Docker Security Workshop

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dockercon 16

Goals of this workshop

Features

- See what features are available in Docker
- What do they do?
- How do you use them?

Understanding

- Look at some tools
- See underlying implementation details
- Learn best practices

Do!

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Don’t!

CAUTION!

Docker is additive to the security of your application ...

… even if you don’t use any of the techniques we cover

Docker aims to be Secure by Default

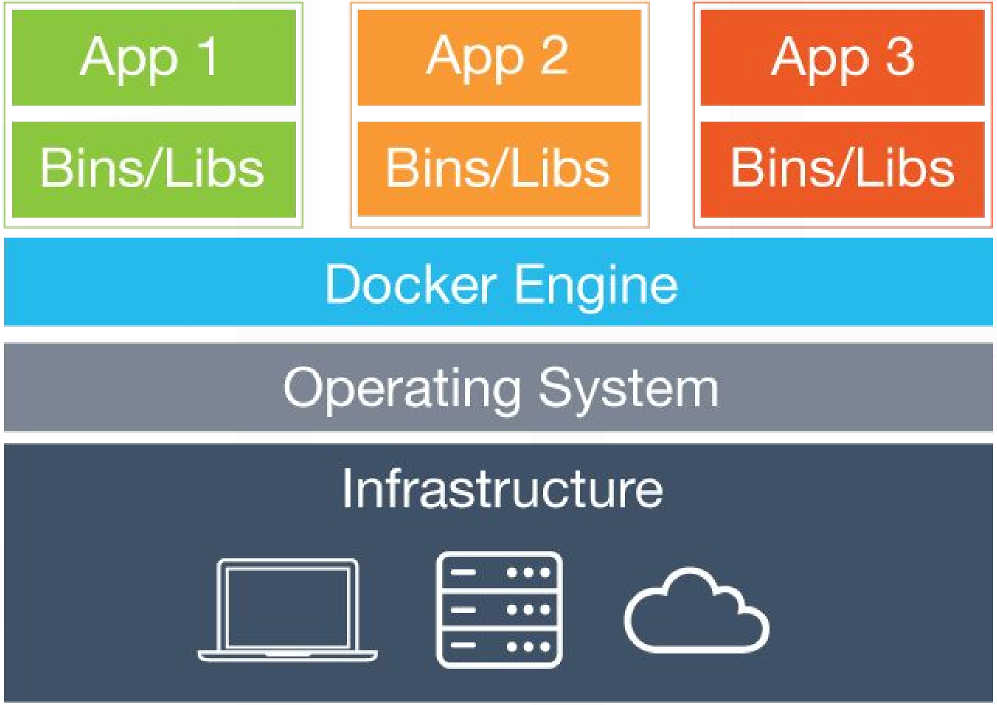
https://docs.docker.com/engine/security/non-events/

CVE-2013-1956, 1957, 1958, 1959, 1979, CVE-2014-4014, 5206, 5207, 7970, 7975, CVE-2015-2925, 8543, CVE-2016-3134, 3135, CVE-2014-0181, CVE-2015-3339, CVE-2014-4699, CVE-2014-9529, CVE-2015-3214, 4036, CVE-2016-0728, CVE-2016-2383

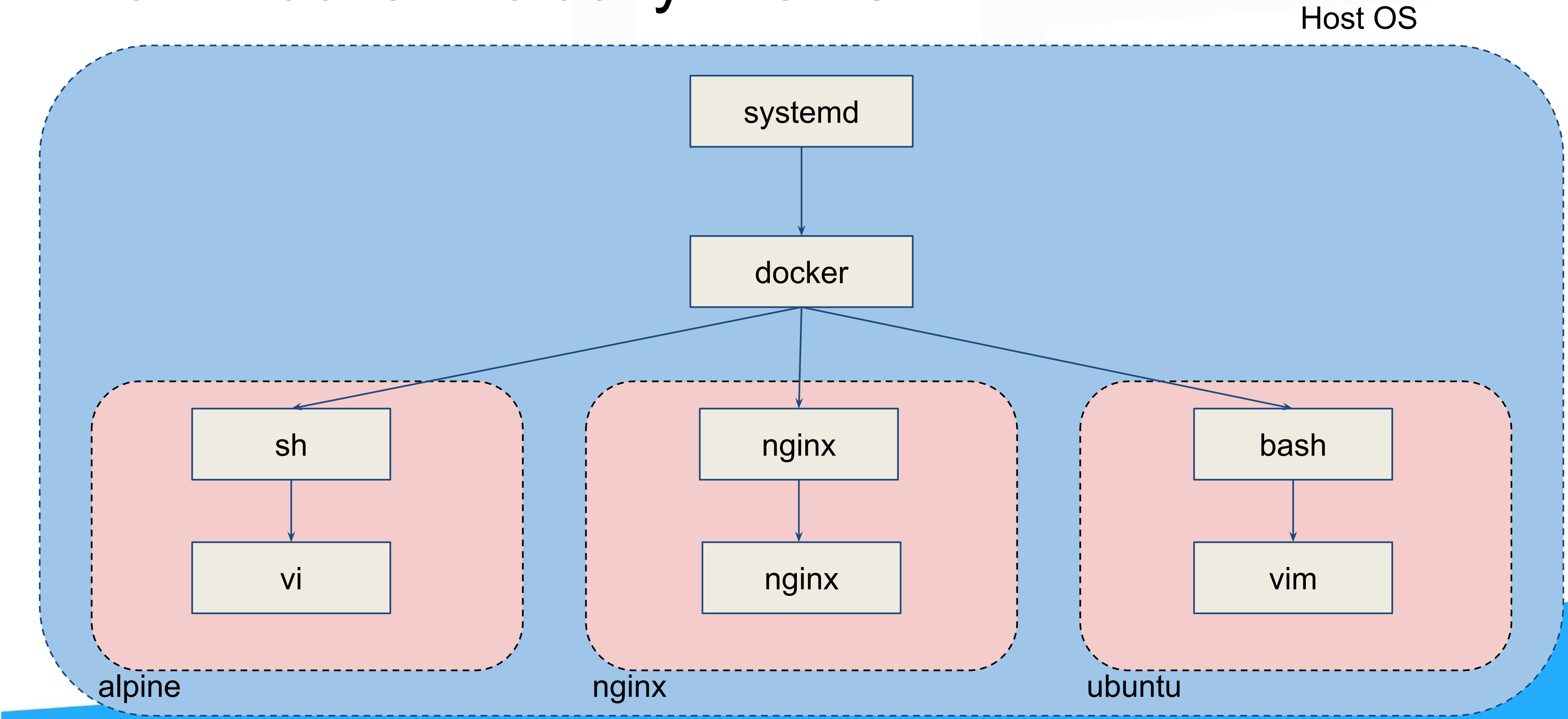
Why?

How do we think about containers?

How we talk about Docker



How Docker Actually Works



Where can we see this?

```
top
```

Anatomy of a Container

Namespaces: “what containers can see”

```
ls -la /proc/<pid>/ns/
```

What’s namespaced?

Cgroup	CLONE_NEWCGROUP	Cgroup root directory
IPC	CLONE_NEWIPC	System V IPC, POSIX message queues
Network	CLONE_NEWNET	Network devices, stacks, ports, etc.
Mount	CLONE_NEWNS	Mount points
PID	CLONE_NEWPID	Process IDs
User	CLONE_NEWUSER	User and group IDs
UTS	CLONE_NEWUTS	Hostname and NIS domain name

Demo using namespaces directly

Create a shell process with pid and fs namespaces.

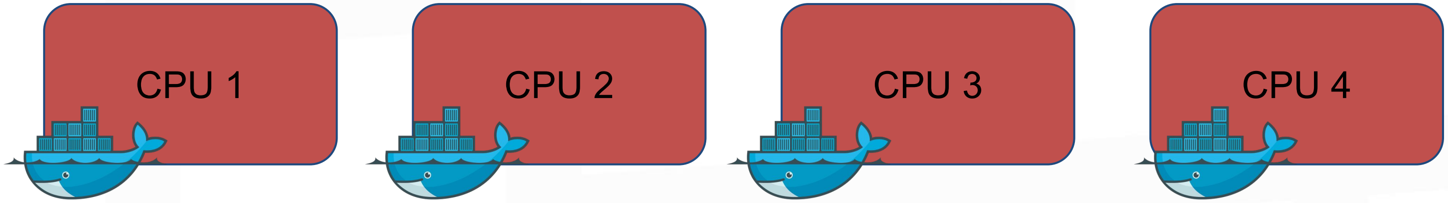
```
$ sudo unshare -fp

$ sudo unshare -fp --mount-proc
```

cgroups: “what containers can use”

Aka “Control Groups” - limit container resources!

- CPU
- Memory
- PIDs

cgroups: “what containers can use”



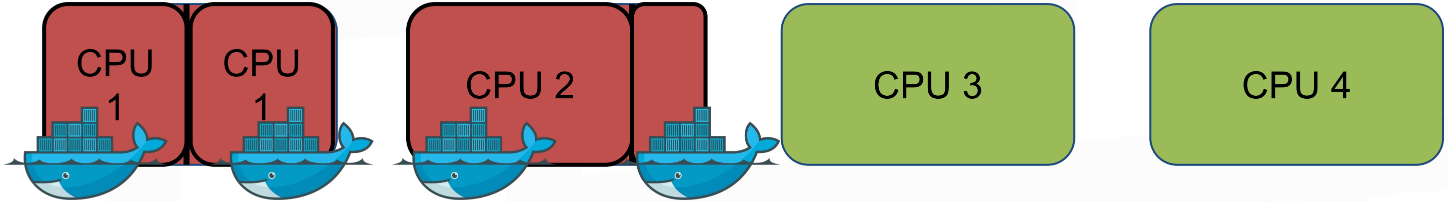
CPU 1

CPU 2

CPU 3

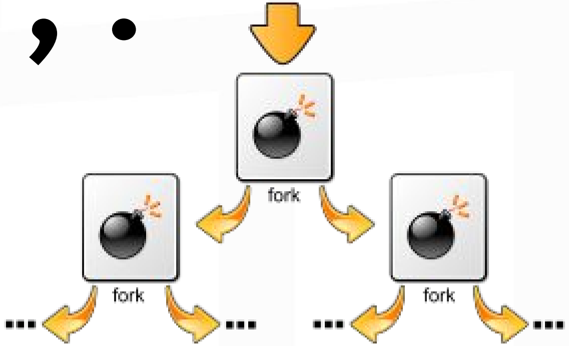
CPU 4

cgroups: “what containers can use”



cgroups: “what containers can use”

```
:(){ :|: & };:
```



Hands-On Exercise

Set up your AWS instance - check your email!

```
chmod 400 <PATH_TO_FILE>/<name>.pem
ssh -i <PATH_TO_FILE>/<name>.pem ubuntu@<Public DNS>
```

Example: `ssh -i riyaz.pem ubuntu@ec2-54-149...compute.amazonaws.com`

```
git clone https://github.com/riyazdf/dockercon-workshop.git
```

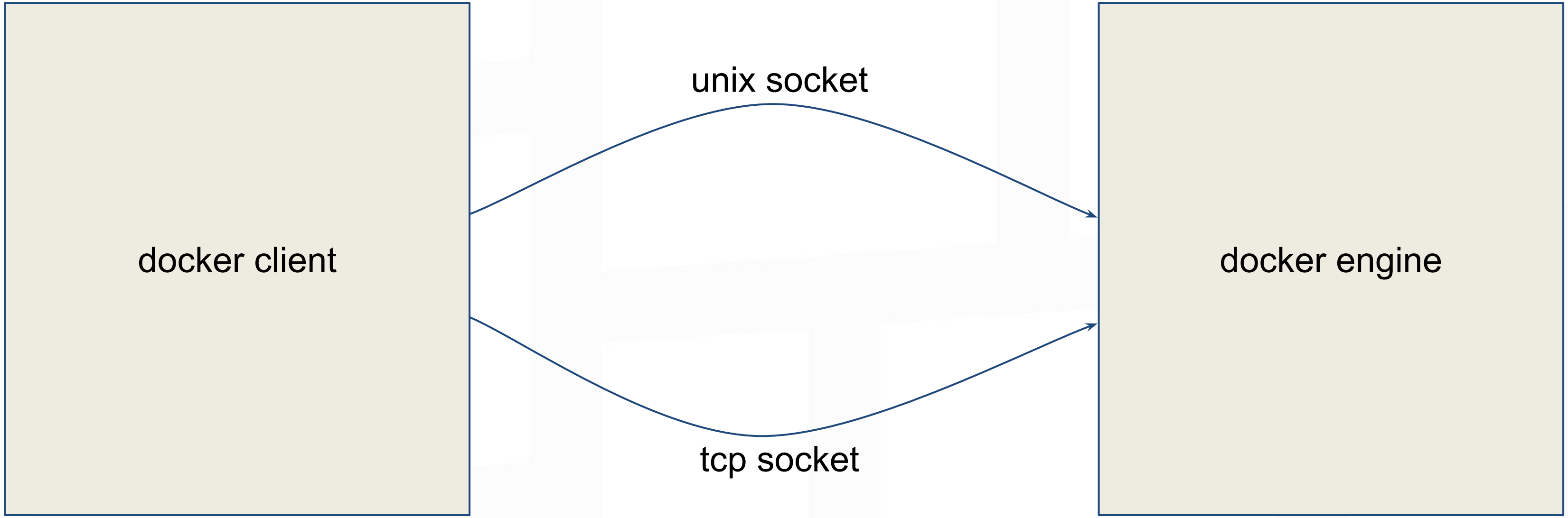
- `cgroups` directory

NOTE: Ubuntu 15.10 does not support PID limits, but 16.04 does if you have it
So *DO NOT* run the fork bomb unless you have another machine.

Securing Client-Engine Communications

“My first 5 minutes…”

Docker Client Server Architecture



Exposing your engine to the internet

Edit config at `/lib/systemd/system/docker.service`

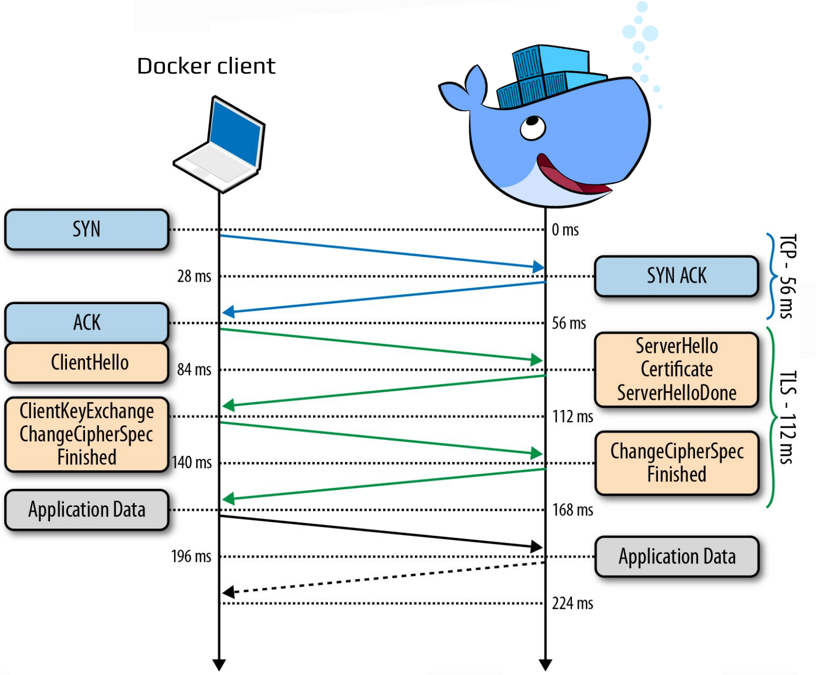
```
- ExecStart=/usr/bin/docker daemon -H fd://
+ ExecStart=/usr/bin/docker daemon -H fd:// -H tcp://0.0.0.0:2376
```

Restart Docker

```
$ sudo systemctl daemon-reload
$ sudo systemctl restart docker
```

One Way TLS

- Same way we trust websites:
  - Server cert and key on engine
  - CA cert on client
  - client authenticates Docker engine



Creating a CA

```
# use a strong passphrase!

$ openssl genrsa -aes256 -out ca-key.pem 4096

$ openssl req -new -x509 -days 365 -key ca-key.pem -sha256 -out ca.pem
```

Creating the daemon cert and key

```
$ openssl genrsa -out server-key.pem 4096

$ openssl req -subj ”/CN=$HOSTNAME” -sha256 -new -key server-key.pem \
    -out server.csr

$ echo subjectAltName = IP:10.10.10.20,IP:127.0.0.1 > extfile.cnf

$ openssl x509 -req -days 365 -sha256 -in server.csr -CA ca.pem \
    -CAkey ca-key.pem -CAcreateserial -out server-cert.pem \
    -extfile extfile.cnf
```

Starting the daemon with the cert and key

```
$> tree /etc/docker
     ├── key.json
     ├── server.pem
     ├── server-key.pem

$> /usr/bin/docker daemon \
     -H tcp://0.0.0.0:2376 -H unix:///var/run/docker.sock \ --storage-driver aufs \
     --tlsverify \
     --tlscert /etc/docker/server.pem \
     --tlskey /etc/docker/server-key.pem
```

Trusting the daemon’s cert on the client

```
$> tree ~/.docker
     ├── config.json
     ├── ca.pem
```

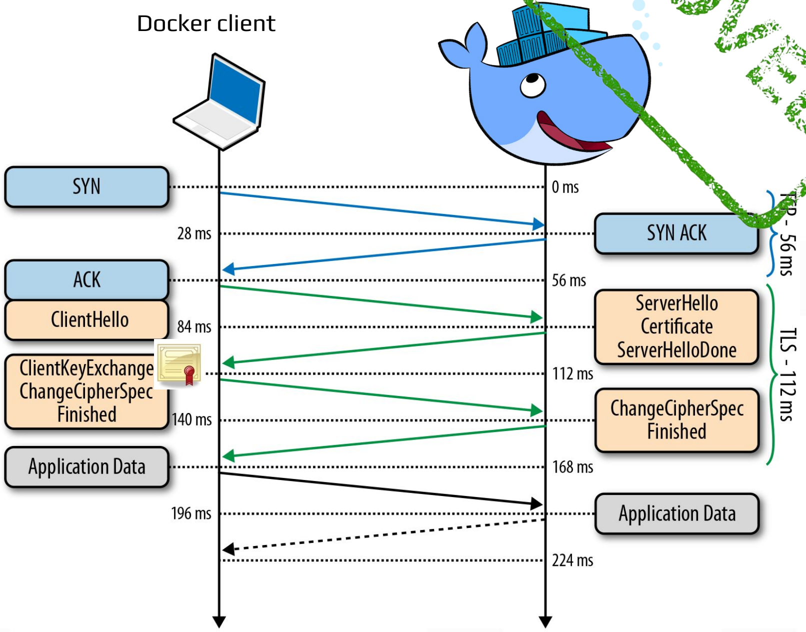
```
$> export DOCKER_CERT_PATH=~/my_cert_directory
$> tree ~/my_cert_directory
     ├── ca.pem
```

Secure by default: `docker-machine`

`docker-machine` does this automatically to set up TLS for you by default!

Best practice: Mutual TLS

- Client also presents certificate
  - Sends after verifying server cert
  - Mutual authentication
- Client CA on daemon (engine)



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Creating client cert and key

```
$ openssl genrsa -out key.pem 4096

$ echo extendedKeyUsage = clientAuth > extfile.cnf

$ openssl x509 -req -days 365 -sha256 -in client.csr -CA ca.pem \
    -CAkey ca-key.pem -CAcreateserial -out cert.pem -extfile extfile.cnf
```

NOTE: this `ca.pem` can (and should) be a different CA

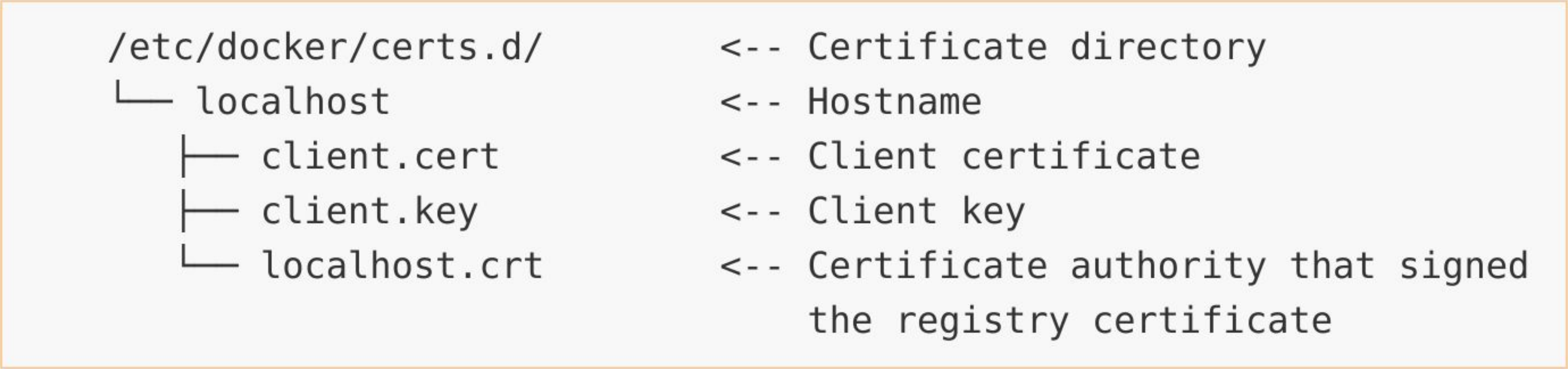
Trusting the client cert on the daemon

```
$> tree /etc/docker
     ├── key.json
     ├── server.pem
     ├── server-key.pem
     ├── ca.pem

$> /usr/bin/docker daemon \
     -H tcp://0.0.0.0:2376 -H unix:///var/run/docker.sock \ --storage-driver aufs \
     --tlsverify \
     --tlscert /etc/docker/server.pem \
     --tlskey /etc/docker/server-key.pem
     --tlscacert /etc/docker/ca.pem
```

Using the client certs on the client

```
$> tree ~/.docker
     ├── config.json
     ├── ca.pem
     ├── cert.pem
     ├── key.pem

$> export DOCKER_CERT_PATH=~/my_cert_directory
$> tree ~/my_cert_directory
     ├── ca.pem
     ├── cert.pem
     ├── key.pem
```

Securing Engine-Registry Communications



```
/etc/docker/certs.d/        <-- Certificate directory
└── localhost               <-- Hostname
   ├── client.cert          <-- Client certificate
   ├── client.key           <-- Client key
   └── localhost.crt        <-- Certificate authority that signed
                                the registry certificate
```

What’s in an image:
The Layered Filesystem

What is a layered filesystem?

Combine multiple directories to look like a single filesystem

- Tombstoning/whiteout files to delete files from lower layers

Supported Implementations

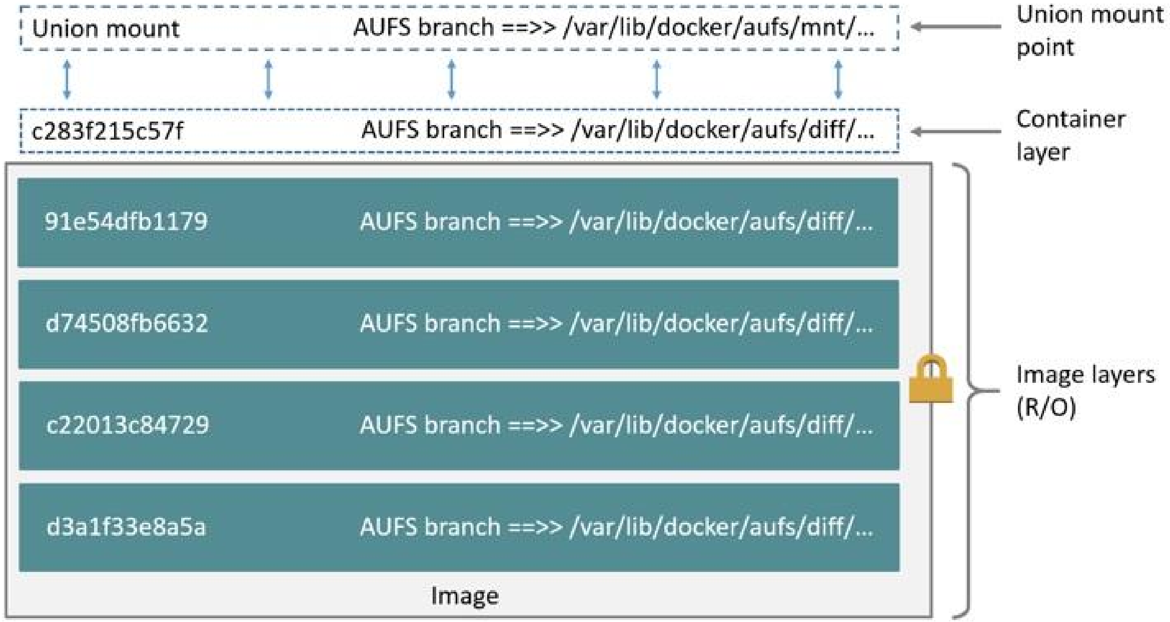
Aufs

Btrfs

OverlayFS

Devicemapper

...



Union mount AUFS branch ==>> /var/lib/docker/aufs/mnt/... ← Union mount point

c283f215c57f AUFS branch ==>> /var/lib/docker/aufs/diff/... ← Container layer

91e54dfb1179 AUFS branch ==>> /var/lib/docker/aufs/diff/...

d74508fb6632 AUFS branch ==>> /var/lib/docker/aufs/diff/...

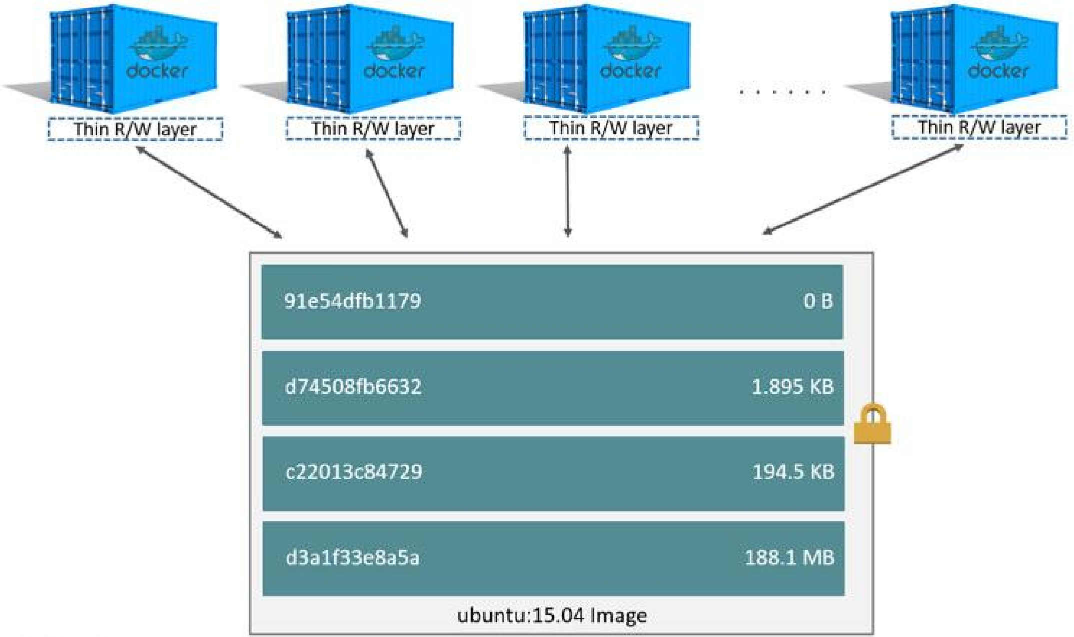
c22013c84729 AUFS branch ==>> /var/lib/docker/aufs/diff/...

d3a1f33e8a5a AUFS branch ==>> /var/lib/docker/aufs/diff/...

Image

Image layers (R/O)

Copy-on-write



91e54dfb1179 0 B

d74508fb6632 1.895 KB

c22013c84729 194.5 KB

d3a1f33e8a5a 188.1 MB

ubuntu:15.04 Image

Best practice: “minimal” base images

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`alpine`

- ~ 2 MB from hub (1 layer!)
- musl libc and busybox

`ubuntu`

- ~ 50 MB from hub

Best practice: verify content

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```
RUN apt-key adv \
      --keyserver hkp://keyserver.ubuntu.com:80 \
      --recv-keys BBEBDCB318AD50EC6865090613B00F1FD2C19886 \
    && echo deb http://repository.spotify.com stable non-free \
    | sudo tee /etc/apt/sources.list.d/spotify.list
```

Best practice: read only containers

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```
$ docker run it --rm --read-only alpine sh
```

Mounts the container’s FS as read-only

Best practice: read-only Volumes

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```
-v /data:/data:ro
```

Common mistake:
mount host location as writable

CAUTION!

```
$ docker run it --rm -v /:/host alpine sh
```

Best practice: minimal, read-only mounts

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```
$ docker run it --rm -v /subdir/we/need:/dir:ro alpine sh
```

Networks

Isolate services

Control which services can talk to which other services

- Easier to audit

Links (legacy)

Allow 2 specific containers to talk to each other.

- Brittle: does not survive container restarts

```
docker run -d --name db mysql:latest
docker run -d --link db wordpress
```

Network Namespace

```
docker network create my_app
docker run -it --rm --net=my_app alpine sh
```

Links are dynamic, can be created to not yet created containers.

Best practice: Use Multiple Networks

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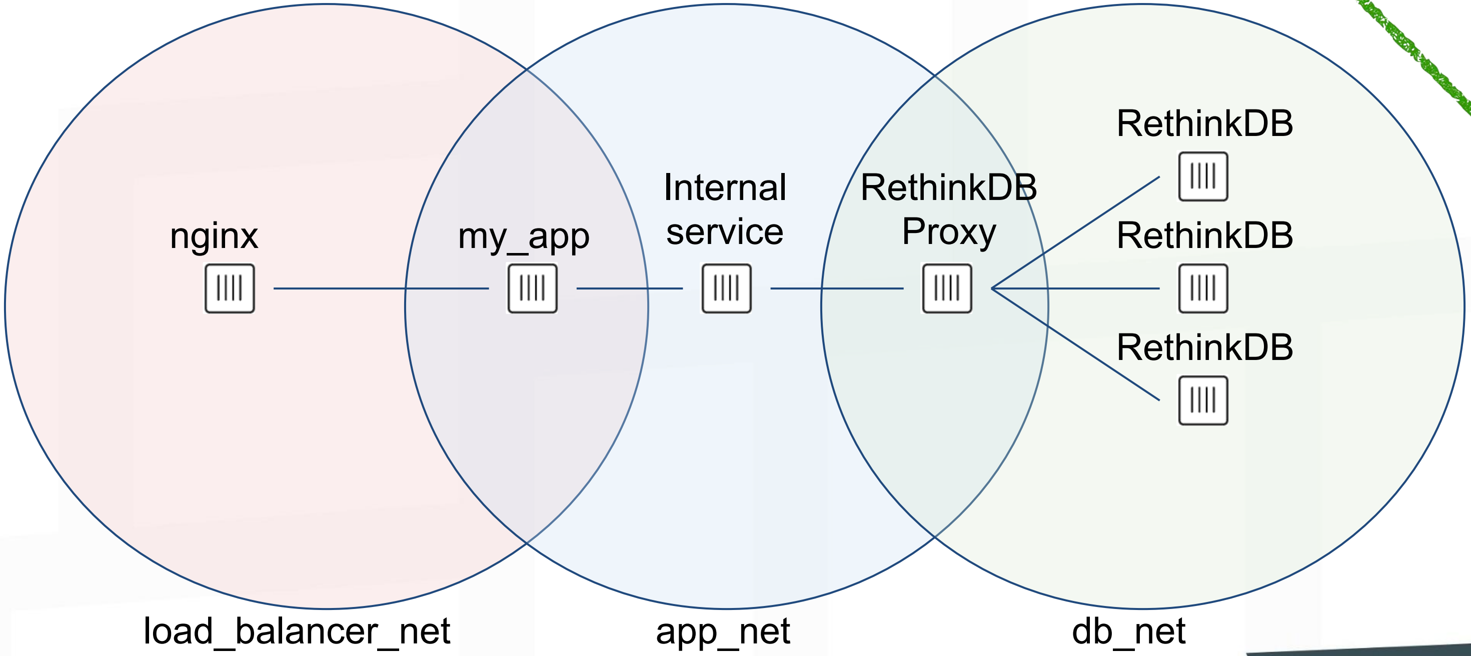

Common Mistake: `--net=host`

CAUTION!

Container can see ***ALL*** network traffic, including traffic on docker virtual networks

Common Mistake: ports exposed on host

CAUTION!

- Unnecessary
- Creates conflicts

Best practice: Mutual TLS

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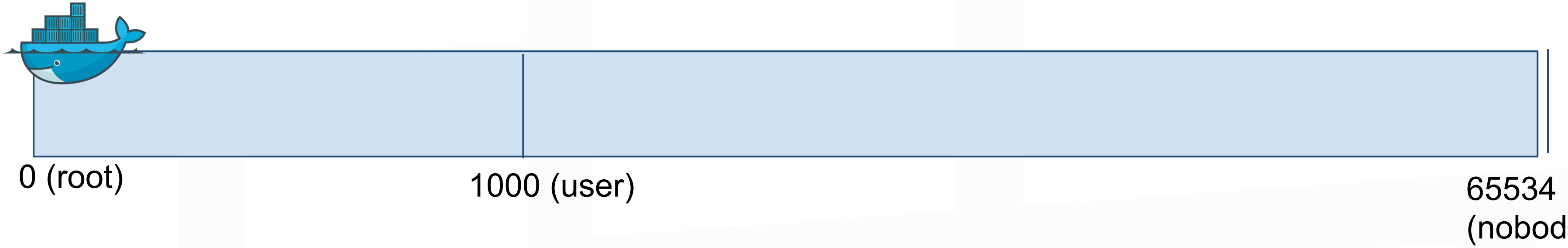
Implementation detail: use mutual TLS between pairs of services that need to talk to each other.

User Management

Default runs as root

```
$ docker run -v /bin:/host/bin -it --rm alpine sh
/ $ whoami
root
/ $ id
uid=0(root) gid=0(root)
/ $ rm /host/bin/sh # WREAK HAVOC TIME!  Please don’t do this
```

root in container == root outside container

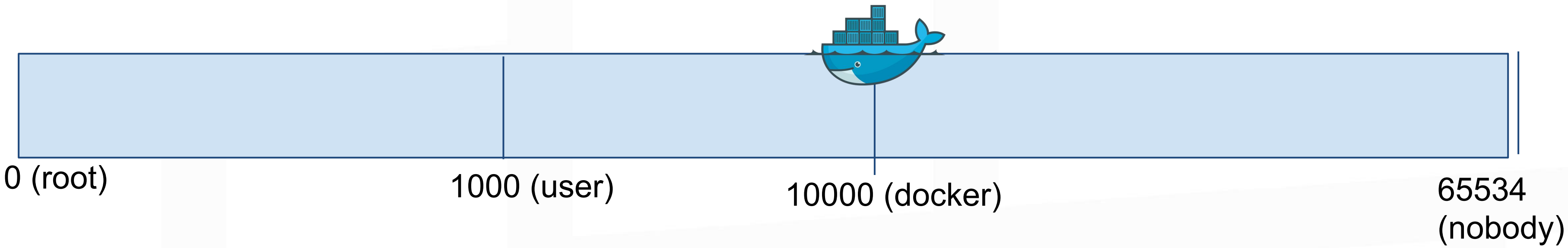


We don’t want this to be the case!
How can we change this?

Step in the right direction: run as a user

```
# Use the --user flag with UID:GID argument
$ docker run -v /bin:/host/bin --user 10000:10000 -it --rm alpine sh
/ $ whoami
whoami: unknown uid 10000
/ $ id
uid=10000 gid=10000
/ $ rm /host/bin/sh
rm: can’t remove ‘sh’: Permission denied
```

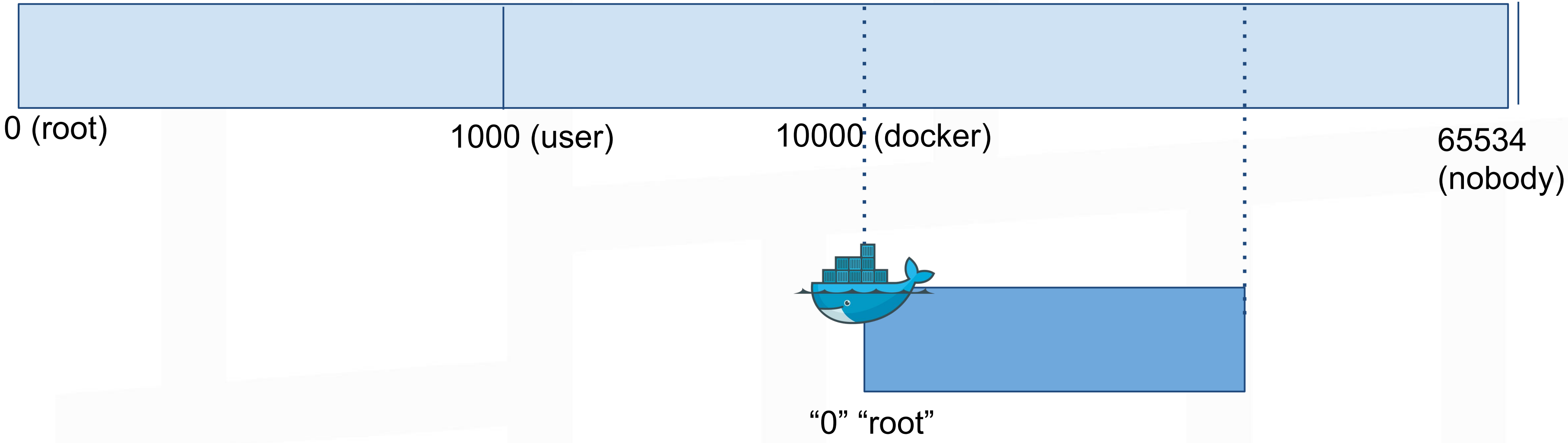
But I still want “root” inside container



Perhaps we need to run a command that needs to look like it’s root in the container, but we don’t want to give it *true* root access to the underlying host

Enable user namespaces

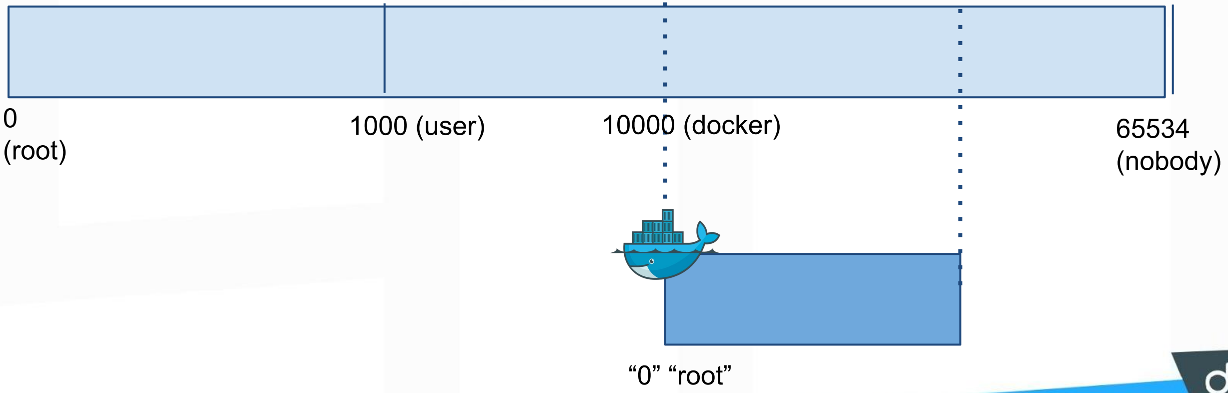
```
$ docker daemon --userns-remap [uid[:gid]]
```



Enable user namespaces - common pitfalls

```
$ docker daemon --userns-remap [uid[:gid]]
```

- Will need to re-pull images and re-create volumes due to container resource and image layer permissions
  - Leave this feature on in production; switching back and forth should only be done in development



Hands-On Exercise && break

github.com/riyazdf/dockercon-workshop - `userns` directory

Image Distribution

Security Goals

Image *Provenance* and *Trust*

- **Provenance:** who made this image?
  - Verify the *publisher* of the image
- **Trust:** have the contents of this image been tampered with?
  - Verify the *integrity* of the image

Pulling by tag

```
$ docker pull alpine:latest
```

Name resolution takes place in registry to find content-address of image

```
$ docker pull alpine
Using default tag: latest
```

Notice that the tag defaults to `latest` if no tags are given!

Pulling by digest

```
$ docker pull alpine@sha256:ea0d1389812...
```

No name resolution!

Security best practice: pulling by digest to enforce consistent and “immutable” pulls because of content-addressability

Content Trust

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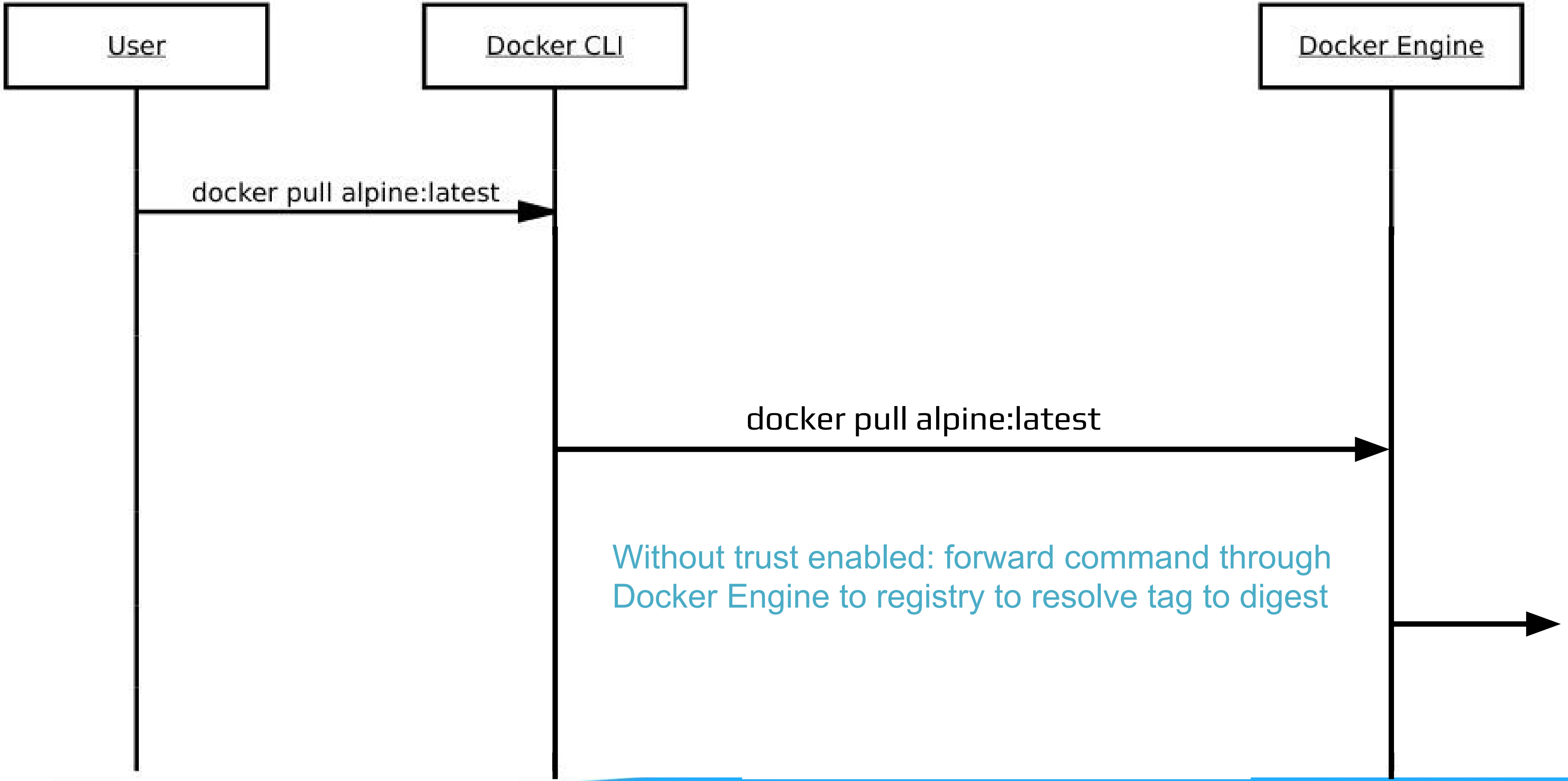
```
$ export DOCKER_CONTENT_TRUST=1
$ docker pull alpine:latest
Pull (1 of 1): alpine:latest@sha256:ea0d1389...
```

Benefits of pull by digest with ease of pull by tag



User

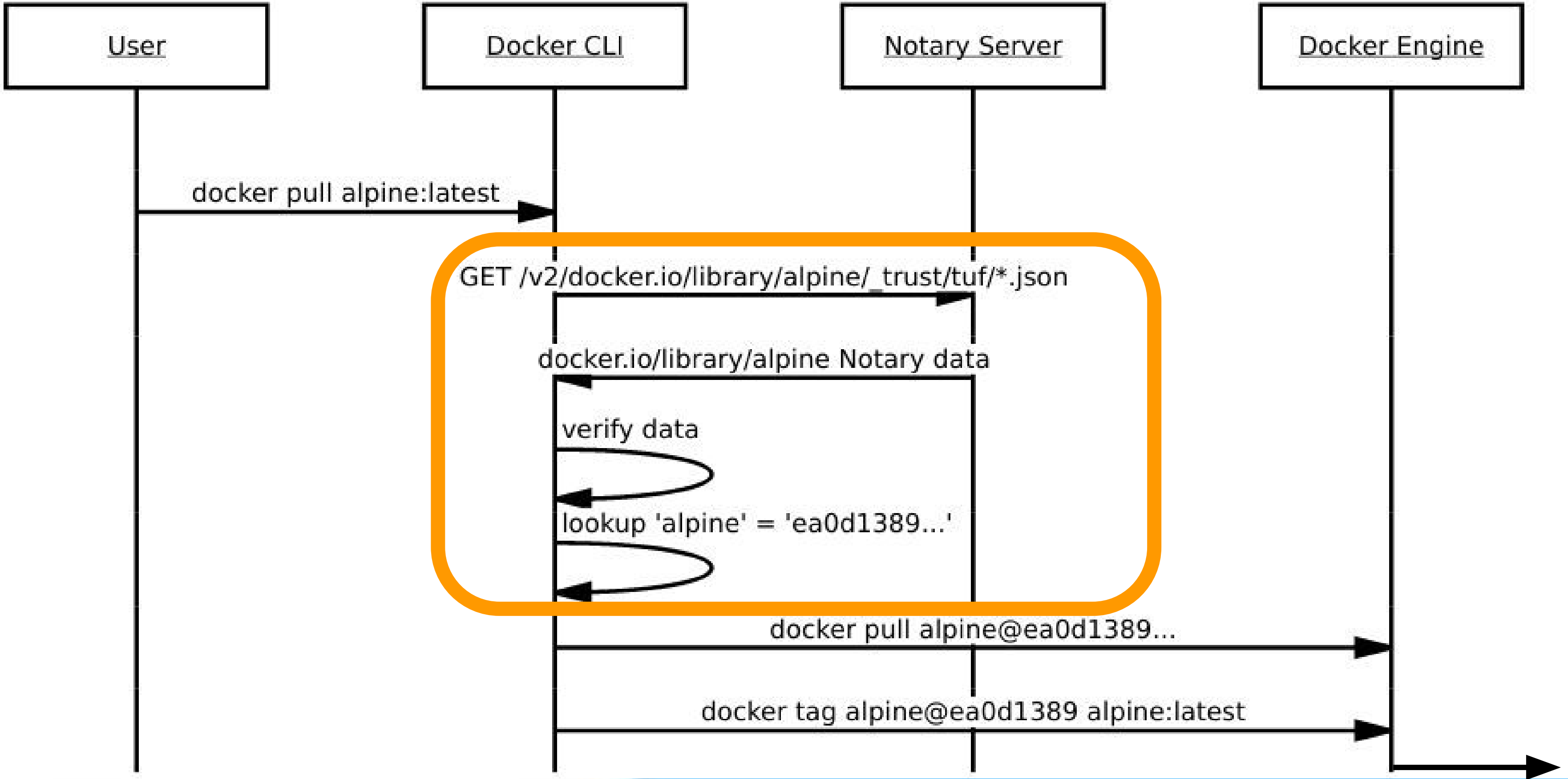
Docker CLI

Docker Engine

docker pull alpine:latest

docker pull alpine:latest

Without trust enabled: forward command through Docker Engine to registry to resolve tag to digest


User
Docker CLI
Notary Server
Docker Engine
docker pull alpine:latest
GET /v2/docker.io/library/alpine/_trust/tuf/*.json
docker.io/library/alpine Notary data
verify data
lookup 'alpine' = 'ea0d1389...'
docker pull alpine@ea0d1389...
docker tag alpine@ea0d1389 alpine:latest

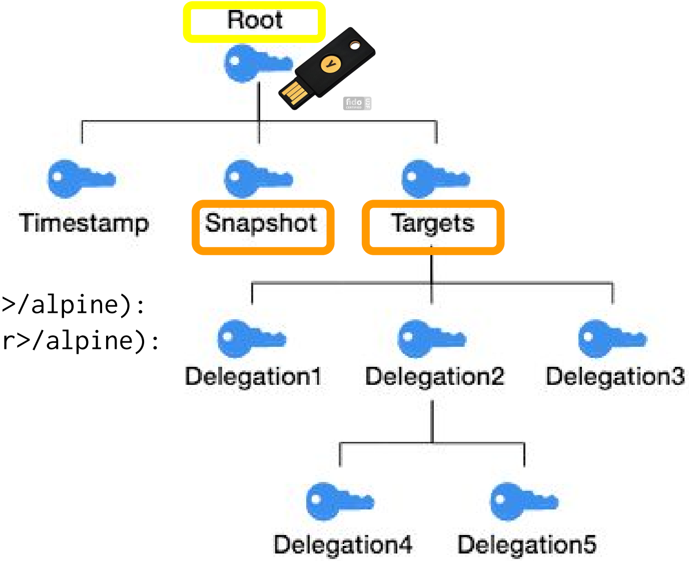
Content Trust (on push)

```
$ export DOCKER_CONTENT_TRUST=1
$ docker tag alpine:latest <user>/alpine:trust
$ docker push <user>/alpine:trust
```

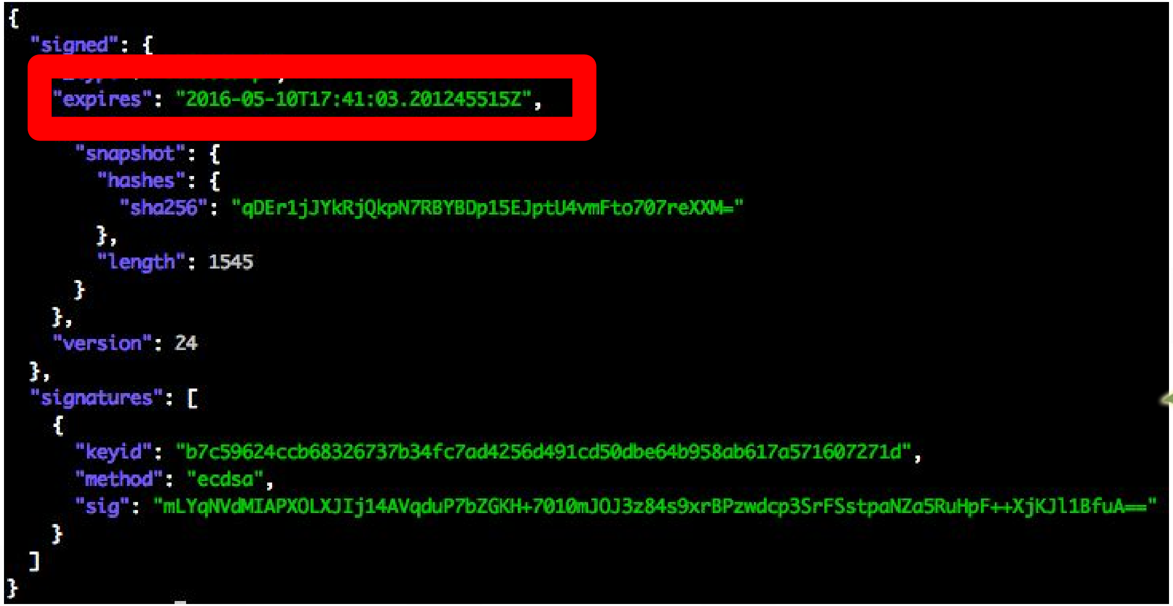
Looks the same as a regular push by tag!

Content Trust (it’s more than gpg)

```
The push refers to a repository [<user>/alpine]
77f08abee8bf: Pushed
trust: digest: sha256:d5de850d728... size: 1355
Signing and pushing trust metadata
Enter passphrase for root key with ID e83f424:
Enter passphrase for new repository key with ID f903fc9 (docker.io/<user>/alpine):
Repeat passphrase for new repository key with ID f903fc9 (docker.io/<user>/alpine):
Finished initializing "docker.io/<user>/alpine"
Successfully signed "docker.io/<user>/alpine":trust
```



Content Trust (it’s more than gpg)



```
{
  "signed": {
    "expires": "2016-05-10T17:41:03.201245515Z",
      "snapshot": {
        "hashes": {
          "sha256": "qDEr1jJYkRjQkpN7RBYBDp15EJptU4vmFto707reXXM="
        },
        "length": 1545
      }
    },
    "version": 24
  },
  "signatures": [
    {
      "keyid": "b7c59624ccb68326737b34fc7ad4256d491cd50dbe64b958ab617a571607271d",
      "method": "ecdsa",
      "sig": "mLYqNVdMIAPXOLXJIj14AVqduP7bZGKH+7010mJOJ3z84s9xrBPzwdcp3SrFSstpaNZa5RuHpF++XjKJl1BfuA=="
    }
  ]
}
```

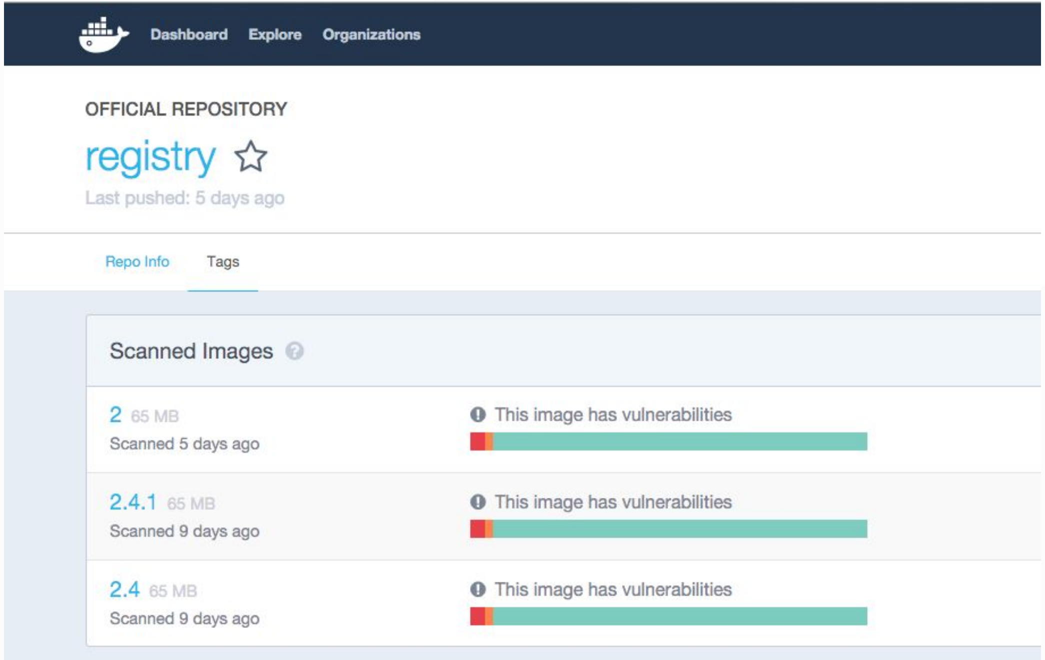
```
$ cat ~/.docker/trust/tuf/docker.io/alpine/metadata/timestamp.json | jq
```

Docker Content Trust / Notary Threat Model

- **Key compromise?**
  - We can recover!
- **Replay attacks?**
  - Not with our freshness guarantees!
- **Untrusted registry?**
  - No problem! DCT/Notary do not root any trust in the underlying content store or transport
  - Use signed TUF metadata to retrieve trusted hashes of content
  - Don’t even need to trust Notary server after first pull - local metadata pins trust, tagging keys are kept client-side for signing

Docker Pull

Only pull trusted images
Use official images when possible!



OFFICIAL REPOSITORY

registry ☆

Last pushed: 5 days ago

Scanned Images

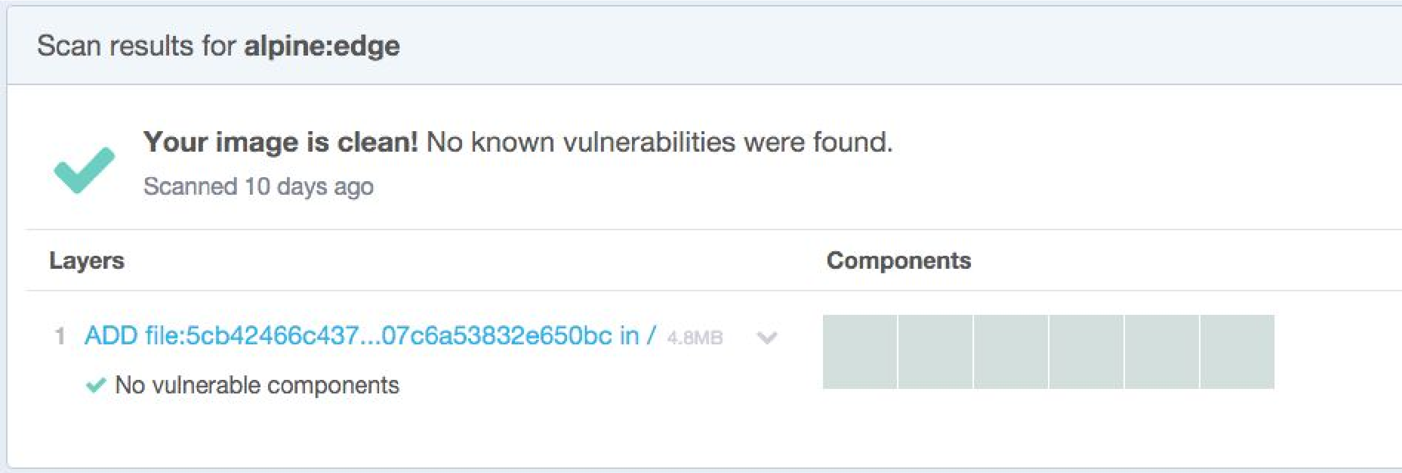
2 65 MB
Scanned 5 days ago
This image has vulnerabilities

2.4.1 65 MB
Scanned 9 days ago
This image has vulnerabilities

2.4 65 MB
Scanned 9 days ago
This image has vulnerabilities

Docker Security Scanning (Nautilus)

Docker Security Scanning (Nautilus)



Scan results for **alpine:edge**

✓ **Your image is clean!** No known vulnerabilities were found.

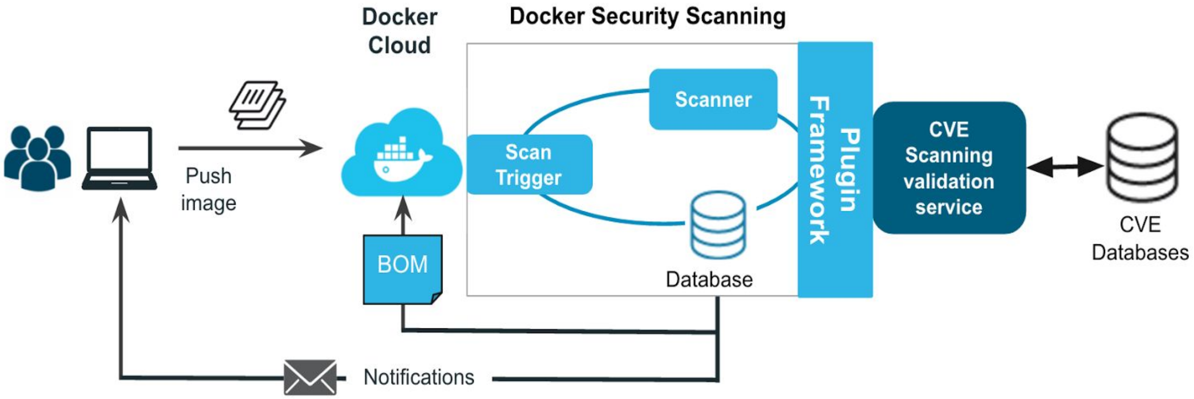
Scanned 10 days ago

Layers	Components
1 ADD file:5cb42466c437...07c6a53832e650bc in / 4.8MB ✓ No vulnerable components	

https://hub.docker.com/r/library/alpine/tags/

- All official images on hub are scanned for vulnerabilities, lobby upstream for fixes!
- Can view scan results after logging into Docker Hub

Docker Security Scanning (Nautilus)



- Checks against CVE database for declared layers
- Also performs binary scan to pick up on *statically linked binaries*
- Official repos have been scanned since Nov 2015, are rescanned often

Hands-On Exercise

github.com/riyazdf/dockercon-workshop - `trust` directory

Capabilities

Root vs Not Root

Capabilities breakdown root permissions into groups that can be individually allowed or blocked

- Often don’t want or need all root permissions
- Can reduce attack surface by reducing capabilities

Docker Default Capabilities

In whitelist:

```
"CAP_CHOWN",
"CAP_DAC_OVERRIDE",
"CAP_FSETID",
"CAP_FOWNER",
"CAP_MKNOD",
"CAP_NET_RAW",
"CAP_SETGID",
"CAP_SETUID",
"CAP_SETFCAP",
"CAP_SETPCAP",
"CAP_NET_BIND_SERVICE",
"CAP_SYS_CHROOT",
"CAP_KILL",
"CAP_AUDIT_WRITE",
```

Not in whitelist:

```
"CAP_AUDIT_CONTROL",
"CAP_BLOCK_SUSPEND",
"CAP_IPC_LOCK",
"CAP_LEASE",
"CAP_MAC_ADMIN",
"CAP_NET_ADMIN",
"CAP_SYS_ADMIN",
"CAP_SYS_MODULE",
"CAP_SYS_PACCT",
"CAP_SYS_RAWIO",
"CAP_SYS_TIME",
"CAP_SYSLOG",
```

```
"CAP_AUDIT_READ",
"CAP_DAC_READ_SEARCH",
"CAP_ICP_OWNER",
"CAP_LINUX_IMMUTABLE",
"CAP_MAC_OVERRIDE",
"CAP_NET_BROADCAST",
"CAP_SYS_BOOT",
"CAP_SYS_NICE",
"CAP_SYS_PTRACE",
"CAP_SYS_RESOURCE",
"CAP_SYS_TTY_CONFIG",
“CAP_WAKE_ALARM",
```

How do we add/remove capabilities?

```
docker run --cap-add
docker run --cap-drop
docker run --cap-drop ALL --cap-add $CAP
```

Configure capabilities in compose

```
cap_add:
  - CAP_NET_BROADCAST
  - CAP_NET_RAW

cap_drop:
  - ALL
```

What to watch out for

- Read the **fine print** for each capability!
  - `man capabilities`
  - i.e. removing `CAP_KILL` only requires permissions checks and enabling bypasses permissions checks. It doesn’t generically enable/disable the ability to kill
  - `CAP_SYS_ADMIN` is nearly root...

What to watch out for

```
$ man capabilities
...
CAP_SYS_ADMIN
              * Perform a range of system administration operations
                including: quotactl(2), mount(2), umount(2), swapon(2),
                setdomainname(2);
              * perform privileged syslog(2) operations (since Linux 2.6.37,
                CAP_SYSLOG should be used to permit such operations);
              * perform VM86_REQUEST_IRQ vm86(2) command;
              * perform IPC_SET and IPC_RMID operations on arbitrary System
                V IPC objects;
              * override RLIMIT_NPROC resource limit;
              * perform operations on trusted and security Extended
                Attributes (see xattr(7));
              * use lookup_dcookie(2);
              * use ioprio_set(2) to assign IOPRIO_CLASS_RT and (before
                Linux 2.6.25) IOPRIO_CLASS_IDLE I/O scheduling classes;
              * forge PID when passing socket credentials via UNIX domain
                sockets;
              * exceed /proc/sys/fs/file-max, the system-wide limit on the
                number of open files, in system calls that open files (e.g.,
                accept(2), execve(2), open(2), pipe(2));
              * employ CLONE_* flags that create new namespaces with
                clone(2) and unshare(2) (but, since Linux 3.8, creating user
                namespaces does not require any capability);
              * call perf_event_open(2);
              * access privileged perf event information;
```

Capabilities and Docker

- No extended attributes in images -> no capabilities elevation normally possible
- Use docker to reduce capabilities
- Docker can’t grant capabilities to non-root users due to some limitations in older kernel versions

Capabilities and Docker

Your options from worst to best:

1. Manual management within the container:
   `docker run --cap-add ALL`
2. Restricted capabilities (still root):
   `docker run --cap-drop ALL --cap-add ABC`
3. No capabilities:
   `docker run --user`

What to watch out for

CAUTION!

```
$ docker run --privileged …
```

gives ***all* capabilities** to the container, also lifts limitations from **device** cgroup

Capabilities demo

More information

github.com/riyazdf/dockercon-workshop - `capabilities` directory

Seccomp

Original Seccomp

On-off feature that disabled all system calls except:

- `exit()`
- `read()`
- `write()`
- `sigreturn()`

Seccomp-BPF

- Extension
- Allows us to configure what system calls are allowed/blocked
- Uses Berkeley Packet Filters (BPF)
- Allows examining system calls in detail before making a decision

Is it enabled?

In the kernel:

```
$ grep SECCOMP /boot/config-$(uname -r) # or zgrep SECCOMP /proc/config.gz
CONFIG_SECCOMP=y
CONFIG_SECCOMP_FILTER=y
```

In docker:

```
$ docker run --rm alpine grep Seccomp /proc/self/status
```

In docker 1.12:

```
$ docker info
```

Default Whitelist

Lots of system calls, what’s excluded:

- acct
- add_key
- adjtimex
- bpf
- clock_adjtime
- clock_settime
- clone
- create_module
- delete_module
- finit_module
- get_kernel_syms
- get_mempolicy
- init_module
- ioperm
- iopl
- kcmp
- kexec_file_load
- kexec_load
- keyctl
- lookup_dcookie
- mbind
- mount
- move_pages
- name_to_handle_at
- nfsservctl
- open_by_handle_at
- perf_event_open
- personality
- pivot_root
- process_vm_readv
- process_vm_writev
- ptrace
- query_module
- quotactl
- reboot
- request_key
- set_mempolicy
- setns
- settimeofday
- stime
- swapon
- swapoff
- sysfs
- _sysctl
- umount
- umount2
- unshare
- uselib
- userfaultfd
- ustat
- vm86
- vm86old

The strace tool

```
$ strace -c -f -S name ls 2>&1 1>/dev/null | tail -n +3 | head -n -2 | awk '{print $(NF)}'

access
arch_prctl
brk
close
execve
fstat
getdents
ioctl
mmap
mprotect
munmap
open
read
write
```

Docker seccomp profile DSL

Seccomp policy example:

```
{
     "defaultAction": "SCMP_ACT_ERRNO",
     "architectures": [
         "SCMP_ARCH_X86_64",
         "SCMP_ARCH_X86",
         "SCMP_ARCH_X32"
     ],
     "syscalls": [
     {
          "name": "accept",
          "action": "SCMP_ACT_ALLOW",
          "args": []
     },
     ...
     ]
}
```

Possible actions:

```
SCMP_ACT_KILL
SCMP_ACT_TRAP
SCMP_ACT_ERRNO
SCMP_ACT_TRACE
SCMP_ACT_ALLOW
```

Docker seccomp profile DSL

More complex filters:

```
"args": [
     {
          "index": 0,
          "op": "SCMP_CMP_MASKED_EQ",
          "value": 2080505856,
          "valueTwo": 0
     }
]
```

```
2080505856 == 0x7C020000
```

Seccomp and the `no-new-privileges` option

APPROVED

Seccomp policies have to be applied before executing your container and be less specific unless you use:

```
--security-opt no-new-privileges
```

In this case you need to allow only `futex stat execve`.

This flag also disables setuid binaries:

```
$ sudo ls
sudo: effective uid is not 0, is /usr/bin/sudo on a file system with the 'nosuid' option set
or an NFS file system without root privileges?
```

More information

github.com/riyazdf/dockercon-workshop - `seccomp` directory

```
$ docker run --rm -it --security-opt seccomp=default-no-chmod.json alpine chmod 777 /
chmod: /: Operation not permitted
```

Linux Security Modules

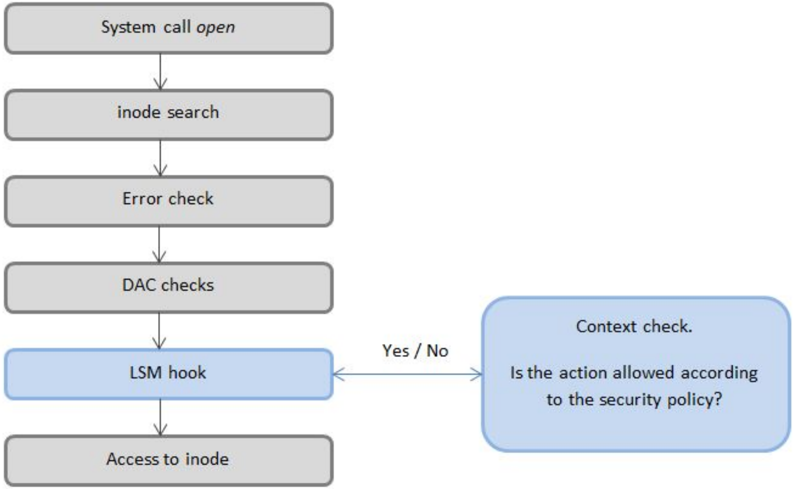
What is a LSM?

A plugin to the linux kernel that allows us to set policies to restrict what a process can do.

Mandatory Access Control: instead of using user-defined permissions to specify access, the underlying system describes permissions itself with labels

What is a LSM?

Under the hood: each LSM implements a kernel interface that hooks into user-level syscalls about to access an important kernel object (inodes, task control blocks, etc.), either allowing them to pass through or denying them outright depending on the application profile



Available LSMs

AppArmor 🐳

SELinux 🐳

Smack

Tomoyo

Deep Dive - AppArmor

File Access Management

AppArmor uses globbing and deny syntax to express filepath restrictions

- `deny /sys/* rwklx` Deny read/write/lock/link/execute on files in /sys/
- `deny /sys/** rwklx` Deny on files in /sys/ **and subdirectories**

Deep Dive - AppArmor

Networking Management

Like firewall rules:

- Can completely disable networking: `deny network`
- Can deny certain permissions: `deny network bind, inet`
- Can specify specific IP/ports : `network tcp src 192.168.1.1:80 dst 170.1.1.0:80`

Deep Dive - AppArmor

Capability Management

AppArmor can also deny capabilities with a simple syntax:

- `deny capability chown,`
- `deny capability dac_override`

Deep Dive - AppArmor

Composability

C-style `include` statements

- `include <abstractions/base>` - built-in bundle of files
- `include "/etc/apparmor.d/include/foo"` - absolute path from file
- `include "../relative_path/bar"` - relative path from file

Deep Dive - AppArmor

Tools for debugging and generating profiles (on Ubuntu):

```
    $ sudo apt install apparmor-utils

    $ aa-complain <PATH_TO_PROFILE> # Watch AppArmor block things!
    $ aa-genprof <PATH_TO_BINARY> # Interactive profile generation!
```

Do I still need Seccomp and Cap-drop?

Why not? Docker sets a profile for each setting by default

- Some overlap but each feature still adds unique functionality
- Defense-in-depth

Common mistake: disabling profiles

CAUTION!

SELinux: `setenforce 0` (on daemon)
http://stopdisablingselinux.com/

AppArmor: `--security-opt apparmor:unconfined` (on `docker run`)
This one's a little harder to do "by accident"

```
docker run --privileged
```

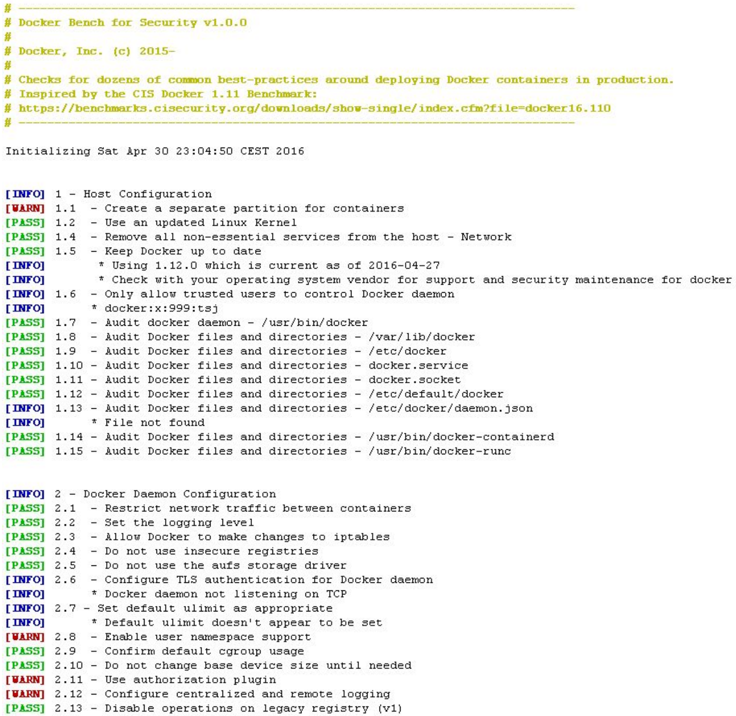
Hands-On Exercise

github.com/riyazdf/dockercon-workshop - `apparmor` directory

Docker Bench

https://dockerbench.com

- Open-source tool for running automated tests
    - inspired by the CIS Docker 1.11 benchmark
- Runs against containers currently running on same host
- Checks for AppArmor, read-only volumes, etc...



```
# ------------------------------------------------------------------------------
# Docker Bench for Security v1.0.0
#
# Docker, Inc. (c) 2015-
#
# Checks for dozens of common best-practices around deploying Docker containers in production.
# Inspired by the CIS Docker 1.11 Benchmark:
# https://benchmarks.cisecurity.org/downloads/show-single/index.cfm?file=docker16.110
# ------------------------------------------------------------------------------

Initializing Sat Apr 30 23:04:50 CEST 2016


[INFO] 1 - Host Configuration
[WARN] 1.1  - Create a separate partition for containers
[PASS] 1.2  - Use an updated Linux Kernel
[PASS] 1.4  - Remove all non-essential services from the host - Network
[PASS] 1.5  - Keep Docker up to date
[INFO]       * Using 1.12.0 which is current as of 2016-04-27
[INFO]       * Check with your operating system vendor for support and security maintenance for docker
[INFO] 1.6  - Only allow trusted users to control Docker daemon
[INFO]      * docker:x:999:tsj
[PASS] 1.7  - Audit docker daemon - /usr/bin/docker
[PASS] 1.8  - Audit Docker files and directories - /var/lib/docker
[PASS] 1.9  - Audit Docker files and directories - /etc/docker
[PASS] 1.10 - Audit Docker files and directories - docker.service
[PASS] 1.11 - Audit Docker files and directories - docker.socket
[PASS] 1.12 - Audit Docker files and directories - /etc/default/docker
[INFO] 1.13 - Audit Docker files and directories - /etc/docker/daemon.json
[INFO]      * File not found
[PASS] 1.14 - Audit Docker files and directories - /usr/bin/docker-containerd
[PASS] 1.15 - Audit Docker files and directories - /usr/bin/docker-runc


[INFO] 2 - Docker Daemon Configuration
[PASS] 2.1  - Restrict network traffic between containers
[PASS] 2.2  - Set the logging level
[PASS] 2.3  - Allow Docker to make changes to iptables
[PASS] 2.4  - Do not use insecure registries
[PASS] 2.5  - Do not use the aufs storage driver
[INFO] 2.6  - Configure TLS authentication for Docker daemon
[INFO]      * Docker daemon not listening on TCP
[INFO] 2.7 - Set default ulimit as appropriate
[INFO]      * Default ulimit doesn't appear to be set
[WARN] 2.8  - Enable user namespace support
[PASS] 2.9  - Confirm default cgroup usage
[PASS] 2.10 - Do not change base device size until needed
[WARN] 2.11 - Use authorization plugin
[WARN] 2.12 - Configure centralized and remote logging
[PASS] 2.13 - Disable operations on legacy registry (v1)
```

View from 10,000 feet:
Docker Security Checklist

Build:

- Use minimal images (alpine)
- Use official images
- Using images pulled by content trust (fresh, pulled by digest from authors you trust)

Ship:

- Push to your consumers with content trust
- View results from Docker Security Scanning

Run:

- Mutual TLS between client/engine
- Read-only volumes and containers
- User namespaces in the daemon
- Limit resources with cgroups
- Use the default apparmor/seccomp/capabilities, or your own tested profiles (not --privileged!)

Thank you!

- Please take the exercises home! We'll accept issues and pull requests :)
- Learn more at https://docs.docker.com/engine/security/security/

Advanced Topics

“Extra for Experts”

AuthZ plugins

Running your own Notary

Deploy a notary

```
$ git clone https://github.com/docker/notary.git
$ cd notary
$ docker-compose up
```

Notary Delegations

```
(admin)$ notary key rotate <GUN> snapshot -r
(user)$ < generates private key and x509 cert, gives user.crt to admin >
(admin)$ notary delegation add <GUN> targets/user user.crt --all-paths
(admin)$ notary publish <GUN>
```

Docker engine >= 1.11 will sign with delegation keys if it detects them