpwatch.pp, asterisk.pp, auditadm.pp, authconfig.pp, authlogin.pp, automount.pp, avahi.pp, awstats.pp, bacula.pp, bcfg2.pp, bind.pp, bitlbee.pp, blueman.pp, bluetooth.pp, boinc.pp, bootloader.pp, brctl.pp, bugzilla.pp, bumblebee.pp, cachefilesd.pp, calamaris.pp, callweaver.pp, canna.pp, ccs.pp, cdrecord.pp, certmaster.pp, certmonger.pp, certwatch.pp, cfengine.pp, cgroup.pp, chrome.pp, chronyd.pp, cipe.pp, clock.pp, clogd.pp, cloudform.pp, cmirrord.pp, cobbler.pp, collectd.pp, colord.pp, comsat.pp, condor.pp, conman.pp, consolekit.pp, couchdb.pp, courier.pp, cpucontrol.pp, cpufreqselector.pp, cron.pp, ctdb.pp, cups.pp, cvs.pp, cyphesis.pp, cyrus.pp, daemontools.pp, dbadm.pp, dbskk.pp, dbus.pp, dcc.pp, ddclient.pp, denyhosts.pp, devicekit.pp, dhcp.pp, dictd.pp, dirsrv-admin.pp, dirsrv.pp, dmesg.pp, dmidecode.pp, dnsmasq.pp, dnssec.pp, docker.pp, dovecot.pp, drbd.pp, dspam.pp, entropyd.pp, exim.pp, fail2ban.pp, fcoe.pp, fetchmail.pp, finger.pp, firewalld.pp, firewallgui.pp, firstboot.pp, fprintd.pp, freeipmi.pp, freqset.pp, fstools.pp, ftp.pp, games.pp, gear.pp, getty.pp, git.pp, gitosis.pp, glance.pp, glusterd.pp, gnome.pp, gpg.pp, gpm.pp, gpsd.pp, gssproxy.pp, guest.pp, hddtemp.pp, hostname.pp, hypervkvp.pp, icecast.pp, inetd.pp, init.pp, inn.pp, iodine.pp, ipa.pp, ipsec.pp, iptables.pp, irc.pp, irqbalance.pp, iscsi.pp, isns.pp, jabber.pp, jetty.pp, jockey.pp, kdump.pp, kdumpgui.pp, keepalived.pp, kerberos.pp, keyboardd.pp, keystone.pp, kismet.pp, ksmtuned.pp, ktalk.pp, l2tp.pp, ldap.pp, libraries.pp, likewise.pp, lircd.pp, livecd.pp, lldpad.pp, loadkeys.pp, locallogin.pp, lockdev.pp, logadm.pp, logging.pp, logrotate.pp, logwatch.pp, lpd.pp, lsm.pp, lvm.pp, mailman.pp, mailscanner.pp, man2html.pp, mandb.pp, mcelog.pp, mediawiki.pp, memcached.pp, milter.pp, mip6d.pp, miscfiles.pp, mock.pp, modemmanager.pp, modutils.pp, mojomojo.pp, motion.pp, mount.pp, mozilla.pp, mpd.pp, mplayer.pp, mrtg.pp, mta.pp, munin.pp, mysql.pp, mythtv.pp, nagios.pp, namespace.pp, ncftool.pp, netlabel.pp, netutils.pp, networkmanager.pp, ninfod.pp, nis.pp, nova.pp, nscd.pp, nsd.pp, nslcd.pp, ntop.pp, ntp.pp, numad.pp, nut.pp, nx.pp, obex.pp, oddjob.pp, openct.pp, openhpid.pp, openshift-origin.pp, openshift.pp, opensm.pp, openvpn.pp, openvswitch.pp, openwsman.pp, oracleasm.pp, osad.pp, pads.pp, passenger.pp, pcmcia.pp, pcp.pp, pcscd.pp, pegasus.pp, permissivedomains.pp, pesign.pp, pingd.pp, piranha.pp, pkcsslotd.pp, pki.pp, plymouthd.pp, podsleuth.pp, policykit.pp, polipo.pp, portmap.pp, portreserve.pp, postfix.pp, postgresql.pp, postgrey.pp, ppp.pp, prelink.pp, prelude.pp, privoxy.pp, procmail.pp, prosody.pp, psad.pp, ptchown.pp, publicfile.pp, pulseaudio.pp, puppet.pp, pwauth.pp, qmail.pp, qpid.pp, quantum.pp, quota.pp, rabbitmq.pp, radius.pp, radvd.pp, raid.pp, rasdaemon.pp, rdisc.pp, readahead.pp, realmd.pp, redis.pp, remotelogin.pp, rhcs.pp, rhev.pp, rhgb.pp, rhnsd.pp, rhsmcertd.pp, ricci.pp, rkhunter.pp, rlogin.pp, rngd.pp, roundup.pp, rpc.pp, rpcbind.pp, rpm.pp, rshd.pp, rssh.pp, rsync.pp, rtas.pp, rtkit.pp, rwho.pp, samba.pp, sambagui.pp, sandbox.pp, sandboxX.pp, sanlock.pp, sasl.pp, sblim.pp, screen.pp, secadm.pp, sectoolm.pp, selinuxutil.pp, sendmail.pp, sensord.pp, setrans.pp, setroubleshoot.pp, seunshare.pp, sge.pp, shorewall.pp, slocate.pp, slpd.pp, smartmon.pp, smokeping.pp, smoltclient.pp, smsd.pp, snapper.pp, snmp.pp, snort.pp, sosreport.pp, soundserver.pp, spamassassin.pp, speech-dispatcher.pp, squid.pp, ssh.pp, sssd.pp, staff.pp, stapserver.pp, stunnel.pp, su.pp, sudo.pp, svnserve.pp, swift.pp, sysadm.pp, sysadm_secadm.pp, sysnetwork.pp, sysstat.pp, systemd.pp, tcpd.pp, tcsd.pp, telepathy.pp, telnet.pp, tftp.pp, tgtd.pp, thin.pp, thumb.pp, tmpreaper.pp, tomcat.pp, tor.pp, tuned.pp, tvtime.pp, udev.pp, ulogd.pp, uml.pp, unconfined.pp, unconfineduser.pp, unlabelednet.pp, unprivuser.pp, updfstab.pp, usbmodules.pp, usbmuxd.pp, userdomain.pp, userhelper.pp, usermanage.pp, usernetctl.pp,uucp.pp, uuidd.pp, varnishd.pp, vbetool.pp, vdagent.pp, vhostmd.pp, virt.pp, vlock.pp, vmtools.pp, vmware.pp, vnstatd.pp, vpn.pp, w3c.pp, watchdog.pp, wdmd.pp, webadm.pp, webalizer.pp, wine.pp, wireshark.pp, xen.pp, xguest.pp,xserver.pp, zabbix.pp, zarafa.pp, zebra.pp, zoneminder.pp, zosremote.pp

# Minimum Policy

- New policy type since Fedora10
  - Minimum policy focus to reduce memory and storage usage consumption

- Suitable size for embedded systems, container, cloud components
  - Policy binary file size reduced to 2.0MB(minimum) from 3.5MB(targeted)

# Multi Level Security Policy (MLS)

- MLS policy enforces MLS access control
  - Default security level is s0, category is nothing

- Practically, military use only

- Cannot run on X window system
  - MLS policy is unsuitable for X

```
# ls –laZ
--snip--
lrwxrwxrwx. root root system_u:object_r:bin_t:s0       sbin -> usr/sbin
drwxr-xr-x. root root system_u:object_r:var_t:s0       srv
dr-xr-xr-x. root root system_u:object_r:sysfs_t:s0     sys
drwxrwxrwt. root root system_u:object_r:tmp_t:s0       tmp
drwxr-xr-x. root root system_u:object_r:usr_t:s0       usr
drwxr-xr-x. root root system_u:object_r:var_t:s0       var
```

# Multi Category Security Policy (MCS)

- MLS enables casual resource isolation
  - Red Hat applied MLS to sandbox, container, virtualization

- Enabling since FedoraCore6
  - However, every users have right of access to category0-1023
  - All resources no assigned category

```
# id –Z
context=unconfined_u:unconfined_r:unconfined_t:s0-s0:c0.c1023
```

# To continue enforcing SELinux

- Take care with file context
  - Verify existing SELinux context using semanage
  - sealert command recommends good labeling to you when access violation has occurred

- You cannot change SELinux context, generate policy module using access violation log
  - Using audit2allow command
    - You *MUST* confirm generated policy source

# Quick Reference

- Sestatus
  - Show SELinux status

- Semanage module/user/login/fcontext –l
  - Show SELinux configuration on your system

- sealert -a /var/log/audit/audit.log
  - Recommend good labeling to you when access violation has occurred

# Quick Reference(2)

- Chcon –t hogehoge_t /var/www/hogehoge/index.html
  - Changing SELinux context (temporary)

- Semanage fcontext –a –t hogehoge_t "/var/www/hogehoge(/.*?)"
  - Changing SELinux context (permanently)

- Restorecon –rv /var/www
  - Applying file context rule to directory

# Conclusion

- Each SELinux access control model is simple, but actually access control is more complex

- Red Hat puts a lot of effort into SELinux, policy and utils for SELinux usability
  - Enlarging default policy modules
  - Encouraging Policy module system
  - Analyzing and generating policies from access violation log

# Appendix: SELinux history

- 2003
  - Merged Linux kernel 2.6
- 2004
  - Enabling SELinux default on FC2(targeted)
- 2006
  - Policy reconstruction with reference policy (semanage, policy module)
  - Full labeled networking support
  - setroubleshot developed by Red Hat
  - MCS debut on FC5
- 2007
  - Xguest developed by Dan Walsh
  - SE-PostgreSQL developed by Kohei Kaigai
  - Strict policy sunked on Fedora 8 (merged targeted policy)
- 2009
  - sVirt presented by Red Hat
  - SELinux Sandbox developed by Dan Walsh
- 2012
  - SE-Android developed by NSA
- 2014
  - Enforcing SELinux on Android 4.4

# References

- “The Flask Security Architecture: System Support for Diverse Security Policies”
  http://www.nsa.gov/research/_files/publications/flask.pdf
- “SELinux Targeted vs Strict policy History and Strategy”
  http://selinuxsymposium.org/2005/presentations/session4/4-1-walsh.pdf
- SELinux/Tutorials/How is the policy provided and loaded
  http://wiki.gentoo.org/wiki/SELinux/Tutorials/How_is_the_policy_provided_and_loaded
- NB PolicyType
  http://selinuxproject.org/page/NB_PolicyType#Policy_Versions_Monolithic
- Getting Started with Reference Policy
  http://oss.tresys.com/projects/refpolicy/wiki/GettingStarted
- Using SELinux on RHEL 6
  http://www.redhat.com/summit/2012/pdf/2012-DevDay-Lab-SELinux-Hacker.pdf
- Introducing the SELinux Sandbox
  http://danwalsh.livejournal.com/28545.html
- Fedora19 Security Guide - Fedora Documentation
  http://docs.fedoraproject.org/en-US/Fedora/19/html/Security_Guide/ch09.html
- MCS (Multi Category Security), New feature of Fedora Core 5
  http://www.secureos.jp/index.php?plugin=attach&refer=events&openfile=20060531_lwe2006_KaiGai.pdf

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