Introduction to OS-Level Virtualization on Linux

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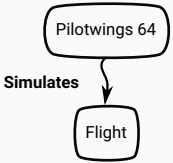
May 25th, 2020

What are Simulation, Emulation, Virtualization?



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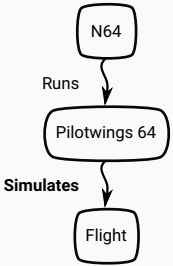

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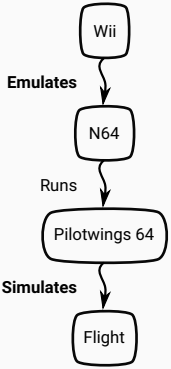

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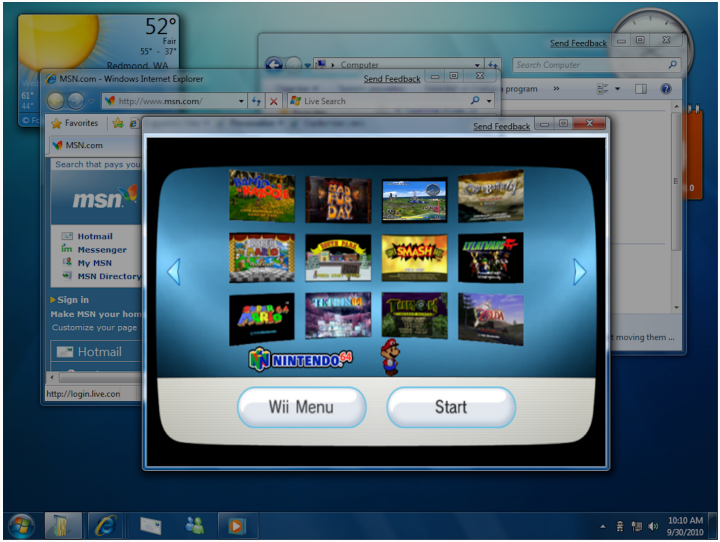

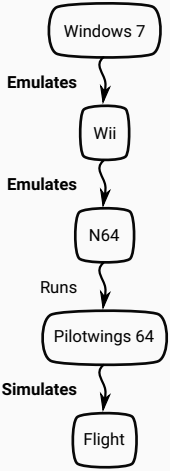

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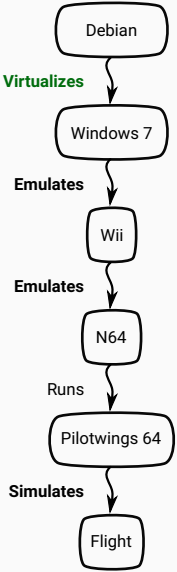

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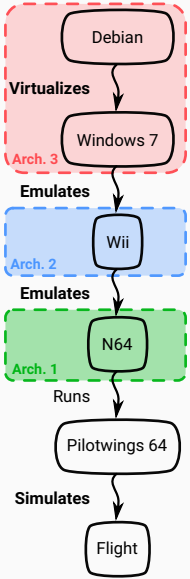
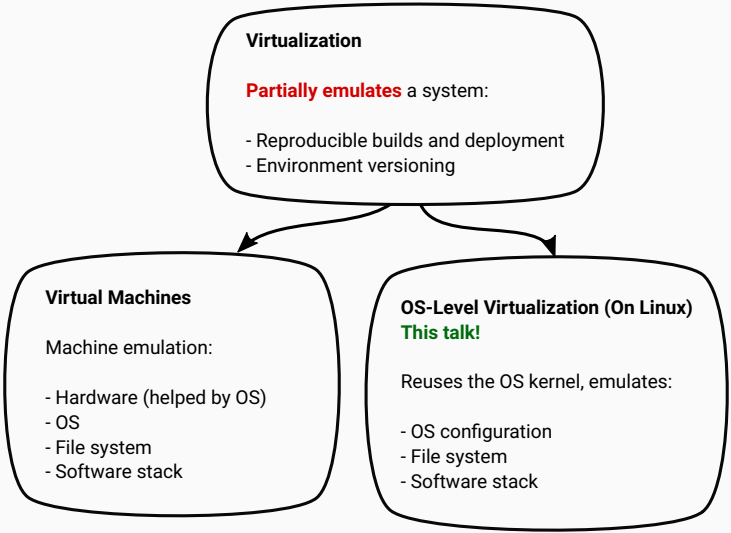


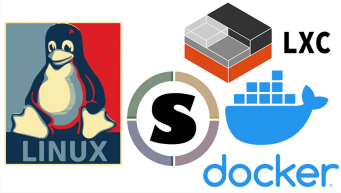
OS-Level Virtualization

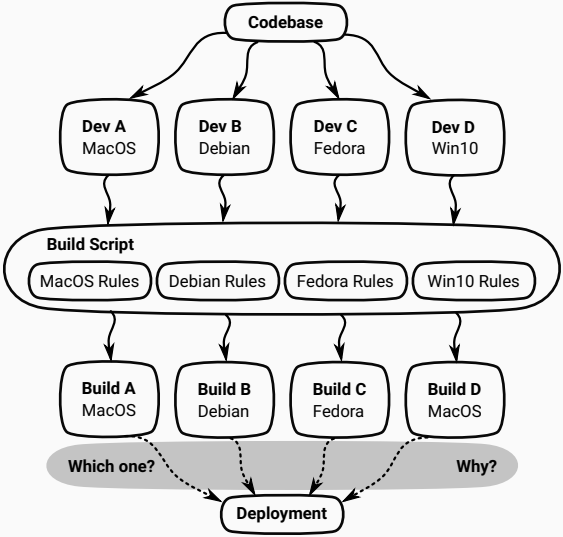


OS-Level Virtualization: Scope of this Talk

Scope

- Why should you use containers?
  - Reproducible builds
  - Environment versioning
  - It's also easier
- How do containers work?
- What tools are available?





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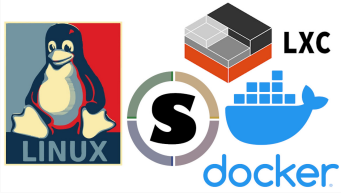
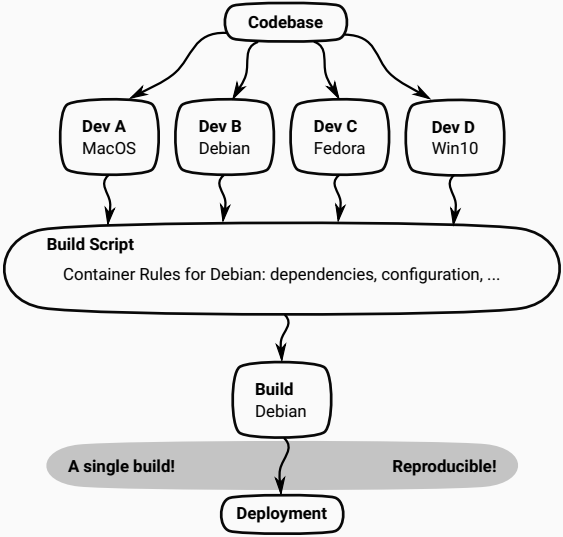
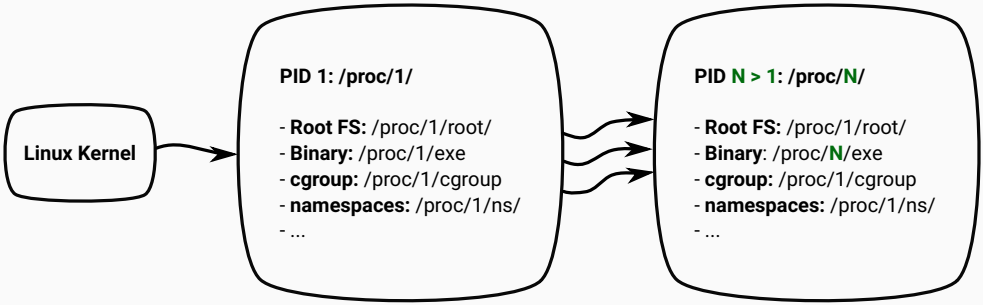




OS-Level Virtualization on Linux



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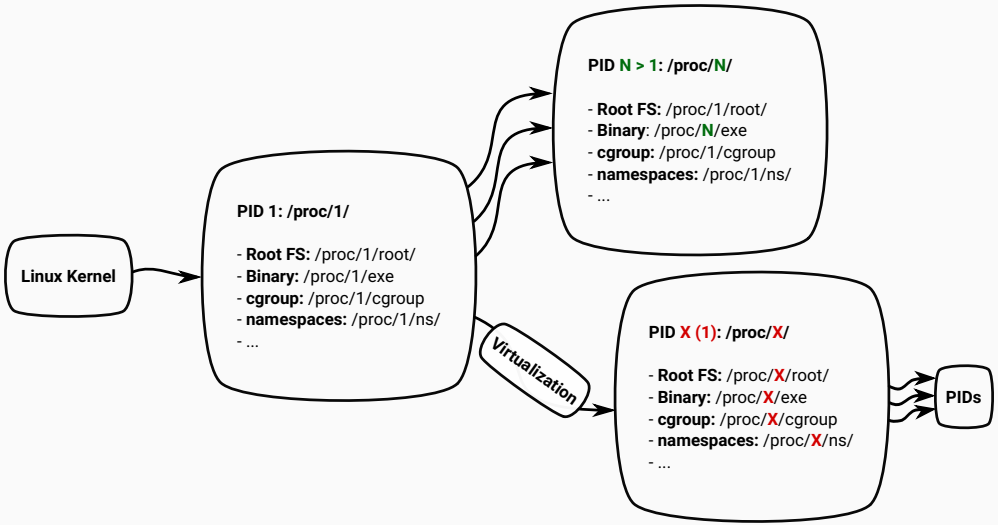
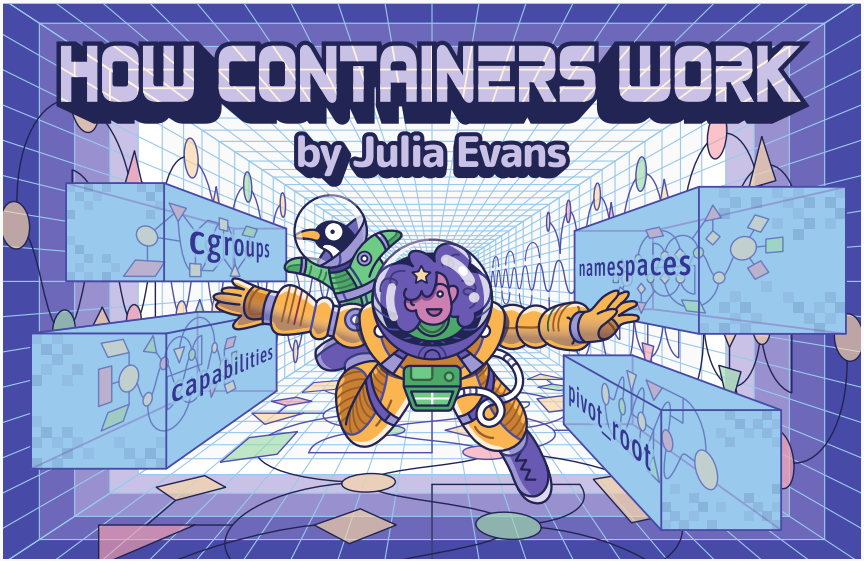


How do Containers Work?



How do Containers Work?

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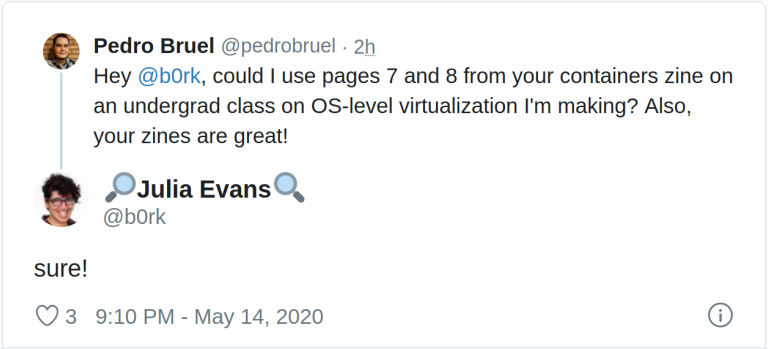

containers = processes

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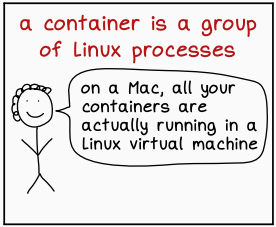

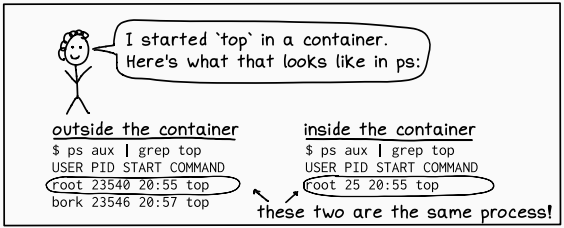

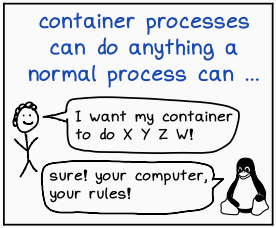

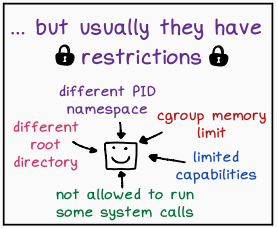

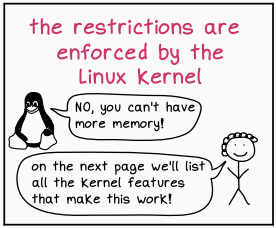

container kernel features

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containers use these Linux kernel features

"container" doesn't have a clear definition, but Docker containers use all of these features.

♥ pivot_root ♥

set a process's root directory to a directory with the contents of the the container image

★ cgroups ★

limit memory/CPU usage for a group of processes

♥ namespaces ♥

allow processes to have their own:

- → network
- → mounts
- → PIDs
- → users
- → hostname
- + more

★ capabilities ★

security: give specific permissions

♥ seccomp-bpf ♥

security: prevent dangerous system calls

★ overlay filesystems ★

this is what makes layers work! Sharing layers saves disk space & helps containers start faster

Containers from Scratch: Obtaing an Image

An image usually means:

- A root file system, and
- Some metadata

We will use the Alpine distribution:

- It's root FS has only 2.4MB
- No need for metadata

Bash Script

```
#!/usr/bin/bash

IMG_DIR="alpine_img"
IMG_REPO="https://us.images.linuxcontainers.org/images"
IMG_URL="$IMG_REPO/alpine/3.11/amd64/default/20200521_13:00/rootfs.tar.xz"
[ ! -d $IMG_DIR ] && \
    mkdir -p $IMG_DIR && \
    curl $IMG_URL | tar xJ -C $IMG_DIR
cd $IMG_DIR
```

Containers from Scratch: Creating cgroups and Setting Limits

We will create a cgroup allowing up to:

- 50% CPU usage: 512/1024 shares
- 10GB of RAM

Script

```
CGROUP_ID="MAC0475-145"
sudo cgcreate -g "cpu,cpuacct,memory:$CGROUP_ID"
sudo cgset -r cpu.shares=512 "$CGROUP_ID"
sudo cgset -r memory.limit_in_bytes=10000000000 "$CGROUP_ID"
```

Containers from Scratch: Launching our Alpine Container

- cgexec: Runs using a cgroup
- unshare: Runs with new namespaces
- chroot: Changes root of the file system
- mount: Here, mounts a new proc directory
- sh: Starts a shell on the container
- We could install depencies now

Script

```
HOSTNAME="alpine-container"
sudo cgexec -g "cpu,cpuacct,memory:$CGROUP_ID" \
     unshare -fmuipn --mount-proc \
     chroot "$PWD/" \
     /bin/sh -c "PATH=/bin && mount -t proc proc /proc && hostname $HOSTNAME && sh"
```

And some cleanup after:

```
sudo cgdelete cpu,cpuacct,memory:/$CGROUP_ID
```