Janos Pasztor

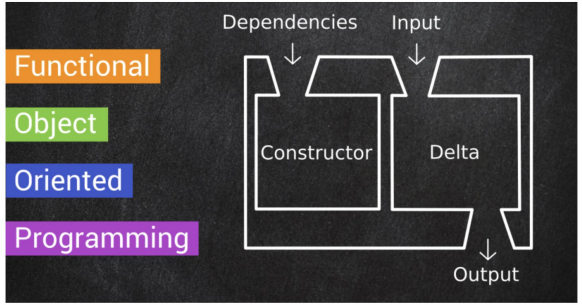
What’s under the hood of Docker?

Process separation in the Linux kernel

What I do

Building your own CDN for Fun and Profit

Fresh from the hold-my-beer department, why don't we build our own little CDN? Oh, and it actually makes sense.



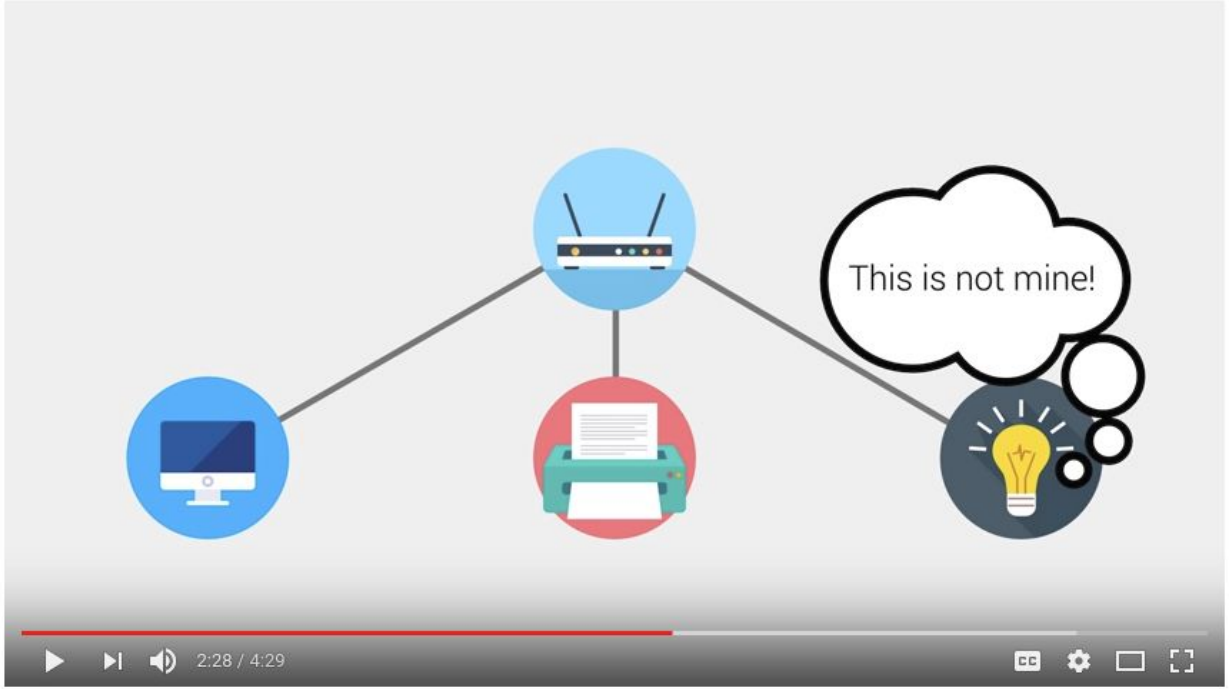
Functional Object Oriented Programming

Does the title strike you as strange? Do you think functional and object oriented programming are two fundamentally contradicting paradigms? I don't think so.

Under the hood of Docker

The runc and rkt container runtimes power Docker & co. But what powers the container runtimes? Read on for a deeper look into containerization technology.

What I do



How does Ethernet work?

23,866 views

363 6 SHARE

What I do

pasztor.at

@janoszen

What I do

@janoszen

CTRL

Today

Today

1. What are containers?

Today

1. What are containers?
2. Containerization history

Today

1. What are containers?
2. Containerization history
3. Capabilities

Today

1. What are containers?
2. Containerization history
3. Capabilities
4. Linux namespaces

Today

1. What are containers?
2. Containerization history
3. Capabilities
4. Linux namespaces
5. Cgroups

Today

1. What are containers?
2. Containerization history
3. Capabilities
4. Linux namespaces
5. Cgroups
6. Seccomp

Today

1. What are containers?
2. Containerization history
3. Capabilities
4. Linux namespaces
5. Cgroups
6. Seccomp
7. AppArmor

Today

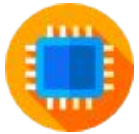
1. What are containers?
2. Containerization history
3. Capabilities
4. Linux namespaces
5. Cgroups
6. Seccomp
7. AppArmor
8. Demo!

Today

A few caveats!

1. What are containers?

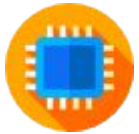
1. What are containers?



Hardware

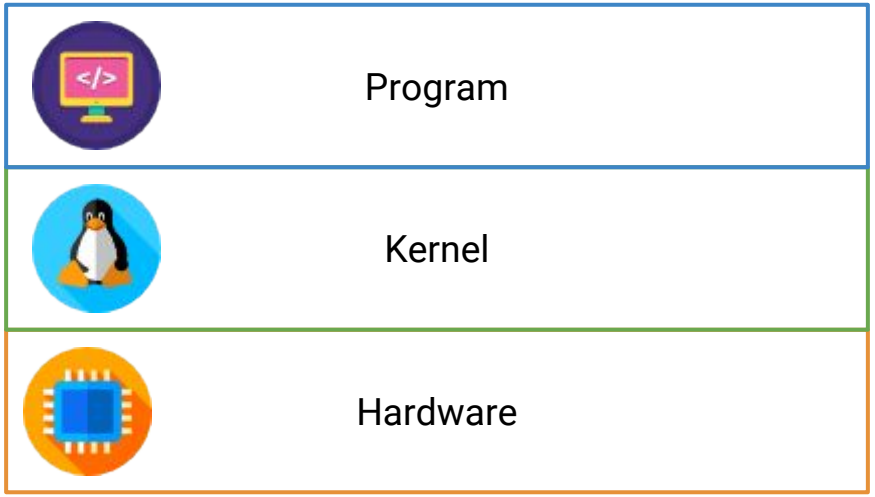
1. What are containers?

Program

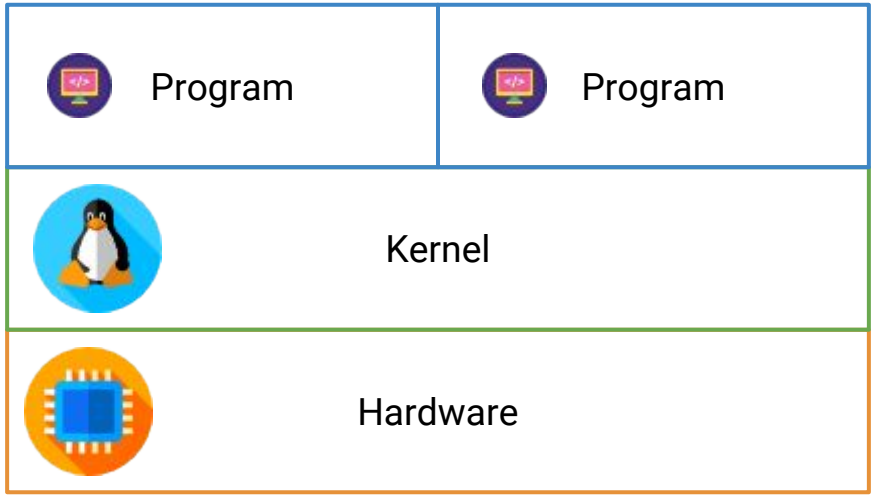


Hardware

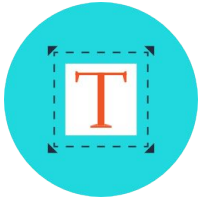
1. What are containers?



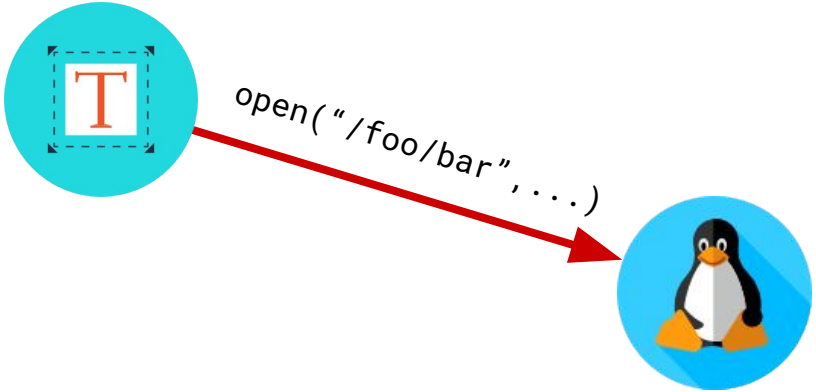
1. What are containers?



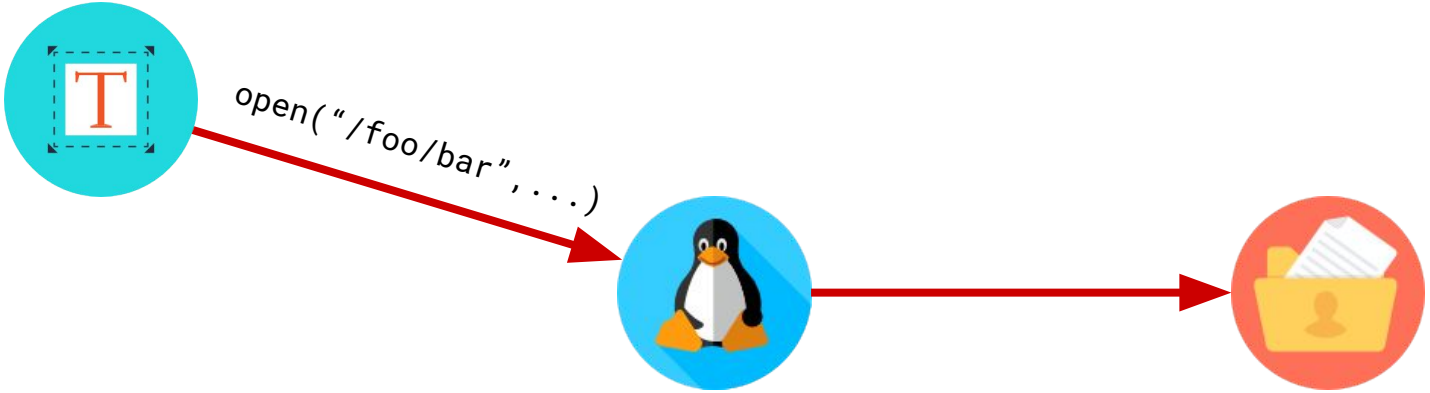
1. What are containers?



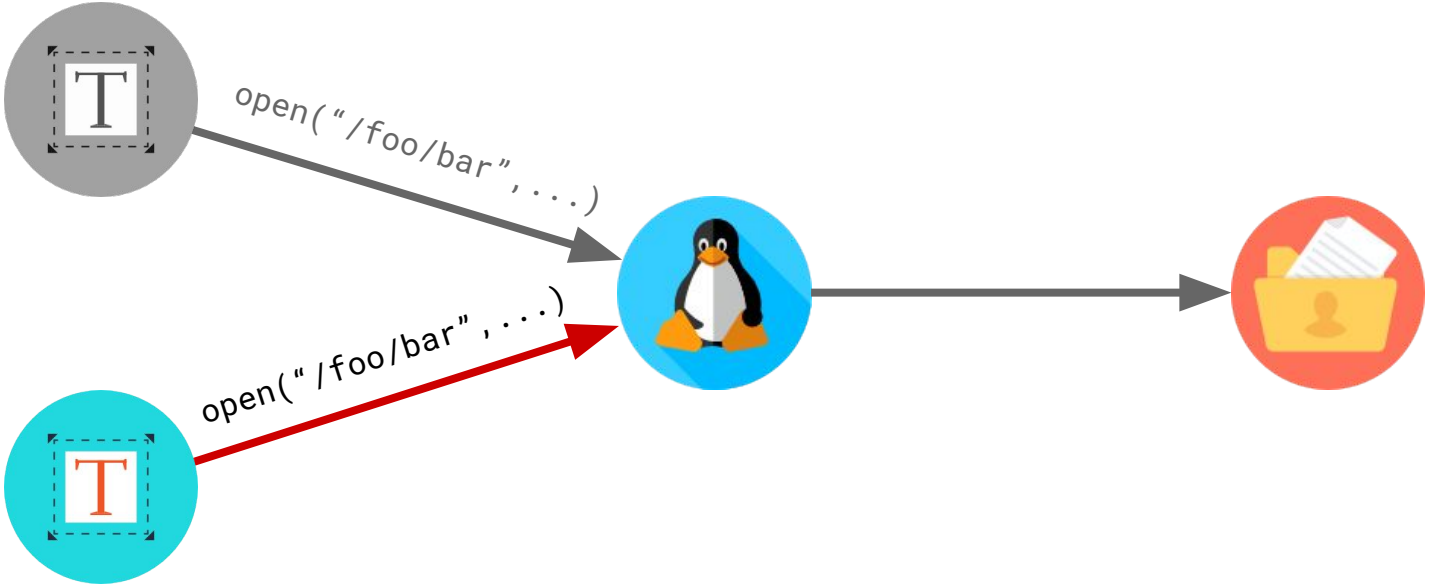
1. What are containers?



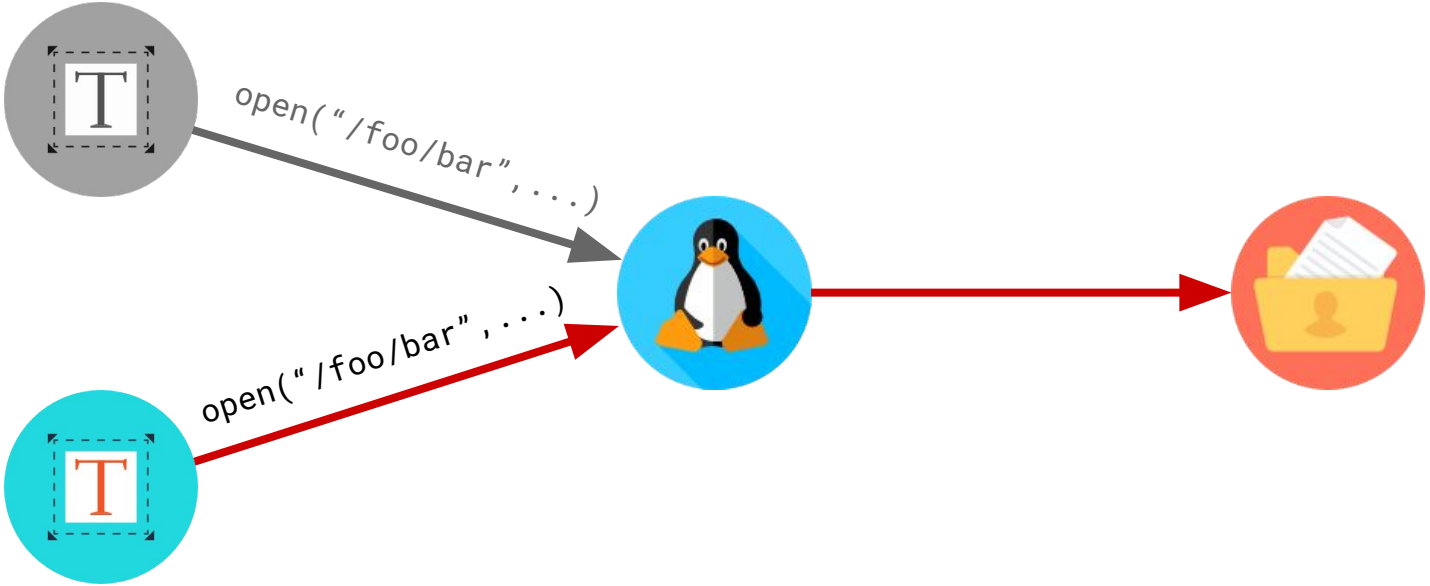
1. What are containers?



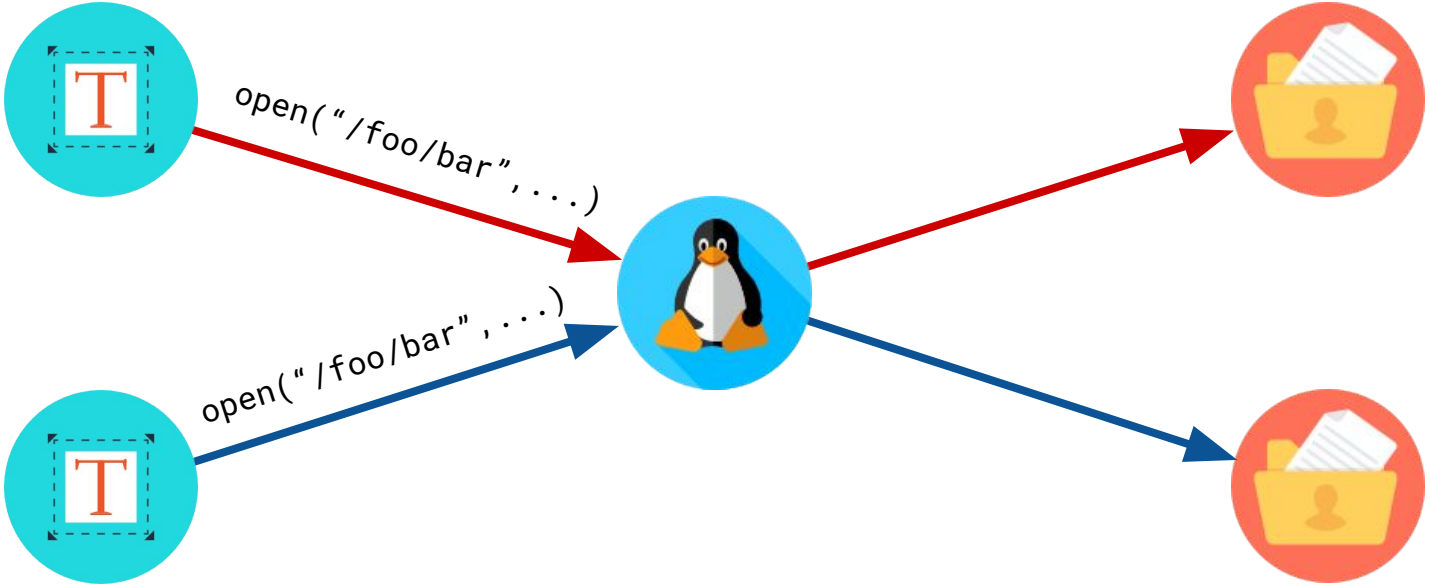
1. What are containers?



1. What are containers?



1. What are containers?



1. What are containers?

Mount

1. What are containers?

Mount

User

1. What are containers?

Mount

User

UTS

1. What are containers?

Mount

User

UTS

Network

1. What are containers?

Mount

Network

User

Process ID

UTS

1. What are containers?

Mount

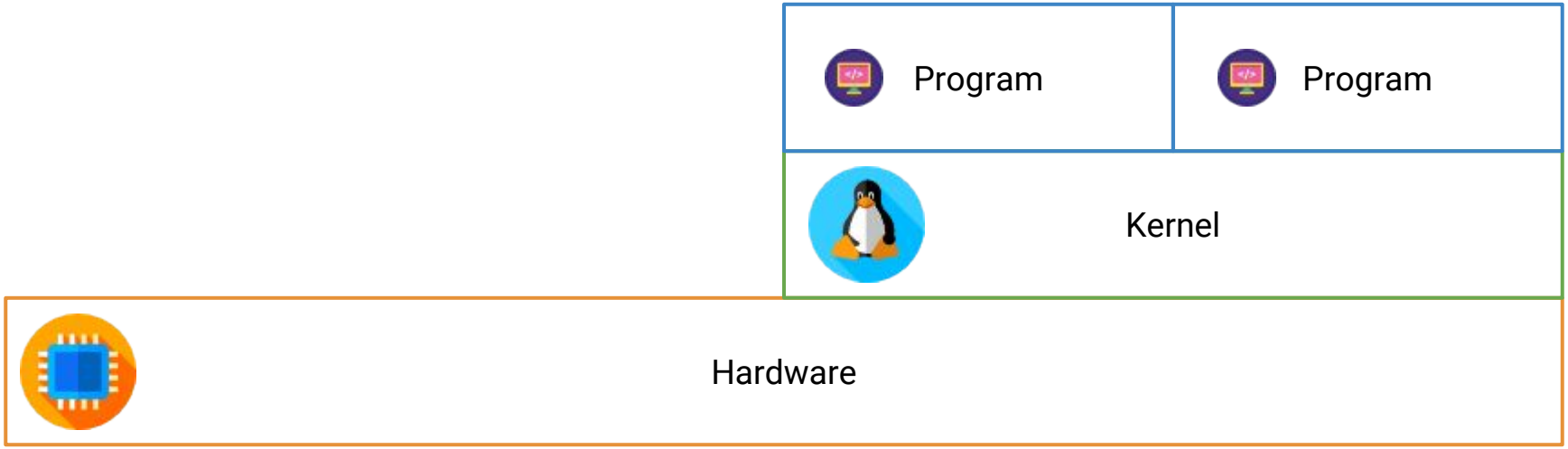
Network

User

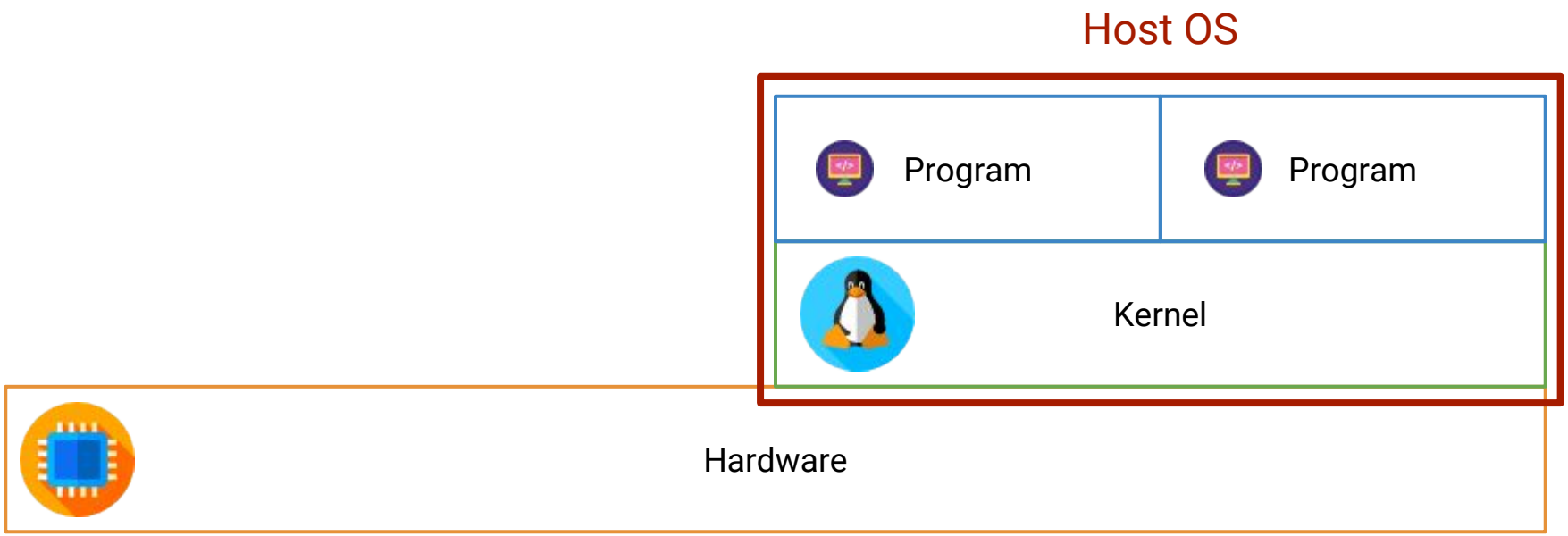
Process ID

UTS

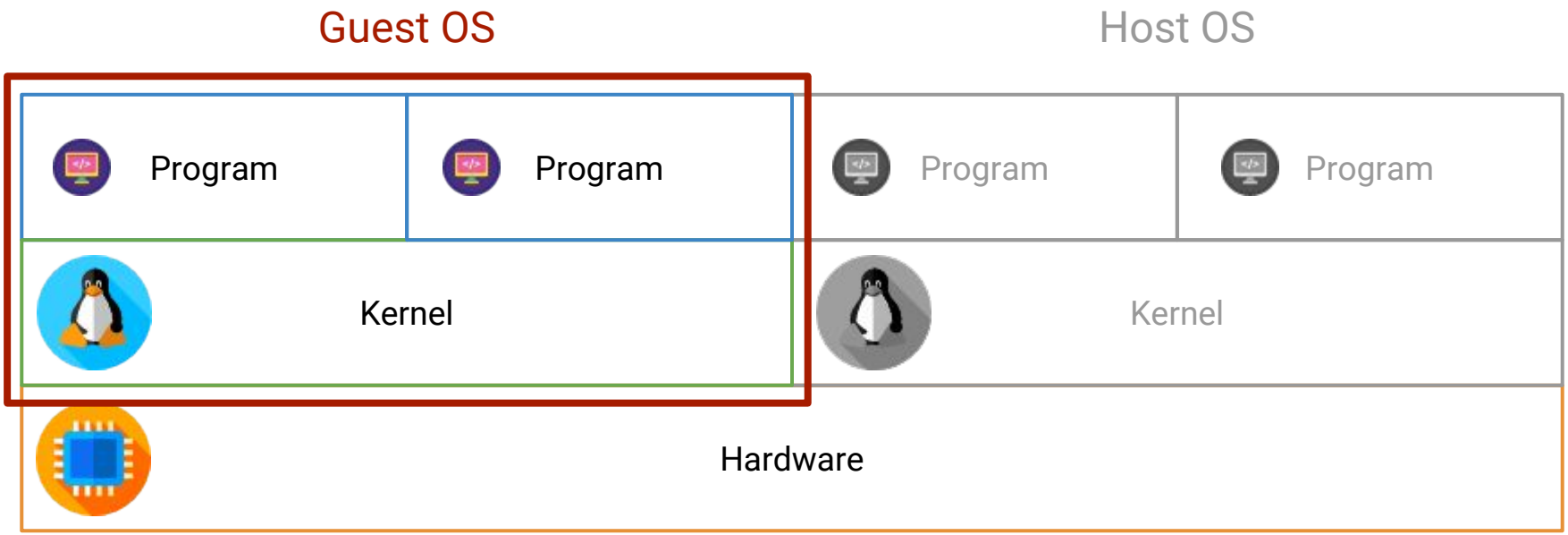
1. What are containers?



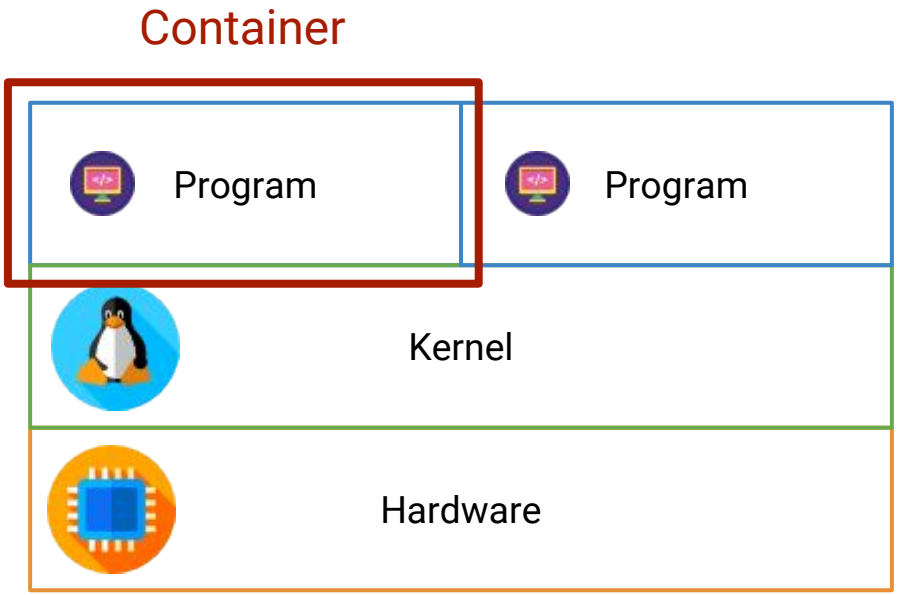
1. What are containers?



1. What are containers?



1. What are containers?



1. What are containers?

```
docker run traefik
```

1. What are containers?

```
ps auwfx
```

1. What are containers?

Host:

- `/usr/bin/dockerd`

1. What are containers?

Host:

```
├ /usr/bin/dockerd
  └ docker-containerd
```

1. What are containers?

Host:

```
├ /usr/bin/dockerd
  └ docker-containerd
    └ docker-containerd-shim
```

1. What are containers?

Host:

```
/usr/bin/dockerd
└docker-containerd
  └docker-containerd-shim
    └/traefik
```

1. What are containers?

Guest:

- /traefik

1. What are containers?

1. Capabilities

1. What are containers?

1. Capabilities
2. Linux namespaces

1. What are containers?

1. Capabilities
2. Linux namespaces
3. Seccomp

1. What are containers?

1. Capabilities
2. Linux namespaces
3. Seccomp
4. AppArmor, SELinux, etc

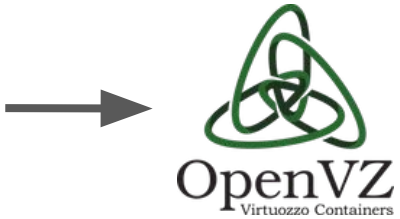
1. What are containers?

1. Capabilities
2. Linux namespaces
3. Seccomp
4. AppArmor, SELinux, etc
5. ...

2. Containerization history

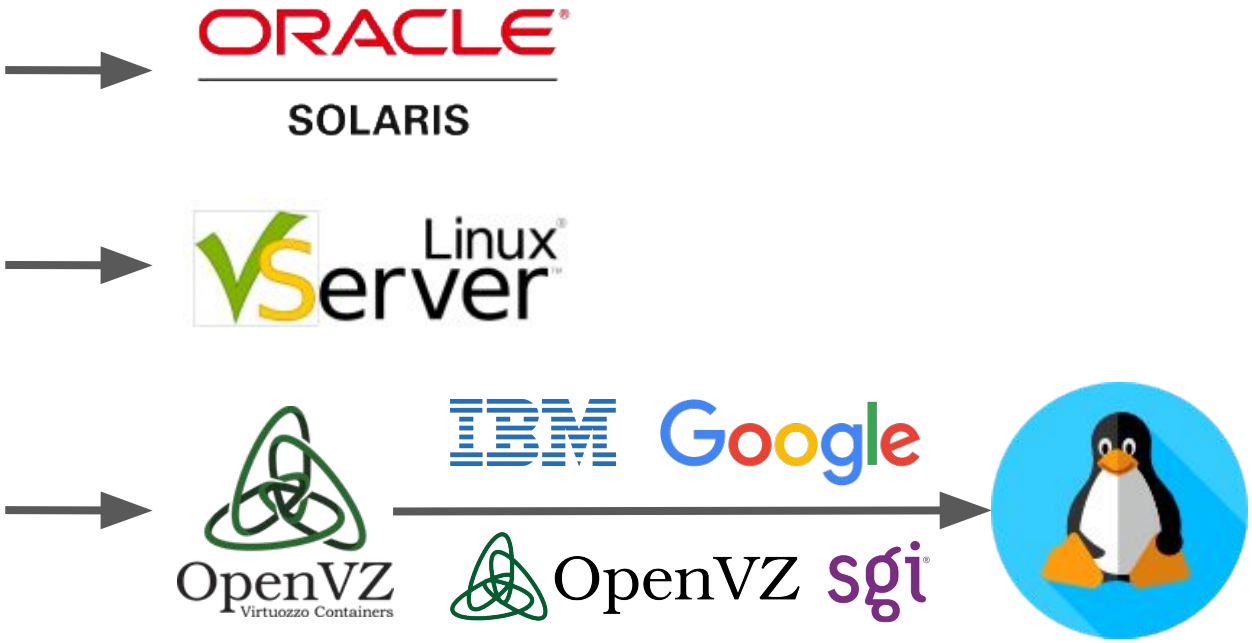
Thank you to Kir Kolyshkin (@kolyshkin) for helping me put this together.

2. Containerization history



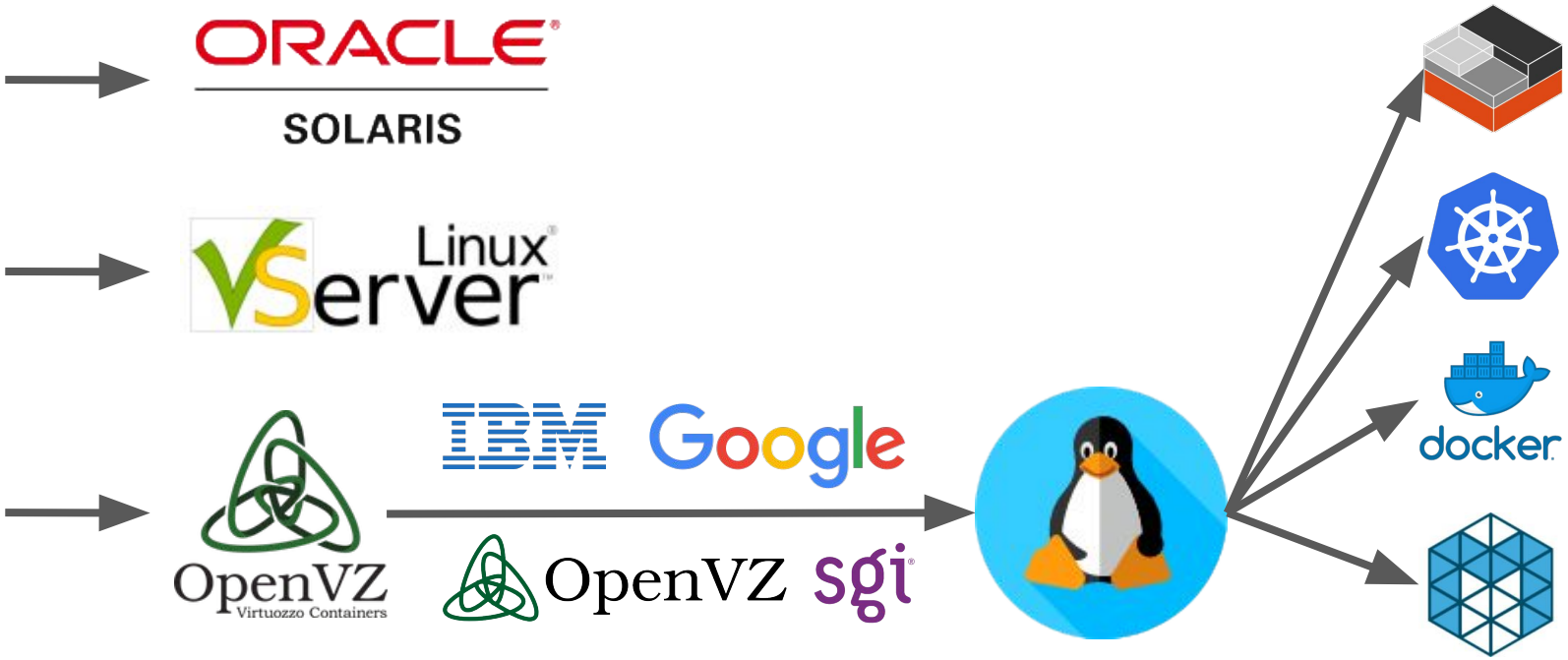
Thank you to Kir Kolyshkin (@kolyshkin) for helping me put this together.

2. Containerization history



Thank you to Kir Kolyshkin (@kolyshkin) for helping me put this together.

2. Containerization history



Thank you to Kir Kolyshkin (@kolyshkin) for helping me put this together.

2. Containerization history

A Brief History of Containers

Jeff Victor & Kir Kolyshkin

3. Capabilities

3. Capabilities

Can you run **ping** as a normal user?

(Shout the answer.)

3. Capabilities

```
$ ls -lah /bin/ping

-rwsr-xr-x 1 root root 44K May  7
2014 /bin/ping
```

3. Capabilities

SUID bit

```
$ ls -lah /bin/ping

-rwsr-xr-x 1 root root 44K May  7
2014 /bin/ping
```

3. Capabilities

CAP_NET_RAW

3. Capabilities

CAP_NET_ADMIN

3. Capabilities

Example: OpenVPN in Docker

3. Capabilities

Example: OpenVPN in Docker

```
docker run \
  --cap-add NET_RAW \
  --cap-add NET_ADMIN \

...
```

3. Capabilities

CAP_CHOWN

3. Capabilities

CAP_KILL

3. Capabilities

CAP_NET_BIND_SERVICE

3. Capabilities

`CAP_SETUID` and `CAP_SETGID`

3. Capabilities

CAP_SYS_CHROOT

3. Capabilities

CAP_SYS_NICE

3. Capabilities

libcap

libcap-ng

prctl

3. Capabilities

```
int main() {
```

3. Capabilities

```
int main() {
    capng_clear(CAPNG_SELECT_BOTH);
```

3. Capabilities

```
int main() {
    capng_clear(CAPNG_SELECT_BOTH);
    capng_apply(CAPNG_SELECT_BOTH);
```

3. Capabilities

```
int main() {
    capng_clear(CAPNG_SELECT_BOTH);
    capng_apply(CAPNG_SELECT_BOTH);
    //Start bash here
}
```

3. Capabilities

Actually, it’s quite hard…

4. Linux namespaces

3. Capabilities

```
int main() {

}
```

3. Capabilities

```
int main() {
    //stack magic





}
```

3. Capabilities

```
int main() {
    //stack magic
    pid_t childPid = clone(




    );

}
```

3. Capabilities

```
int main() {
    //stack magic
    pid_t childPid = clone(
          childFunction,




    );

}
```

3. Capabilities

```
int main() {
    //stack magic
    pid_t childPid = clone(
          childFunction,
          stackTop,


    );

}
```

3. Capabilities

```
int main() {
    //stack magic
    pid_t childPid = clone(
          childFunction,
          stackTop,
          CLONE_NEWNS | CLONE_NEWNET | SIGCHLD,

    );

}
```

3. Capabilities

```
int main() {
    //stack magic
    pid_t childPid = clone(
            childFunction,
            stackTop,
            CLONE_NEWNS | CLONE_NEWNET | SIGCHLD,
            {}
    );

}
```

3. Capabilities

```
int main() {
    //stack magic
    pid_t childPid = clone(
            childFunction,
            stackTop,
            CLONE_NEWNS | CLONE_NEWNET | SIGCHLD,
            {}
    );
    //wait for child here
}
```

3. Capabilities

```
int main() {
    //stack magic
    pid_t childPid = clone(
            childFunction,
            stackTop,
            CLONE_NEWNS | CLONE_NEWNET | SIGCHLD,
            {}
    );
    //wait for child here
}
```

3. Capabilities

```
static int childFunction(void *arg) {
    //Start bash here
}
```

3. Capabilities

`clone()`: New process in NS

3. Capabilities

`clone()`: New process in NS

`unshare()`: Existing process in NS

3. Capabilities

`clone()`:	New process in NS
`unshare()`:	Existing process in NS
`setns()`:	Join NS

3. Capabilities

```
TARGET=my_nginx_container
```

3. Capabilities

```
TARGET=my_nginx_container
docker run \
  -ti
  janoszen/debug
```

3. Capabilities

```
TARGET=my_nginx_container
docker run \
  --pid container:$TARGET \
  --net container:$TARGET \




  -ti
  janoszen/debug
```

3. Capabilities

```
TARGET=my_nginx_container
docker run \
  --pid container:$TARGET \
  --net container:$TARGET \
  --cap-add NET_RAW \
  --cap-add NET_ADMIN \
  --cap-add SYS_PTRACE \
  -ti
  janoszen/debug
```

5. Cgroups

5. Cgroups

```
cgroup on /sys/fs/cgroup/cpuset type cgroup
(rw,nosuid,nodev,noexec,relatime,cpuset)
```

5. Cgroups

```
cgcreate -g cpu,cpuacct:/my_group
```

5. Cgroups

```
cgcreate -g cpu,cpuacct:/my_group

cgclassify -g cpu,cpuacct:/my_group 26432
```

5. Cgroups

```
cgcreate -g cpu,cpuacct:/my_group

cgclassify -g cpu,cpuacct:/my_group 26432

echo "2" > /sys/fs/cgroup/cpuset/my_group/cpuset.cpus
```

5. Cgroups

`cpuset.cpus`

5. Cgroups

`cpu.shares`

5. Cgroups

`cpu.rt_runtime_us`

`cpu.rt_period_us`

5. Cgroups

`memory.limit_in_bytes`

5. Cgroups

`memory.memsw.limit_in_bytes`

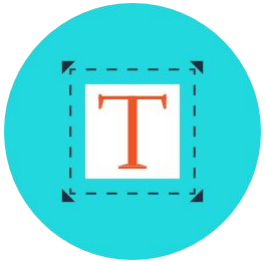
5. Cgroups

`blkio.throttle.read_bps_device`

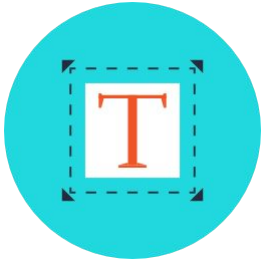
`blkio.throttle.write_bps_device`

6. Seccomp

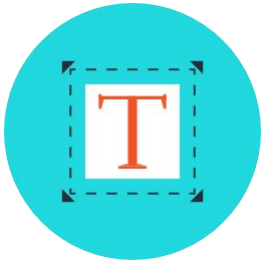
6. Seccomp

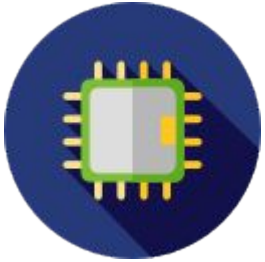


6. Seccomp

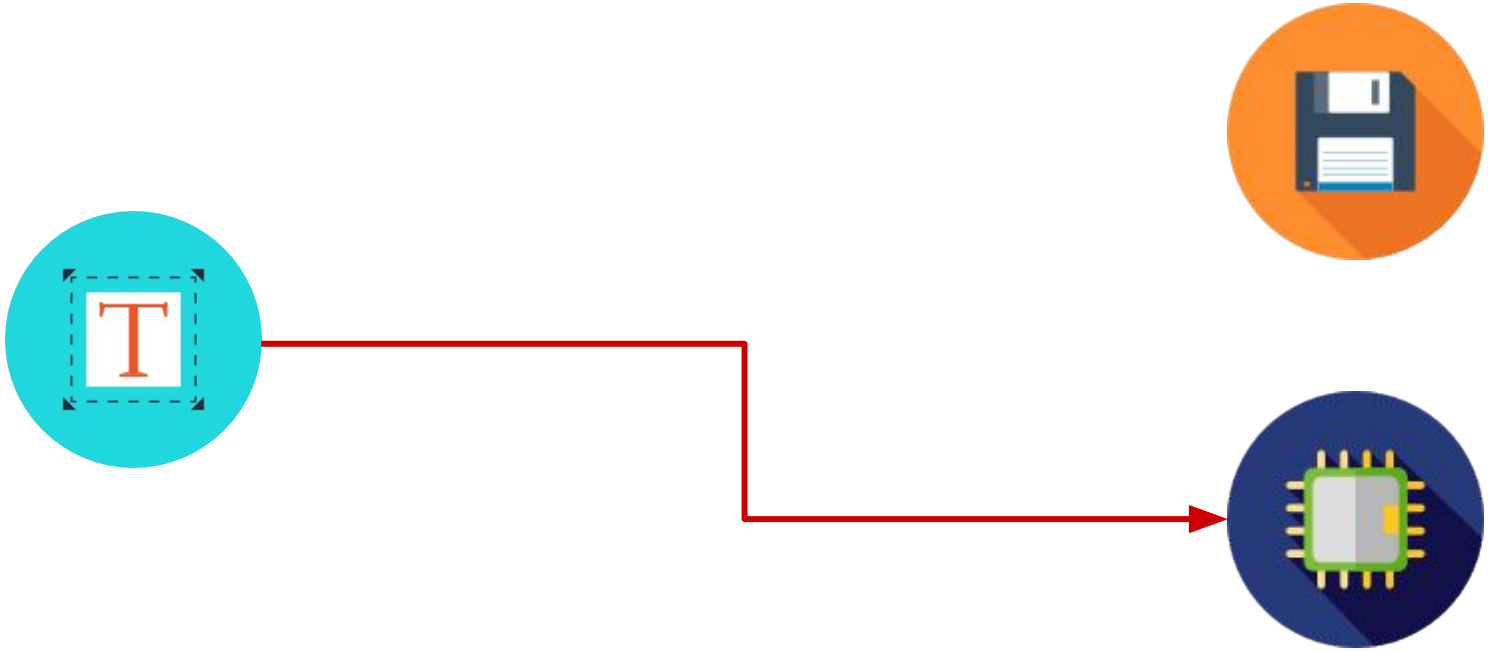


6. Seccomp

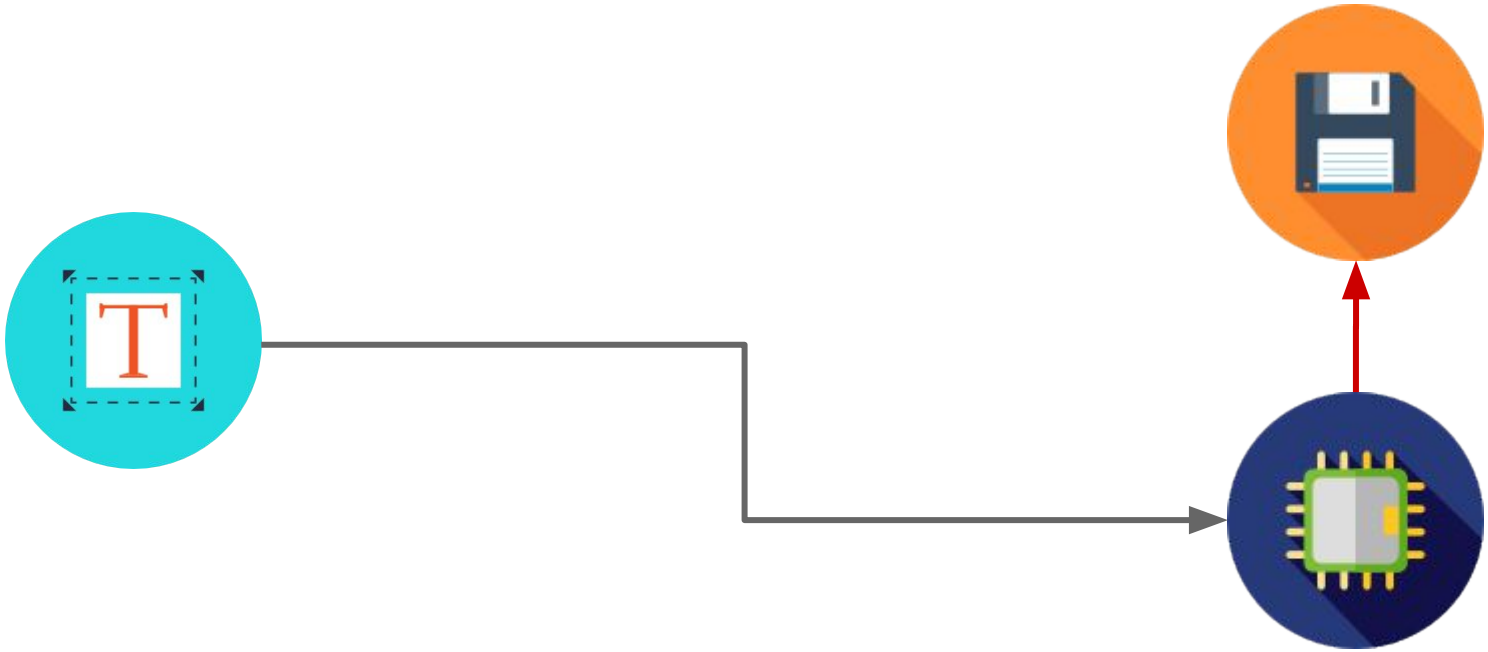




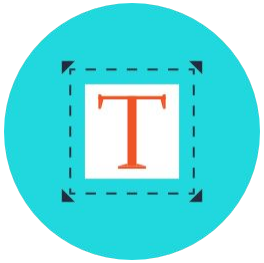
6. Seccomp

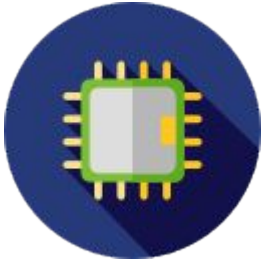


6. Seccomp

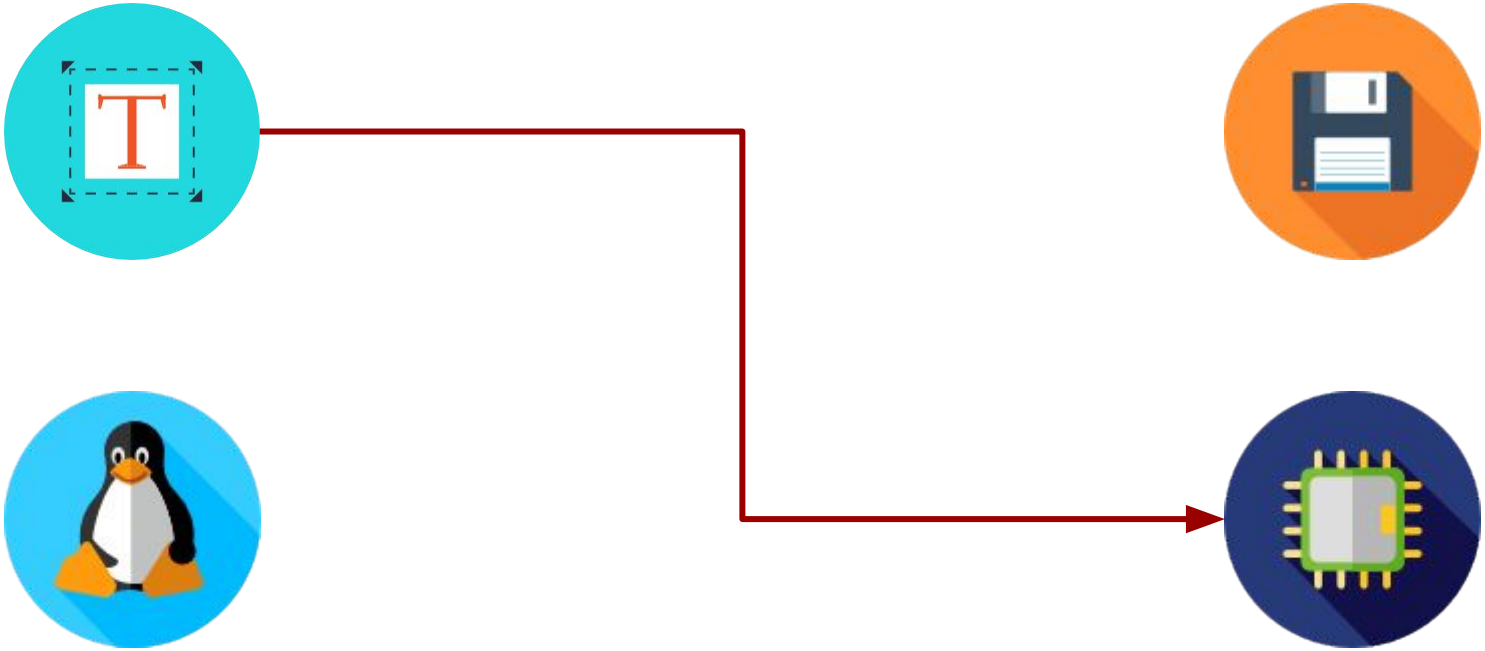


6. Seccomp

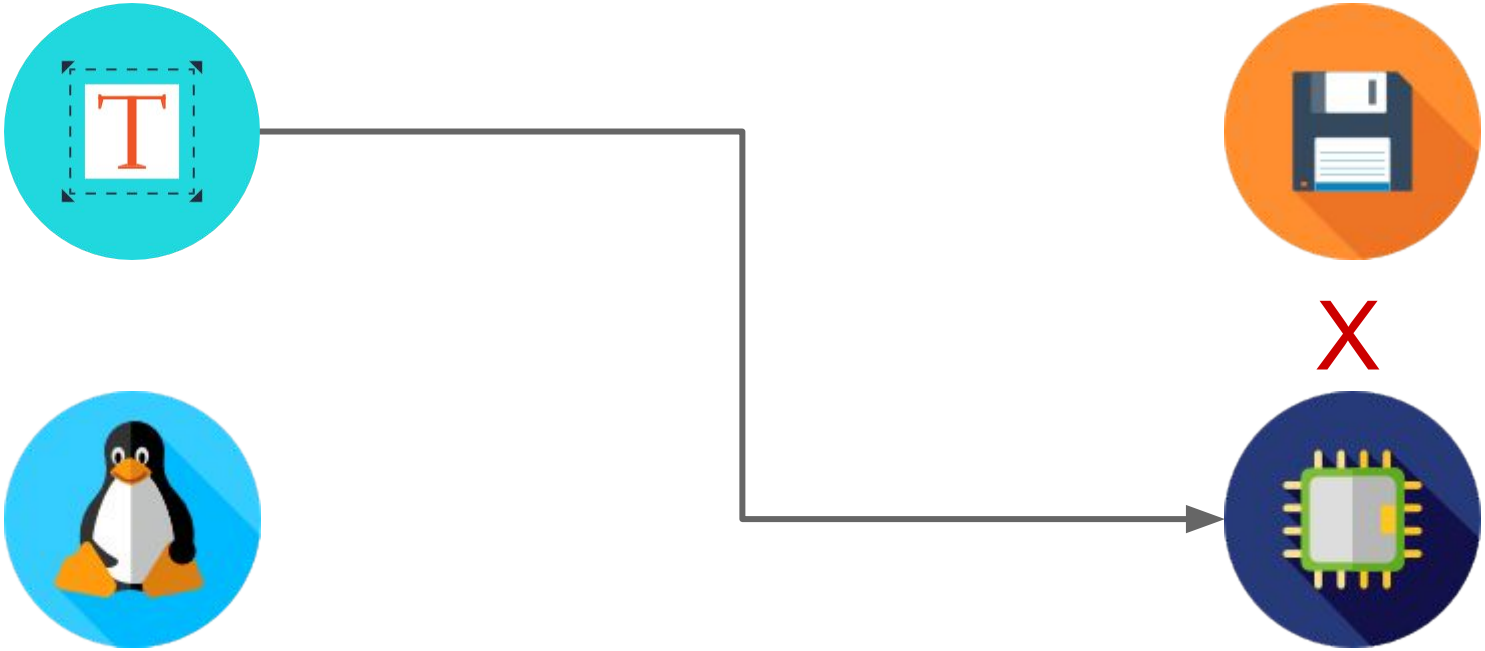




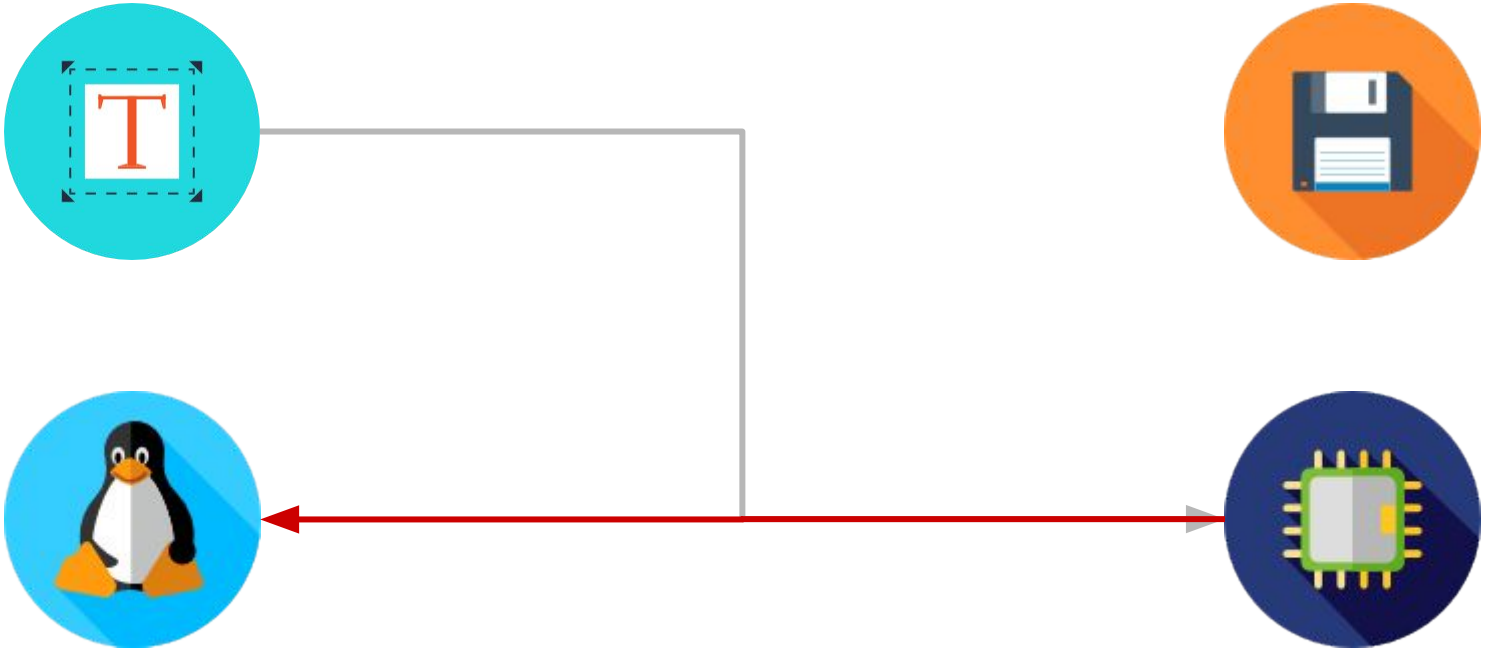
6. Seccomp



6. Seccomp

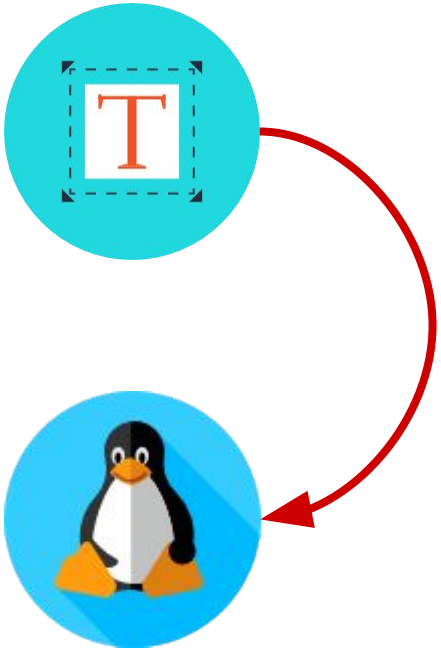


6. Seccomp



6. Seccomp

6. Seccomp



6. Seccomp

```
ctx = seccomp_init(SCMP_ACT_ALLOW);
```

6. Seccomp

```
ctx = seccomp_init(SCMP_ACT_ALLOW);

seccomp_rule_add(
    ctx,
    SCMP_ACT_KILL,
    SCMP_SYS(bind),
    0
);
```

6. Seccomp

```
ctx = seccomp_init(SCMP_ACT_ALLOW);

seccomp_rule_add(
    ctx,
    SCMP_ACT_KILL,
    SCMP_SYS(bind),
    0
);

seccomp_load(ctx)
```

7. AppArmor

7. AppArmor

```
deny network raw
```

7. AppArmor

```
deny mount
```

7. AppArmor

```
deny @{PROC}/sysrq-trigger rwklx
```

7. AppArmor

```
capability setuid
```

8. Demo

8. Demo

github.com/janoszen

8. Demo

It’s 2018; Are My Containers Secure Yet?!

Phil Estes @ 11:10

Questions?

@janoszen

Slide design by Bence Santha