CONTAINERS & DOCKER

HOMELAB CLUB AT UMD

10/07/2025

“WELL, IT WORKS ON MY MACHINE”

THE PROBLEM

Development and production environments vary greatly

OPERATING SYSTEM

ENVIRONMENT VARIABLES

INSTALLED APPLICATIONS

THE SOLUTION

CONTAINERS

AND VIRTUAL MACHINES

WHAT DOES A CONTAINER DO?

- Provides a separate environment for an application or group of applications that is lightweight and portable
  - Isolated (contained haha)
  - Scalable
  - Consistent

HOW DO I START USING CONTAINERS?

Many providers of container services, each with their own pros and cons

- Docker
- Podman
- Kubernetes
- Portainer
- …

Docker is the simplest and most widely used, so we will show how to use that

IMAGES

The building block for containers

Contains:

- Files
- Binaries
- Libraries
- Configurations

Essentially a "snapshot" of an environment

CREATING AN IMAGE IN DOCKER

Use a Dockerfile!

Create a file named “Dockerfile” and put in whatever commands you need

COMMON COMMANDS

- `FROM <image>` - specify the base image.
- `WORKDIR <path>` - sets the working directory in the image.
- `COPY <host-path> <image-path>` - copies files from the host to the image.
- `RUN <command>` - run the specified command in the default shell.
- `ENV <name> <value>` - set an environment variable in the image.
- `EXPOSE <port-number>` - expose a port on the image and set it to use a host’s port.
- `USER <user-or-uid>` - set the user for all following instructions.
- `CMD ["<command>", "<arg1>"]` - run the given command when the container is started.

BUILD AND RUN

To build an image from a Dockerfile, simply type into a terminal

```
docker build .
```

This will create an image in the current directory.

To run it from there, type in

```
docker image ls
```

Identify the image that you want to run

```
docker run <image>
```

COMPARISONS

CONTAINERS VS. VIRTUAL MACHINES (VM)

Containers:

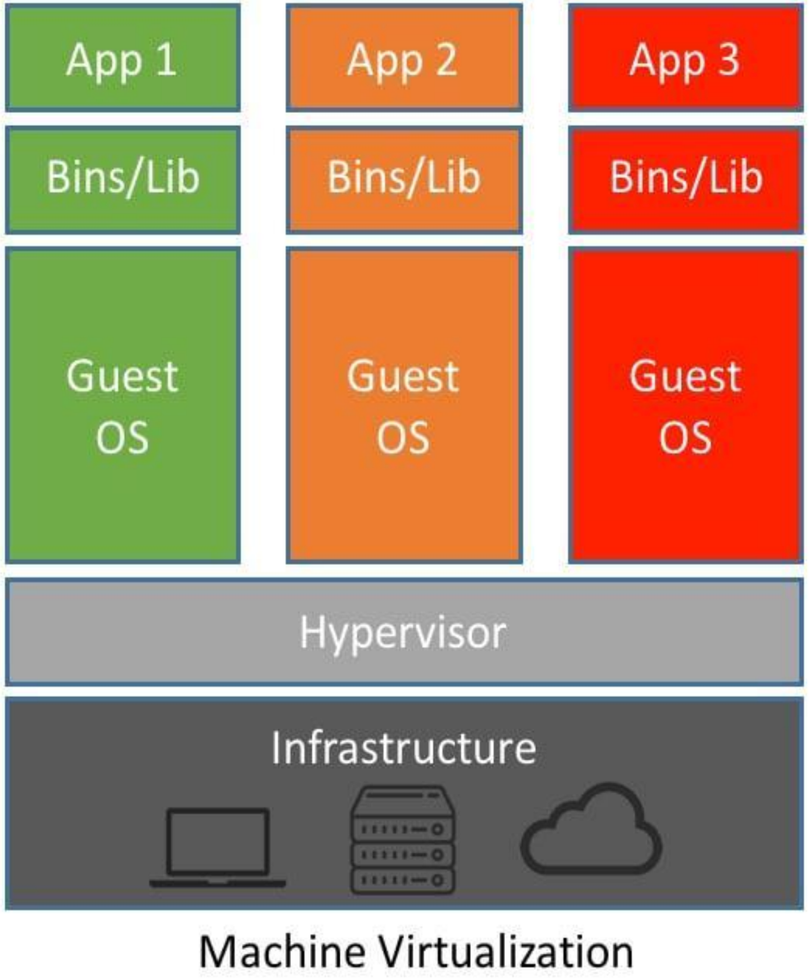
Share kernel space with the host machine

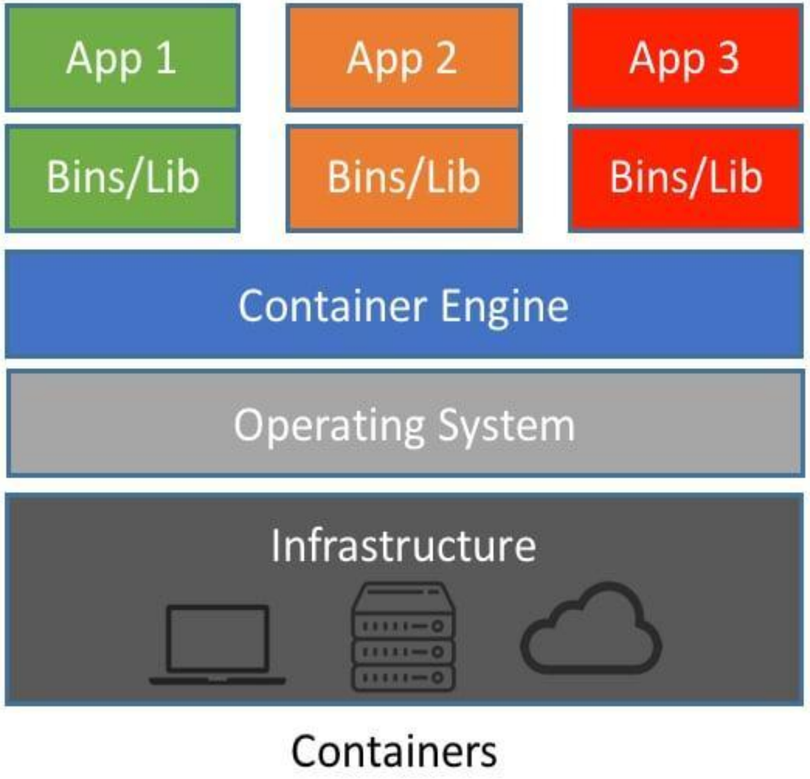
- Pros
  - Lightweight
  - More portable and scalable
- Cons
  - Less secure

VMs:

Ship with their own Operating System and kernel space

- Pros
  - Better segmentation = more secure
- Cons
  - Require more resources than a container


App 1
App 2
App 3
Bins/Lib
Bins/Lib
Bins/Lib
Guest OS
Guest OS
Guest OS
Hypervisor
Infrastructure
Machine Virtualization


App 1
App 2
App 3
Bins/Lib
Bins/Lib
Bins/Lib
Container Engine
Operating System
Infrastructure
Containers

CONTAINER RUNTIMES

Docker

- Pros
  - All-in-one, can build and execute containers
  - Very widespread
- Cons
  - Typically requires root privileges

Podman

- Pros
  - Daemon-less
  - Root-less
  - Compatible with docker images
- Cons
  - Doesn’t have its own image creation tool
  - Requires more setup

CONTAINER DEEP DIVE

DEPENDENCIES

Containers rely* on three different linux technologies in order to function

- Namespaces
- Chroot
- Cgroups

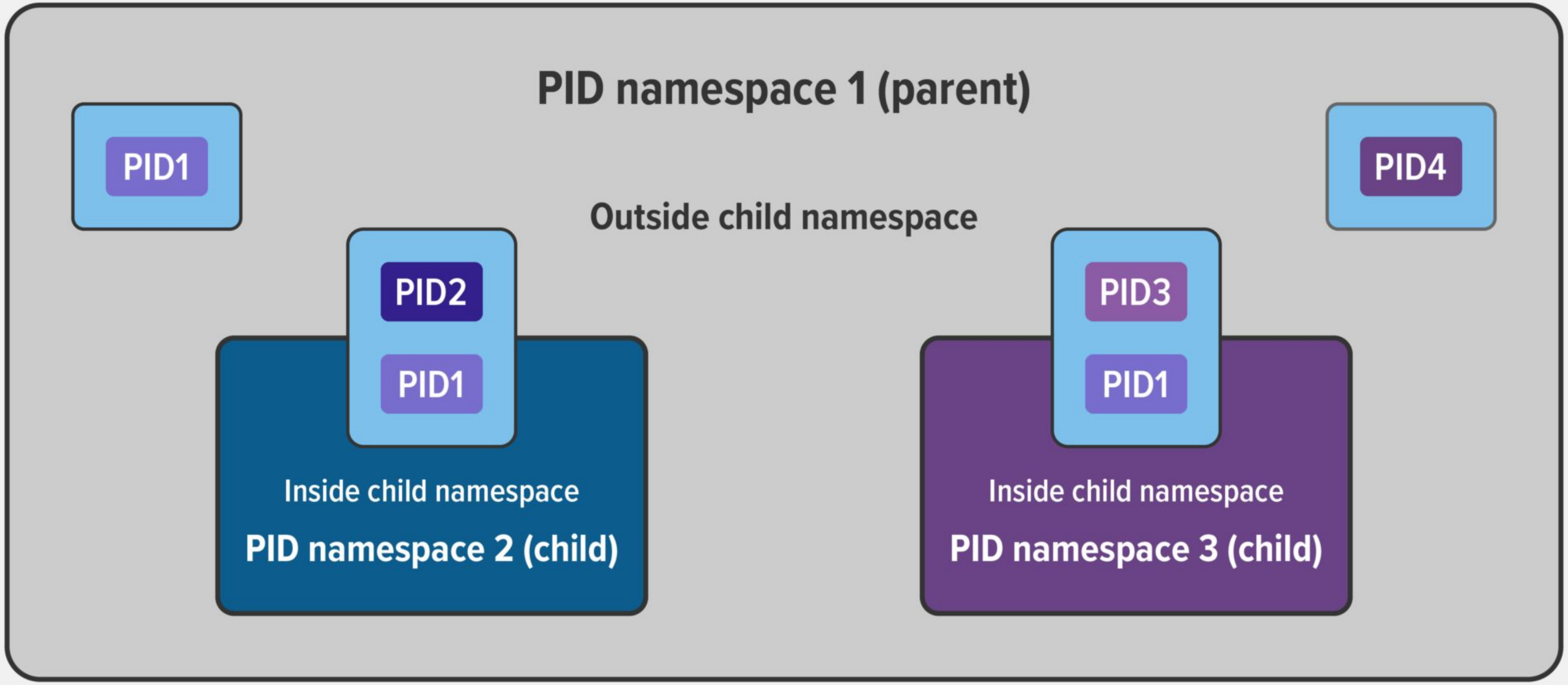
NAMESPACES

Namespaces are a tool that is useful in isolating processes on a linux machine.

They partition **<u>software</u>** resources that limit what resources certain processes can see.

There are different kinds of namespaces in linux

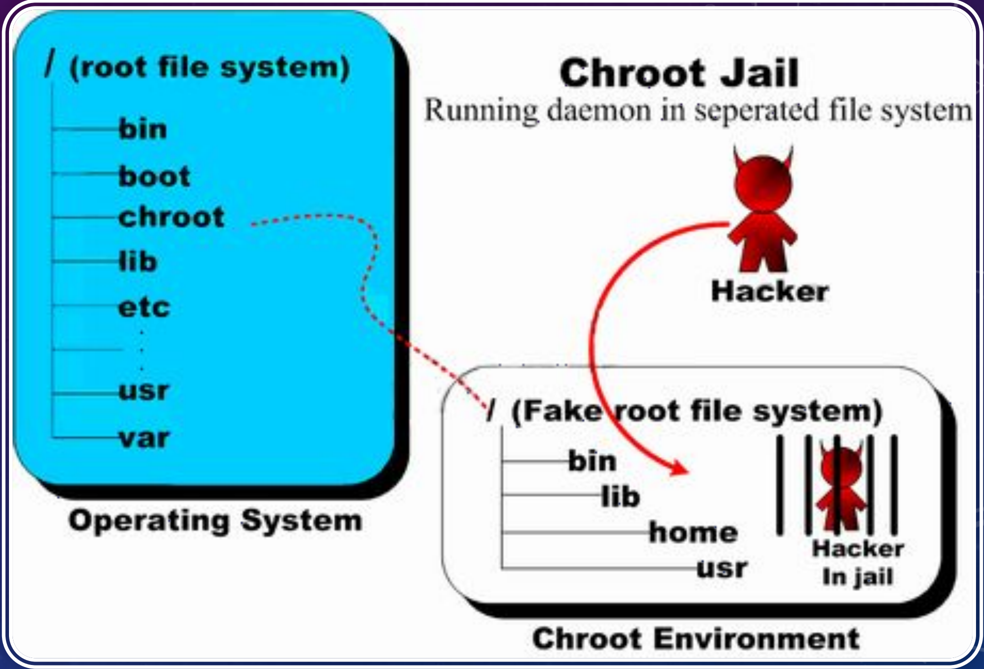
- User namespaces
- Process ID(PID) namespaces
- Network namespaces
- Mount namespaces
- …



Example of a PID namespace

CHROOT

This is a Linux command that will change the root filesystem for a process



CGROUPS

Cgroups are useful for managing **hardware** resources in sets of processes

Resource limits
set a hard limit for the amount of resources a cgroup can use

Prioritization
You can give one cgroup a higher proportion of resources compared to others when they contend for resources

Accounting
resource usage is monitored at the cgroup level

Control
processes in a cgroup can be frozen, stopped, and restarted all at once

QUESTIONS, COMMENTS, CONCERNS?

Website

Discord

Terplink