O bezpieczeństwie kontenerów linuksowych

16 sesja linuksowa

Wrocław, 2019-04-06

Maciej Lasyk

$ whois maciej.lasyk.info

- 6 raz na Sesji – dzięki!
- wspomaga projekt Fedora
- @docent-net
- github.com/docent-net/
- maciej.lasyk.info
- dlugodystansowy.pl

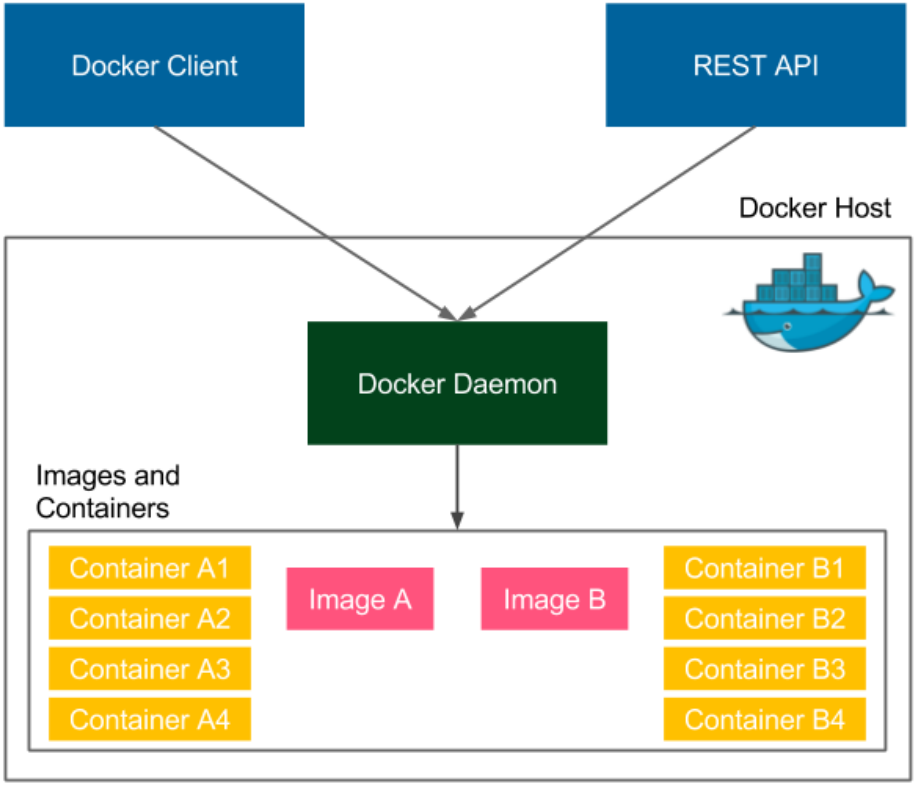
Join Fedora Infrastructure!

https://fedoraproject.org/wiki/Infrastructure/GettingStarted

Linux containers?

- Used for process containment
- Linux namespaces for providing users/FS/others view
- Cgroups v1/v2 for resources management
- Linux LSMs for sealing security holes
- **By design not created for providing additional security layer**
- Some storage copy-on-write magic (not needed btw at all)
- Quo-vadis containers: https://www.youtube.com/watch?v=_GSLj-c_LMI

Docker architecture



Docker architecture

- Binary client ($ docker)
- REST API on docker.sock by default
- ...booring? Not rly
- $ docker run --privileged -v /:/host:rw
- (unless SELinux which by default denies socket access)

Docker security considerations

- docker run --user foo
  - executes the process in the container as non - root
  - dockerd, containerd, and runc still running as root

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Docker security considerations

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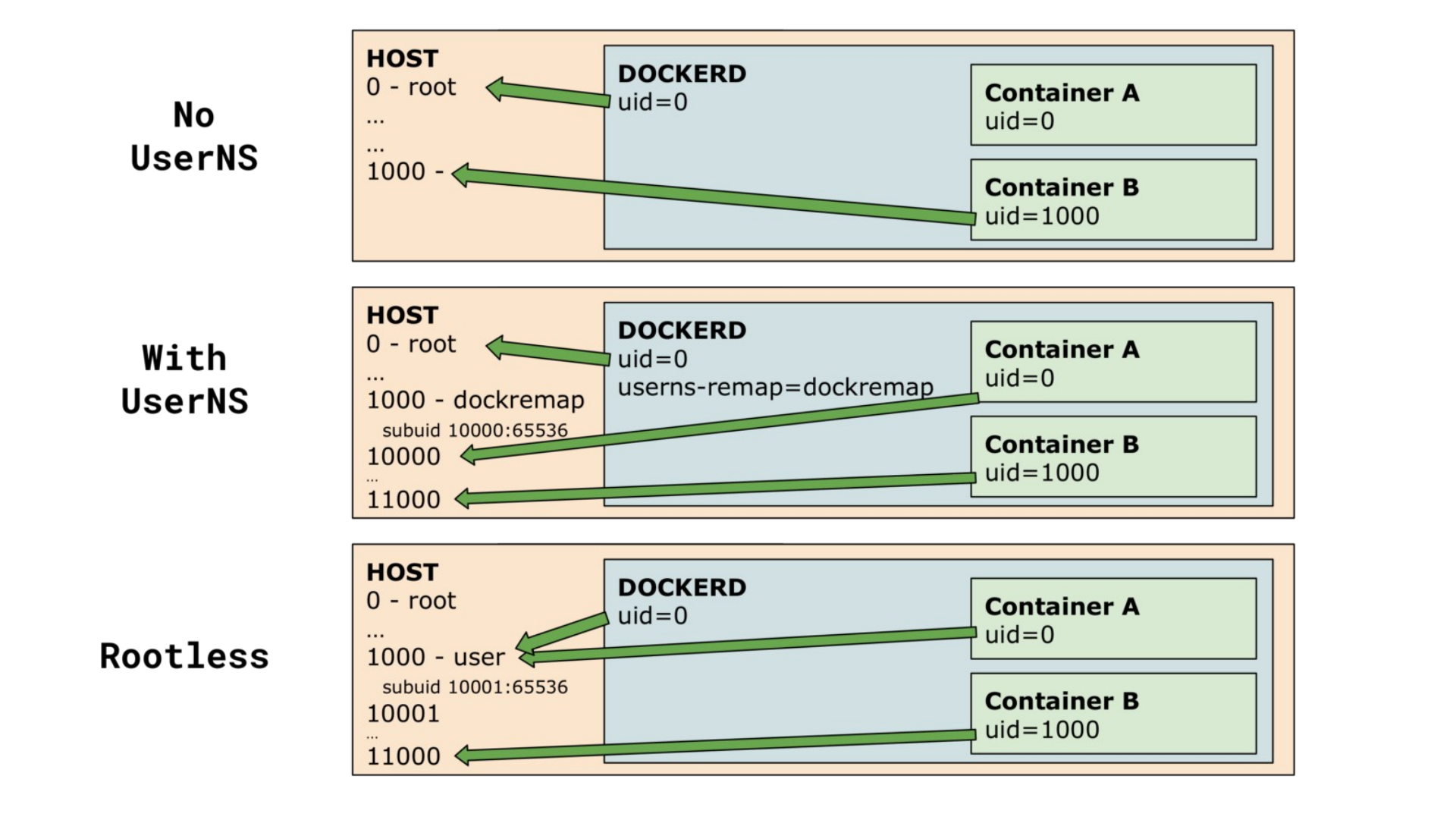
- USER in Dockerfile
  - same as above
  - you can't run dnf/yum/apt-get install whatever
- usermod -aG docker foo
  - allows non - root user to connect to docker.sock
  - remember docker run --privileged -v /:/host - DON'T

Docker - what are privileged containers?

- Basically Linux capabilities unlimited
- See man 7 capabilities
- Try: --cap-drop=ALL
- Read: runtime-privilege-and-linux-capabilities

Docker - rootless considerations

- https://docs.docker.com/engine/security/userns-remap/
- dockerd --userns-remap
  - executes containers as non - root (dockremap) using user namespaces
  - most similar to rootless, but still needs dockerd, containerd, runc to run from root


No
UserNS
HOST
0 - root
...
...
1000 -
DOCKERD
uid=0
Container A
uid=0
Container B
uid=1000
With
UserNS
HOST
0 - root
...
1000 - dockremap
subuid 10000:65536
10000
...
11000
DOCKERD
uid=0
userns-remap=dockremap
Container A
uid=0
Container B
uid=1000
Rootless
HOST
0 - root
...
1000 - user
subuid 10001:65536
10001
...
11000
DOCKERD
uid=0
Container A
uid=0
Container B
uid=1000

Rootless finally in Docker?

- Original issue: https://github.com/moby/moby/pull/38050
- https://engineering.docker.com/2019/02/experimenting-with-rootless-docker/
- Downsides:
  - w/out cgroups (so no resource management)
  - w/out apparmor and SELinux
  - w/out overlay networks
  - w/out ports exposing directly - needs socat
  - On Ubuntu overlayFS, rest VFS which is no good for production
- **So this is an experiment**

“Containers do not contain”

- Originally said by Dan Walsh: docker-security-selinux
- “I have heard people say Docker containers are as secure as running processes in separate VMs/KVM.”
- “I know people are downloading random Docker images and then launching them on their host.”
- “I have even seen PaaS servers (not OpenShift, yet) allowing users to upload their own images to run on a multi-tenant system.”
- “I have a co-worker who said: "Docker is about running random code downloaded from the Internet and running it as root.”

“Containers do not contain”

- **Containers were not created for/security by design!**
- Solaris zones were, and have great support directly from FS (see ZFS, Crossbow)
- See Containers do not contain

Docker & SELinux

- Stop disabling SELinux
- “Container security: frustration in the RedHat security team was high because of difficulties to integrate patches into the Docker product [...]” [source]
- See: Docker versus Systemd - Can't we just get along?

Docker & SELinux - do you really need LSM?

Major kernel subsystems are not namespaced like:

- Cgroups
- file systems under /sys
- /proc/sys, /proc/sysrq-trigger, /proc/irq, /proc/bus

Devices are not namespaced:

- /dev/mem
- /dev/sd* file system devices

Kernel Modules are not namespaced

If you can communicate or attack one of these as a privileged process, you can own the system.

Docker seccomp

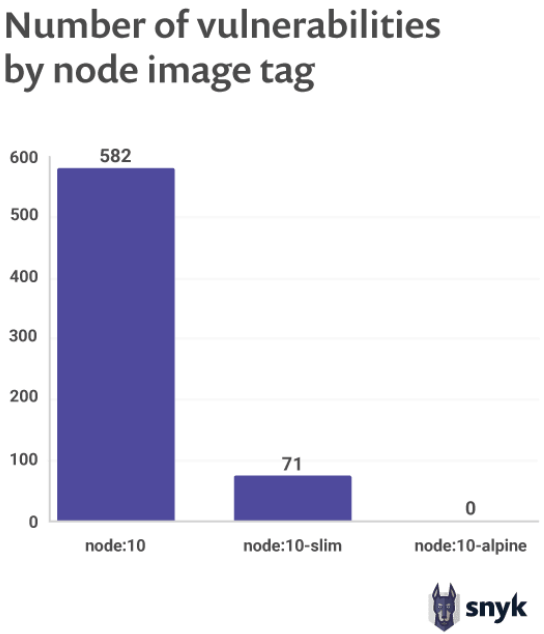
- Kernel w/seccomp
- Docker-engine w/seccomp
- Read: https://docs.docker.com/engine/security/seccomp/

Docker images

- Remember ““I have a co-worker who said: "Docker is about running random code downloaded from the Internet and running it as root.”?
- Read most-popular-docker-images-each-contain-at-least-30-vulnerabilities/

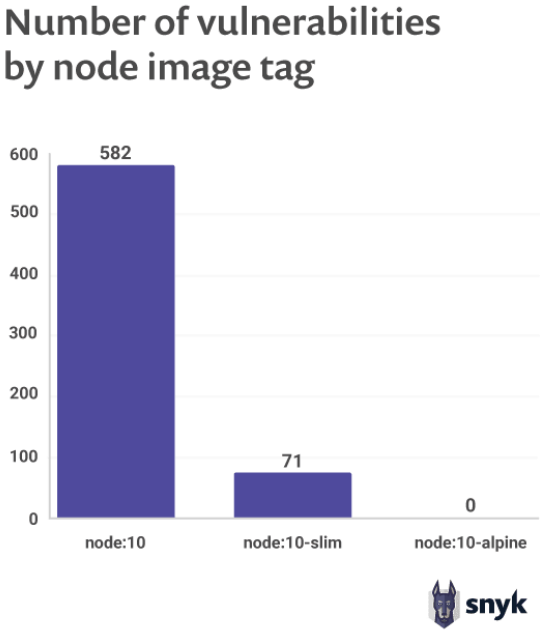
Docker images

- Remember ““I have a co-worker who said: "Docker is about running random code downloaded from the Internet and running it as root.”?
- Read [most-popular-docker-images-each-contain-at-least-30-vulnerabilities/]



Docker images

- Remember ““I have a co-worker who said: "Docker is about running random code downloaded from the Internet and running it as root.”?
- Read [most-popular-docker-images-each-contain-at-least-30-vulnerabilities/]



[...] Alpine Linux doesn’t maintain a security advisory program, which means that if a system library has vulnerabilities, Alpine Linux will not issue an official advisory about it [...]

Is Alpine images secure as they say?

- **Alpine Linux is a security-oriented, lightweight Linux distribution based on musl libc and busybox.**
- Top G results: **Alpine so secure, very fast, best, why use anything else?**
- APK - yet another packaging system
  - How much effort needs maintaining packaging system and packages?
  - https://news.ycombinator.com/item?id=17981452
  - 2 pplf for review(!): https://wiki.alpinelinux.org/wiki/Creating_an_Alpine_package#Code_review
  - **“To successfully have your package pass through code reviewers (as of Feb 18, 2018 are nmeum and jirutka on GitHub) and possible increased acceptance, the following conventions need to be followed:”**
  - Looks like npm install
  - Why not rpm or deb? (because no glibc!)
  - Last year no critical security problems with dnf/yum/apt; those are very stable and many, many ppl work on it; and review processes are thorough maintained by number of ppl

Is Alpine images secure as they say?

- Alpine has Kernel patched by unofficial grsecurity
- Unofficial because grsec is no more free
- Can you really maintain Kernel patches for free? NO

Franklin Richards was here @io_r_us · 30 Nov 2017

grsec is never comming back is it ?

will cgroups and the like be extensively used ?

2

Jakub Jirutka @JakubJirutka · 30 Nov 2017

We still ship kernel with grsecurity patches, we've just renamed it to "hardened". However, this is probably the last release with grsec.

1

Franklin Richards was here @io_r_us · 1 Dec 2017

It may be worth considering a community effort to get hold of the grsecurity sources again. Also, grsec says they still provide sources to long term subscribers and contributors. That did not work out ?

1

Jakub Jirutka @JakubJirutka · 1 Dec 2017

We've already considered it. Grsecurity used to be released only as single really HUGE patch file, so it's totally unmaintainable.

3

https://twitter.com/grsecurity/status/936422357757022209

Alpine: musl vs glibc

- How many of you can compile w/first and the second?
- Can u rly strace w/musl?
- Operational drama
- Glibc is huge as its support & ppl behind it (G, RH, Canonical, IBM, whatever)
- Some binaries will crash in corner cases w/musl
- Read: what_is_musl_and_glibc
- systemd will not work w/musl

Alpine: so why ppl use it?

- Because it’s small; few of MBs (6 or smt)
- “If it consists of just few libs it must be secure”
- Do you have any other ideas?

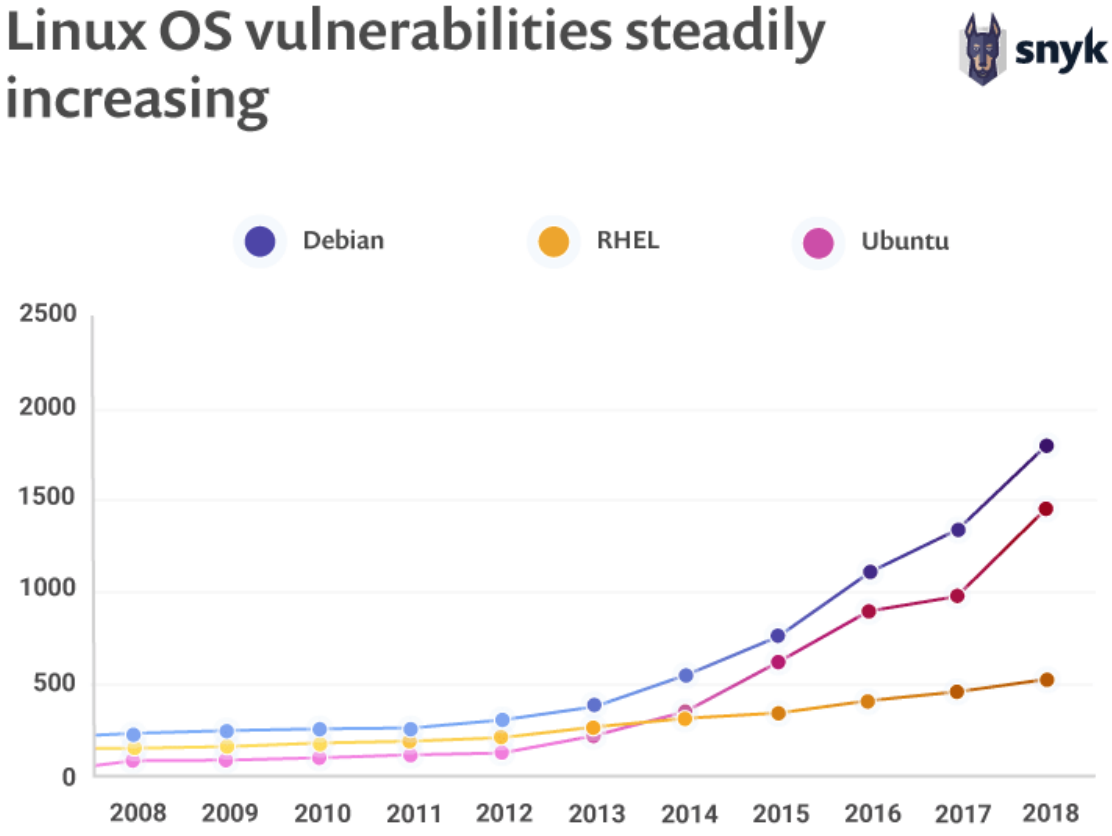
Alpine: so why ppl use it?

- Because it’s small; few of MBs (6 or smt)
  - We have currently layered FSes w/copy-on-write
  - You can really download 100mb image very fast
  - You don’t have to redownload it at all
- “If it consists of just few libs it must be secure”
  - Yeah, add more and pray that those are secure (remember they don’t have security advisory program!)
- Do you have any other ideas?

Alpine: history

- Created w/routers, small boxes etc in mind
- Why so high adoption in Docker?
  - Because Docker hub had gigantic performance problems these times, so little Alpine fixed it
  - Because back then storage drivers (aufs /n Debians and devicemapper on RHs) sucked a lot and layers were just too big to handle w/good performance [thx Marcin]

Which image?


Linux OS vulnerabilities steadily increasing
snyk
Debian
RHEL
Ubuntu
2500
2000
1500
1000
500
0
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

Docker & systemd

"This is Lennart Poettering," said Walsh, showing a picture. "This is Solomon Hykes", showing another. "Neither one of them is willing to compromise much. And I get to be in the middle between them."

[source]

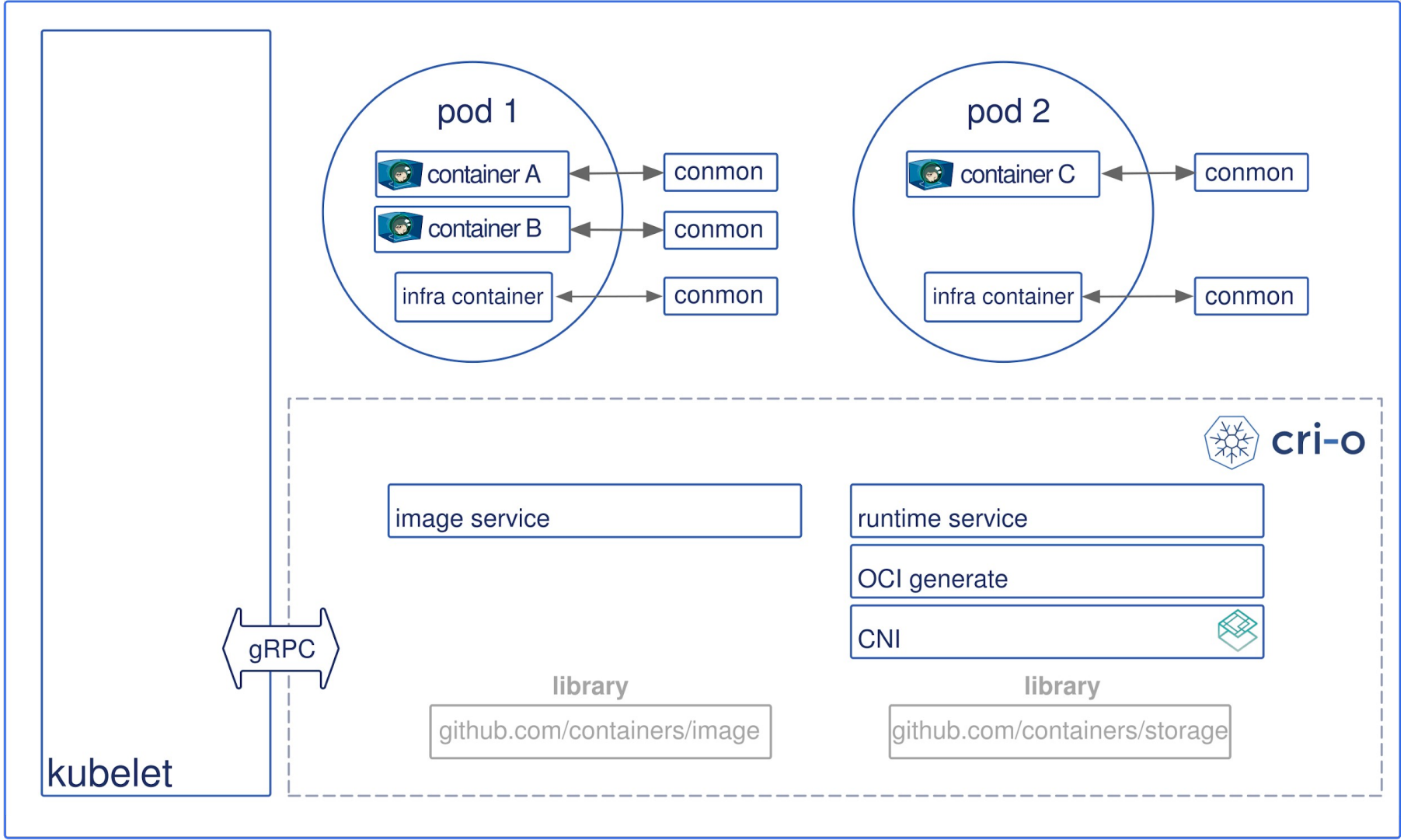
Docker & systemd

"According to Walsh's presentation, the root cause of the conflict is that the Docker daemon is designed to take over a lot of the functions that systemd also performs for Linux. These include initialization, service activation, security, and logging. "In a lot of ways Docker wants to be systemd," he claimed. "It dreams of being systemd.""

[source]

Is there a world without Docker?

- Yeah, Podman and CRI-O
- **“CRI-O owes a great deal of gratitude to the upstream Docker project. As Isaac Newton said “If I have seen further, it is by standing on the shoulders of giants.”**


pod 1
container A
container B
infra container
conmon
conmon
conmon
pod 2
container C
infra container
conmon
conmon
cri-o
image service
runtime service
OCI generate
CNI
gRPC
library
github.com/containers/image
library
github.com/containers/storage
kubelet

Podman - what is it?

- drop-in replacement for docker
- #nobigfatdaemons
- one process per container (supervised by init, e.g. systemd)
- systemd-cgroups: https://asciinema.org/a/182946
- user-namespaces
- rootless containers (in k8s pod share same user namespace)
- support for fuse (on newer Kernels w/out root)/overlays
- systemd-features:
  - automated start
  - dependencies between specified containers and other system services (or even containers)
  - socket-activation
  - sd-notify

Podman - howto

- dnf/yum install -y podman
- alias docker=podman

Podman - user namespaces?

- Read podman-and-user-namespaces
- each container runs in own user namespace
- “Since the real UID=0 is not mapped into the container, any file owned by root will be treated as owned by nobody. Even if the process inside the container has CAP_DAC_OVERRIDE, it can't override this protection. DAC_OVERRIDE enables root processes to read/write any file on the system, even if the process was not owned by root or world readable or writable.”
- “Podman can use different user namespaces on the same image because of **automatic chowning** built into containers/storage by a team led by Nalin Dahyabhai. “

Podman - user namespaces?

- Read [podman-and-user-namespaces]
- each container runs in own user namespace
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```
func SafeChown(name string, uid, gid int) error {
    return checkChownErr(os.Chown(name, uid, gid), name, uid, gid)
}
```

Podman - user namespaces

```
$ sudo bash -c "echo Test > /tmp/test"
$ sudo chmod 600 /tmp/test
$ sudo ls -l /tmp/test
-rw-------. 1 root root 5 Dec 17 16:40 /tmp/test
```

```
$ sudo podman run -ti -v /tmp/test:/tmp/test:Z --uidmap 0:100000:5000 fedora sh
# id
uid=0(root) gid=0(root) groups=0(root)
# ls -l /tmp/test
-rw-rw----. 1 nobody nobody 8 Nov 30 12:40 /tmp/test
# cat /tmp/test
cat: /tmp/test: Permission denied
```

~~Docker~~ Podman security considerations

- podman run
  - executes the process in the container as current user
  - dockerd, containerd, and runc not running as **#nobigfatdaemons**
- USER in Dockerfile
  - same as above
  - you can run dnf/yum/apt-get install whatever
- usermod -aG docker foo
  - No usermod as no docker.socket

Podman rootless

- Read how-does-rootless-podman-work
- Watch: replacing_docker_with_podman
- Working out-of-the-box
- “The Podman tool is enabling people to build and use containers without sacrificing the security of the system; you can give your developers the access they need without giving them root.”

What if no Docker, no Podman - just Linux?

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systemd FTW!

What if no Docker, no Podman - just Linux?

systemd FTW!

- systemd-run process confinement
- systemd portable services
- systemd-nspawn

Process confinement w/systemd-run

- See my systemd talks here
- **man systemd.resource-control**
  - ProtectHome=true, ProtectSystem=Strict, ReadOnlyDirectories, InAccessibleDirectoreis, ReadWriteDirectories, PrivateTmp, TemporaryFileSystem, BindPath, BindReadOnlyPath
  - MemoryMax and others
  - CPUQuota and others
  - IPAddressDeny and others
- Read ip-accounting-and-access-lists-with-systemd

Process confinement w/systemd-run

- **systemd-run -p <param1> -p <param2> -t /bin/sh**
  - IPAddressDeny=any + IPAddressAllow=8.8.8.8 + IPAddressAllow=127.0.0.0/8
  - ProtectSystem=strict
  - ProtectHome=true
  - PrivateTmp=true
  - BindPaths=/mnt/sd-test
  - CPUQuota=20%

systemd-nspawn

- watch “systemd-nspawn is chroot on steroids” (Lennart Poettering)
- created for debugging boot process of Linux OS (by RedHat / Lennart & co)
- single process/service w/systemd as init
- quite low - level
- this was mainly for debugging init process when working on systemd
- steeper learning curve
- **man systemd-nspawn**

systemd portable services

- Watch: portable_services_are_ready_to_use
- Read:
  - walkthrough for Portable Services, walkthrough for Portable Services in Go
  - portable services
  - dynamic-users-with-systemd.html
- normal services w/optional chroot and some containment
- multiple sandboxing options
- leave no artifacts
- Own transient user database
- Builtin ready security profiles
- This is just a wrapper around systemd (portablectl)

systemd portable services - dynamic users

- nss-systemd (not using /etc/passwd at all)
- man 5 systemd.exec
- Setting DynamicUser=yes implies ProtectSystem=strict and ProtectHome=read-only and PrivateTmp=yes
- These sand-boxing options turn off write access to pretty much the whole OS directory tree, with a few relevant exceptions, such as the API file systems /proc, /sys and so on, as well as /tmp and /var/tmp.
- Setting DynamicUser=yes implies RemoveIPC=yes
- allocation of users cheap and ephemeral

Process confinement w/systemd-run

- **systemd-run -p <param1> -p <param2> -t /bin/sh**
  - IPAddressDeny=any + IPAddressAllow=8.8.8.8 + IPAddressAllow=127.0.0.0/8
  - ProtectSystem=strict
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  - PrivateTmp=true
  - BindPaths=/mnt/sd-test
  - CPUQuota=20%
  - DynamicUser=true (see id)
  - PrivateUsers=true (see ps, ls)

systemd-analyze security

- analyzes the security and sandboxing settings of one or more specified service units
- The command checks for various security-related service settings, assigning each a numeric "exposure level" value, depending on how important a setting is
- It then calculates an overall exposure level for the whole unit, which is an estimation in the range 0.0…10.0 indicating how exposed a service is security-wise

Sources, urls, ppl

- https://rootlesscontaine.rs/
- https://snyk.io/blog/top-ten-most-popular-docker-images-each-contain-at-least-30-vulnerabilities/
- https://media.ccc.de/v/ASG2018-177-replacing_docker_with_podman
- https://opensource.com/article/19/2/how-does-rootless-podman-work
- https://opensource.com/article/18/12/podman-and-user-namespaces
- https://opensource.com/article/18/10/podman-more-secure-way-run-containers
- https://www.youtube.com/watch?v=-MvKe5TFW7g
- https://www.projectatomic.io/blog/2018/02/reintroduction-podman/
- https://learning.oreilly.com/library/view/continuous-delivery-with/9781787125230/5ef77ae7-ce0c-4f85-92a6-a336bbfe8c29.xhtml
- https://www.certdepot.net/death-of-docker/
- https://opensource.com/business/14/7/docker-security-selinux

Special thanks to Dan Walsh, Lennart Poettering and Marcin Skarbek <3

Dzięki, pytania?

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