Red Hat
Enterprise Linux

Using SELinux with container runtimes

Because privileged containers are scary

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Who am I ?

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- RHEL & Fedora Contributor (selinux-policy, xguest, udica, netlabel_tools)
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Why?

New cluster:

- SELinux enforcing by default

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Privileged containers are scary

What are privileged containers anyway?

Why is SELinux important at all?

Quick SELinux introduction

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TECHNOLOGY FOR **PROCESS ISOLATION** TO MITIGATE ATTACKS VIA PRIVILEGE ESCALATION

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CONTAINER_T CONTAINER_FILE_T

ARE **LABELS**

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ASSIGNED TO PROCESSES

ASSIGNED TO PROCESSES

ASSIGNED TO SYSTEM RESOURCES

ASSIGNED TO PROCESSES

ASSIGNED TO SYSTEM RESOURCES

BY SELINUX SECURITY POLICY

LABELS IN REALITY

STORED IN EXTENDED ATTRIBUTES OF FILE SYSTEMS - EXT2,EXT3, EXT4 ...

 # getfattr -n security.selinux /etc/passwd
getfattr: Removing leading '/' from absolute path names
file: etc/passwd
security.selinux="**system_u:object_r:passwd_file_t:s0**"

 # ls -Z /etc/passwd
system_u:object_r:passwd_file_t:s0 /etc/passwd

```
$ ps -eZ | grep container_t
system_u:system_r:container_t:s0:c435,c872 17864 pts/0 00:00:00
bash
system_u:system_r:container_t:s0:c236,c541 17865 pts/0 00:00:00
bash
system_u:system_r:container_t:s0:c123,c456 17866 pts/0 00:00:00
bash
```

SELINUX POLICY DESCRIBES AN **INTERACTION** BETWEEN PROCESSES AND SYSTEM RESOURCES

```
allow container_t container_file_t:file {getattr open read};
```

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BY DEFAULT **EVERYTHING** IS DENIED AND YOU DEFINE POLICY RULES TO ALLOW CERTAIN REQUESTS.

Generic container SELinux policy

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Protects the host system from container processes

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process type - **container_t**

file type -**container_file_t**

Every Container Runtime CVE container breakout was a file system breakout.

CVE-2019-5736 Execution of malicious containers allows for container escape and access to host filesystem

SELinux Blocked

CVE-2015-3627 Insecure opening of file-descriptor 1 leading to privilege escalation

SELinux Blocked

CVE-2015-3630 Read/write proc paths allow host modification & information disclosure

SELinux Blocked

CVE-2015-3631 Volume mounts allow LSM profile escalation

SELinux Blocked

CVE-2016-9962 RunC Exec Vulnerability

SELinux Blocked

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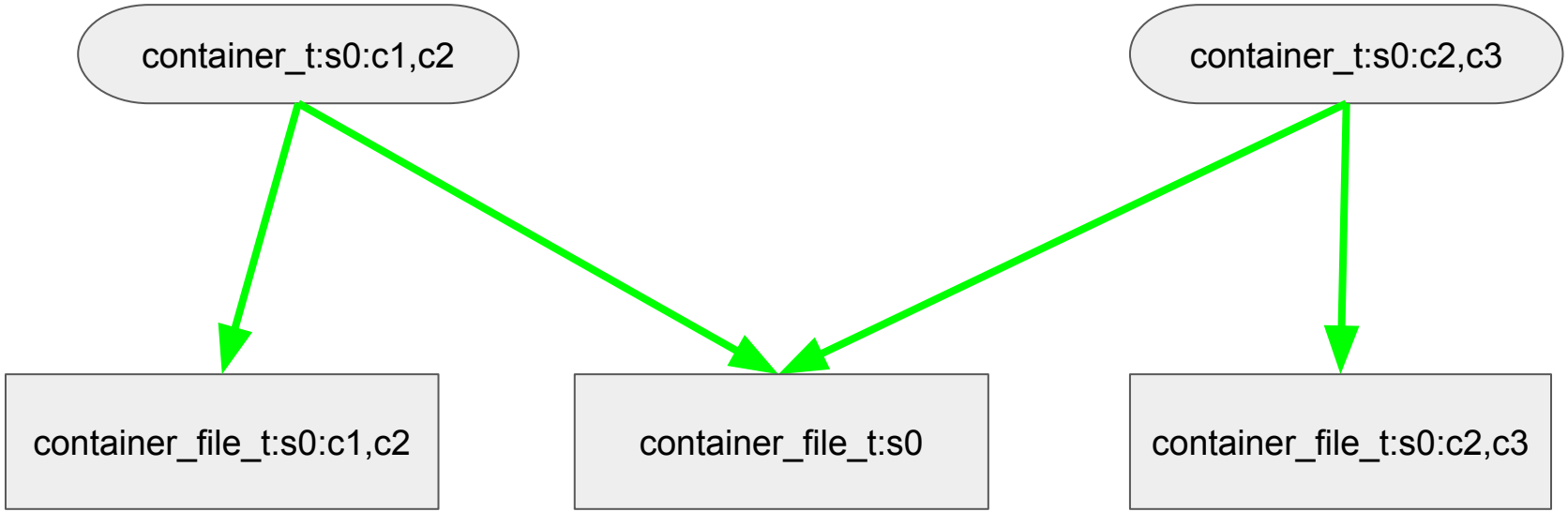
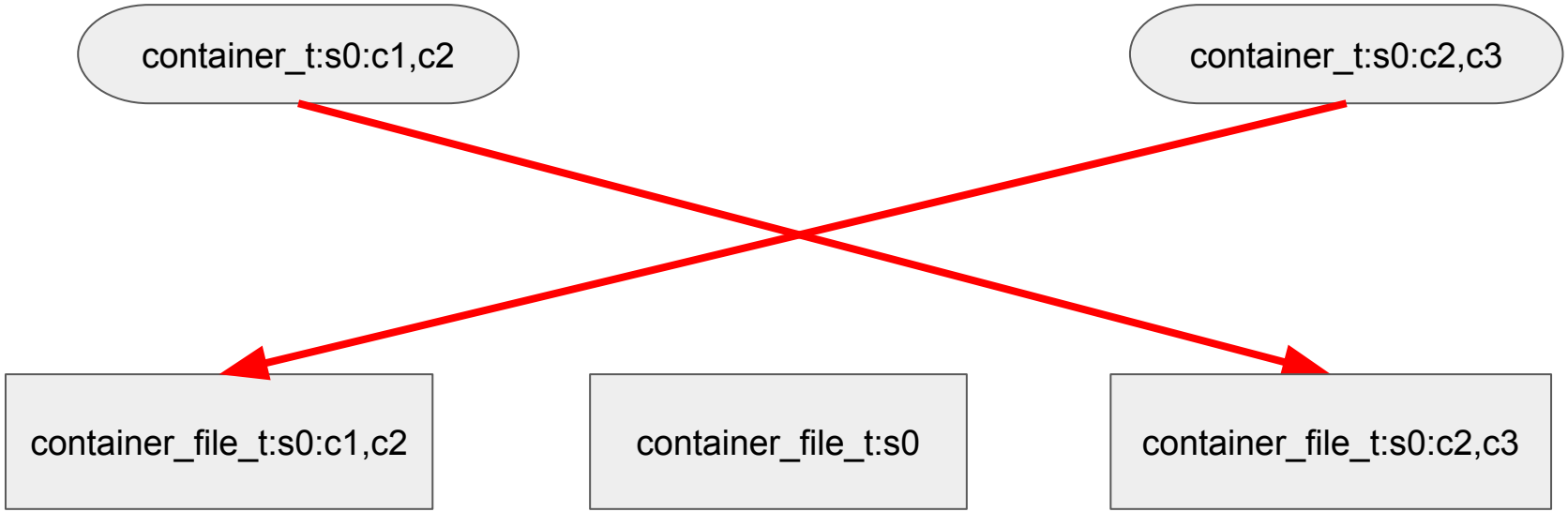
SELinux has contained them ALL.

What about containers attacking each other?

Multi Category Security Based on MLS (Multi Level Security)


container_t:s0:c1,c2
container_t:s0:c2,c3
container_file_t:s0:c1,c2
container_file_t:s0
container_file_t:s0:c2,c3


container_t:s0:c1,c2
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- container_t:s0:c1,c2
  - container_file_t:s0:c1,c2
  - container_file_t:s0
- container_t:s0:c2,c3
  - container_file_t:s0:c2,c3
  - container_file_t:s0

- container_t:s0:c1,c2
  - container_file_t:s0:c1,c2
  - container_file_t:s0
- container_t:s0:c2,c3
  - container_file_t:s0:c2,c3
  - container_file_t:s0

Relabeling in container engines:

podman run -d -v /var/lib/mydb:/var/lib/mariadb:Z rhel7-mariadb

- container_t:s0:c1,c2
  - container_file_t:s0:c1,c2
  - container_file_t:s0
- container_t:s0:c2,c3
  - container_file_t:s0:c2,c3
  - container_file_t:s0

Relabeling in container engines:

podman run -d -v /var/lib/mydb:/var/lib/mariadb:Z rhel7-mariadb

podman run -ti -v /home/lvrabec/shared:/home/lvrabec/shared:z fedora /bin/sh

podman run -ti -v /home/lvrabec/shared:/home/lvrabec/shared:z fedora /bin/sh

Problems with SELinux Container Confinement

Default Container Type (container_t) too strict for certain use cases, e.g:

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Default Container Type (container_t) too strict for certain use cases, e.g:

- Fedora SilverBlue project needs containers to read/write home directory
- Fluentd project needs containers to be able to read logs in /var/log directory

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- No SELinux Network Controls
  - All container processes can bind to any network port

Default Container Type (container_t) too loose for certain use cases, e.g:

- No SELinux Network Controls
  - All container processes can bind to any network port
- No SELinux control on Linux Capabilities
  - All container processes can use all linux capabilities

Current Situation

podman run -d -v /var/log:/var/log:Z fluentd

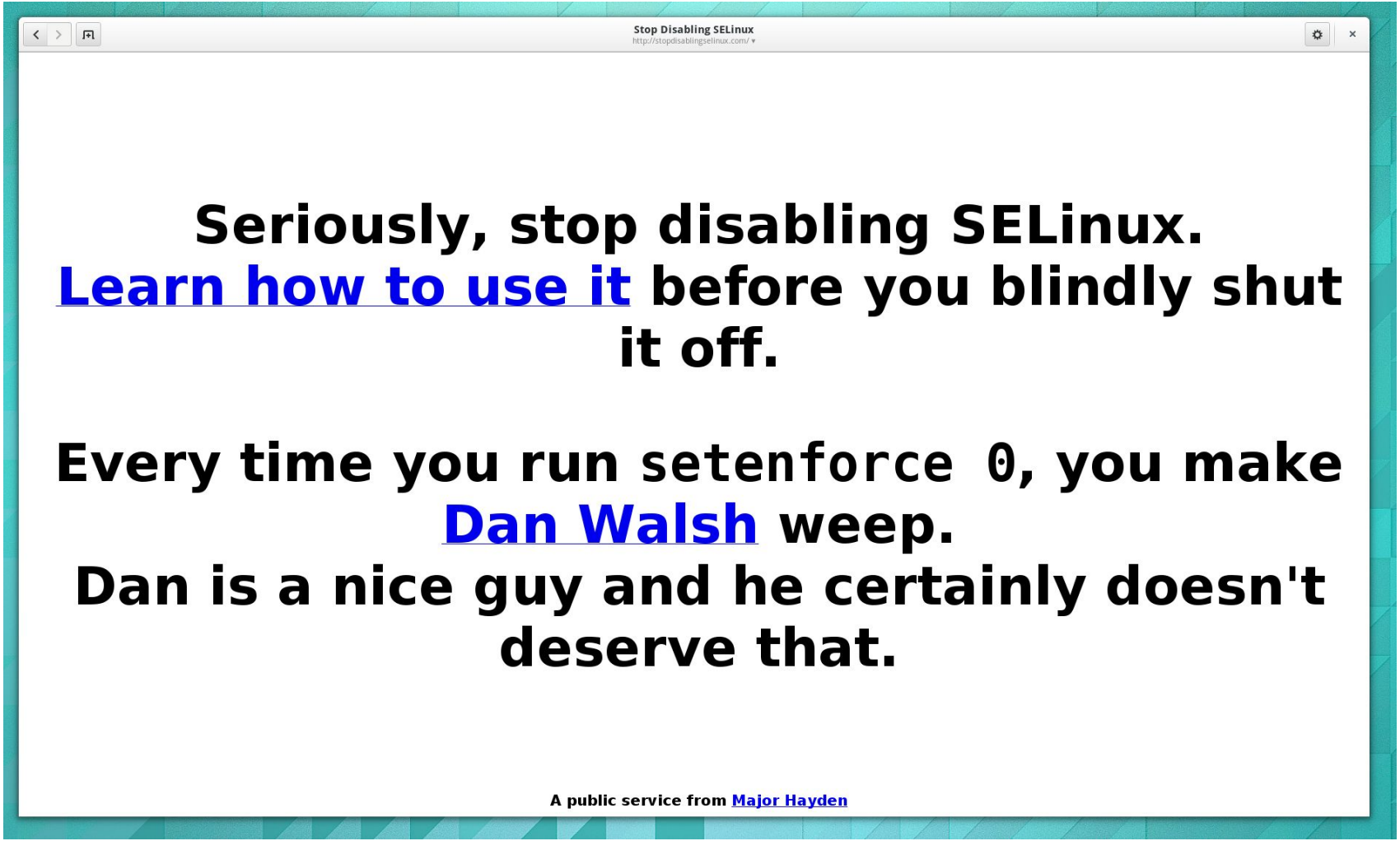
- BAD: Tells podman to set labels on /var/log directory to be container specific.
- Other confined tools will no longer be able to write their logs

podman run -d -v /var/log:/var/log:Z fluentd

- BAD: Tells podman to set labels on /var/log directory to be container specific.
- Other confined tools will no longer be able to write their logs

podman run -ti -v /home:/home --security-opt label:disabled fedora sh

- Turn off SELinux container separation for these use cases


Stop Disabling SELinux
http://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.
A public service from Major Hayden

- Solutions
  - Write completely new SELinux policy for custom container
    - Best solution
    - Too difficult for system administrators
      - SELinux expertise required

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  - Write completely new SELinux policy for custom container
    - Best solution
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  - Add additional rules for container_t type
    - Not ideal still difficult for system administrators
    - Rules apply to all containers, not just specific container.

Solution: Udica Project

Udica ~ Fishing rod

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Udica is a tool for generating SELinux security profiles for containers.

- Example container
  - Mounting /home as read/write
  - Mounting /var/spool as read only
  - Exposing port tcp/21

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  - Mounting /home as read/write
  - Mounting /var/spool as read only
  - Exposing port tcp/21

- Generic SELinux domain for container
  - Cannot read/write /home
  - Cannot read /var/spool
  - Exposes all ports

Let's generate SELinux policy for example container!

Live Demo!

https://github.com/containers/Demos/tree/master/security/SELinuxUdica

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Using udica to solve these issues

```
# podman run -v /home:/home:ro -v /var/spool:/var/spool:rw -p 21:21 -it fedora bash

#  podman inspect -l | udica  my_container

# semodule -i my_container.cil /usr/share/udica/templates/{base_container.cil,net_container.cil,home_container.cil}

# podman run --security-opt label=type:my_container.process -v /home:/home:ro -v /var/spool:/var/spool:rw -p 21:21 -it fedora bash
```

Using udica to solve these issues

```
# ps -efZ | grep my_container.process

unconfined_u:system_r:container_runtime_t:s0-s0:c0.c1023 root 8837 5865  0 14:29 pts/0 00:00:00 podman run
--security-opt label=type:my_container.process -v /home:/home:ro -v /var/spool:/var/spool:rw -p 21:21 -it fedora bash

system_u:system_r:my_container.process:s0:c116,c171 root 8920 8909  0 14:29 pts/0 00:00:00 bash
```

Udica under the hood

- Concept based on "block inheritance" SELinux CIL language

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- Udica creates policy combining rules from specified CIL blocks(templates)
  - Inspecting container JSON file
    - Mounts
    - Ports
    - Capabilities

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- Udica creates policy combining rules from specified CIL blocks(templates)
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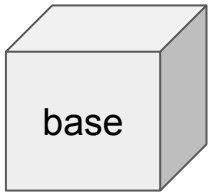
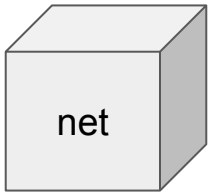
    - Mounts
    - Ports
    - Capabilities
  - Combines with default container template file
    - /usr/share/udica/templates/base_container.cil

Allows read/exec /usr & read /etc



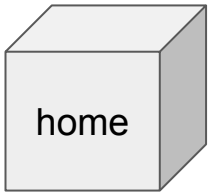
Required for every container

Allows network access

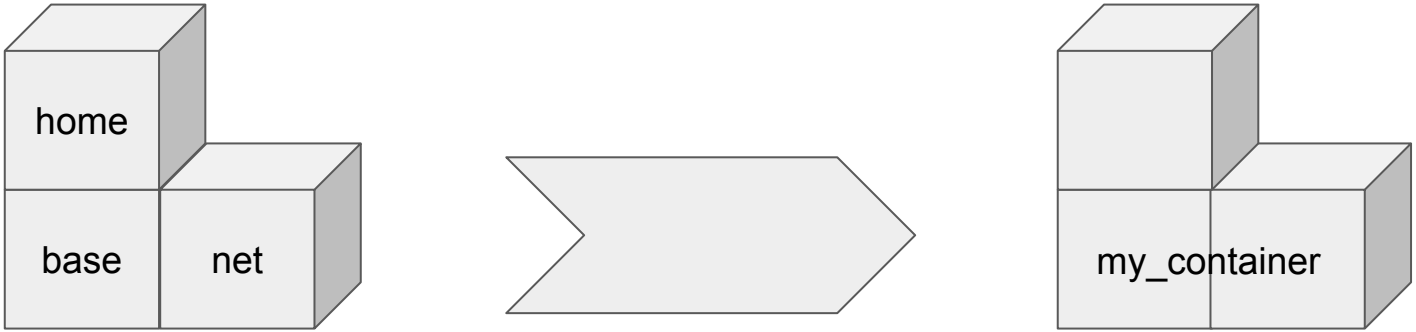


+ Allowing bind on ftp_port_t (21)

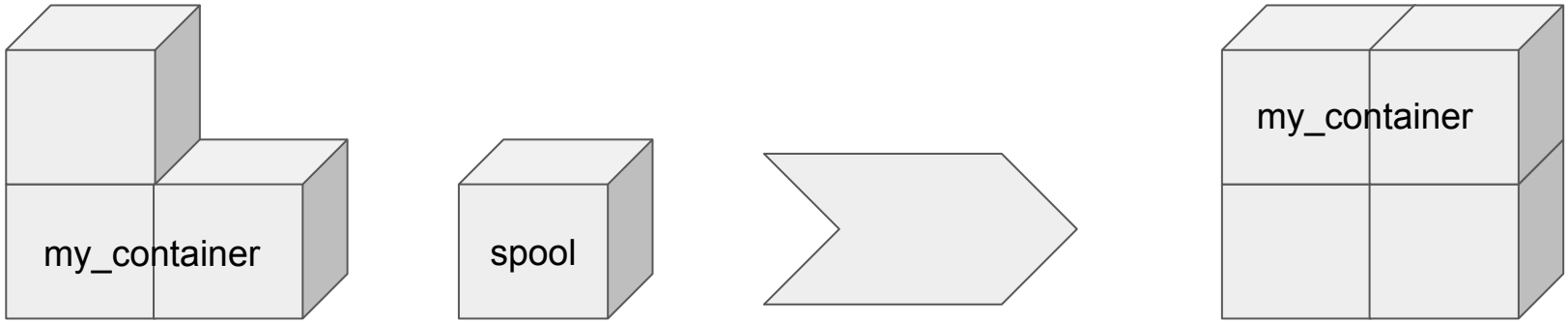
Allows access homedirs



+ Add only read/write perms



- No block for /var/spool
- Udica will detect all labels what could be inside /var/spool and create allow rules in my_container policy.



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Using the new type with container runtimes

```
# podman run --security-opt label=type:my_container.process -v
/home:/home:rw -v /var/spool:/var/spool:ro -p 21:21 -it fedora bash
# docker run --security-opt label=type:my_container.process -v
/home:/home:rw -v /var/spool:/var/spool:ro -p 21:21 -it fedora bash
# buildah bud --security-opt label=type:my_container.process -f
Dockerfile .
```

```
apiVersion: v1
kind: Pod
metadata:
  name: udica-demo
spec:
  containers:
  - name: udica
    image: gcr.io/google-samples/node-hello:1.0
    securityContext:
    seLinuxOptions:
          type: "my_container.process"
```

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QUESTIONS?

Demo	https://github.com/demos/SELinuxEscape
Udica	https://github.com/containers/udica
Podman	https://podman.io
Generic SELinux policy	https://github.com/containers/container-selinux
Udica PoC	https://github.com/fedora-selinux/container-selinux-customization

Thank you

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