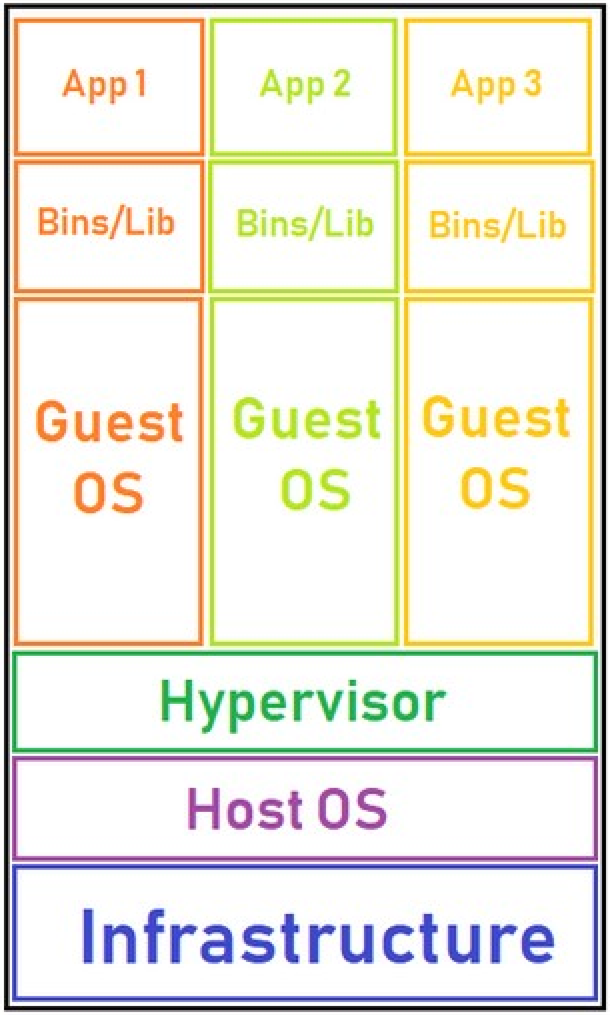
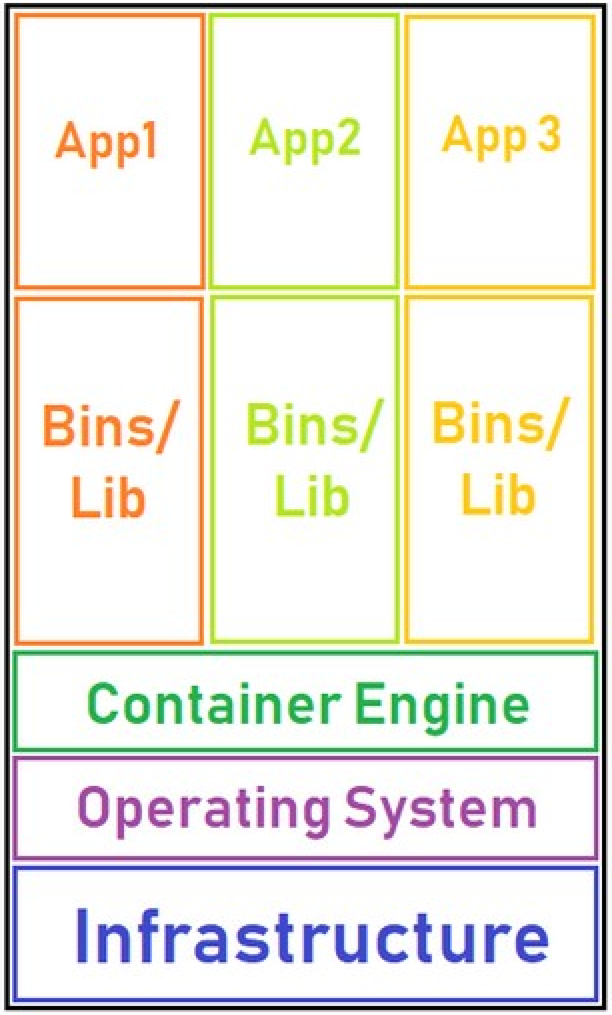
Images and Containers

Virtualization vs Containerization

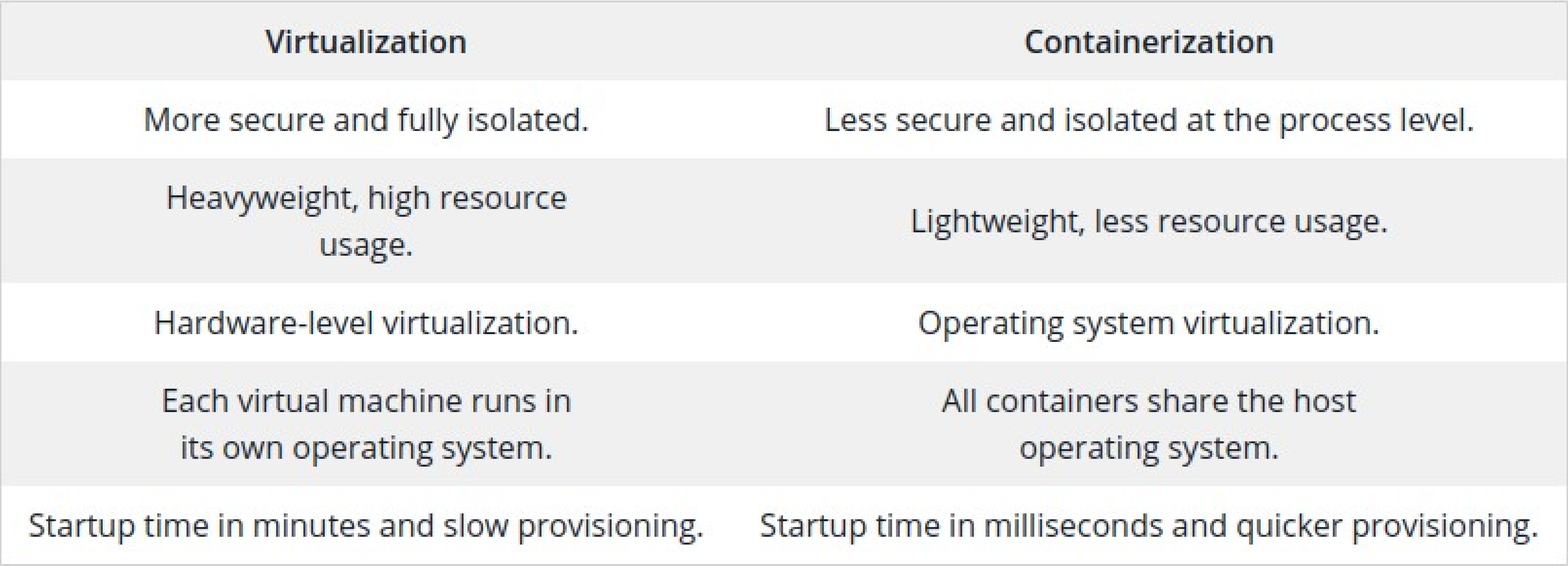


Virtualization



Containerization

Virtualization vs Containerization



Virtualization	Containerization
More secure and fully isolated.	Less secure and isolated at the process level.
Heavyweight, high resource usage.	Lightweight, less resource usage.
Hardware-level virtualization.	Operating system virtualization.
Each virtual machine runs in its own operating system.	All containers share the host operating system.
Startup time in minutes and slow provisioning.	Startup time in milliseconds and quicker provisioning.

Container runtime

LXC containers

LXC containers are part of the Linux open-source program. They allow you to run multiple isolated Linux systems on one host for application environments that resemble a VM. LXC containers operate independently instead of being managed by a central-access program.

Docker

Docker is a collection of platforms that can be used to create, manage, and deploy Linux application containers at the OS-level. Docker containers are hosted on a Docker Engine that is the client-server application host.

CRI-O

CRI-O is the implementation of Kubernetes Container Runtime Interface (CRI) for Open Container Initiative (OCI) runtime. It’s an open-source tool that’s a lightweight container engine replacement for Docker in Kubernetes. Using CRI-O enables Kubernetes to use OCI-compliant runtime for running pods.

Podman

Podman is an open-source containerization engine that, unlike Docker, doesn’t use a central daemon, enabling the creation and deployment of self-sufficient and isolated containers. The design of Podman containers is security-focused through isolation and user privileges with standard non-root access.

Containerd

Containerd is a daemon that’s compatible with both Windows and Linux environments. It’s an abstracted interface layer between the container engines and runtime, allowing for easier management of containers. It’s an open-source project that originated as one of the primary building blocks of Docker before separating.

runC

runC is a lightweight container runtime that’s OS-universal. It started out as a low-level Docker component that helped with the security and architecture of the platform. Using the stand-alone version of the tool, runC is a container runtime that isn’t tied to a specific container type, cloud provider, or hardware.

Docker Engine

- The Docker engine is the core software that runs and manages containers

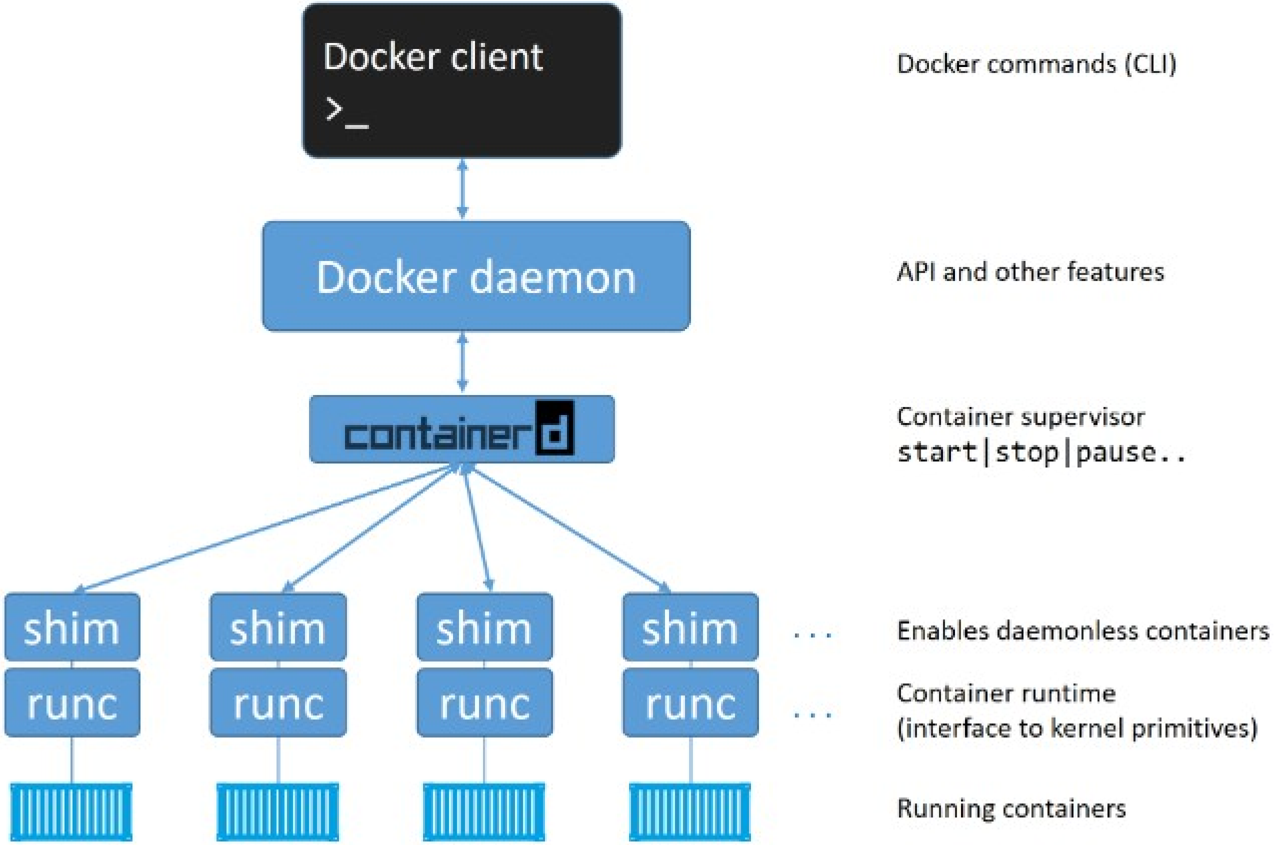
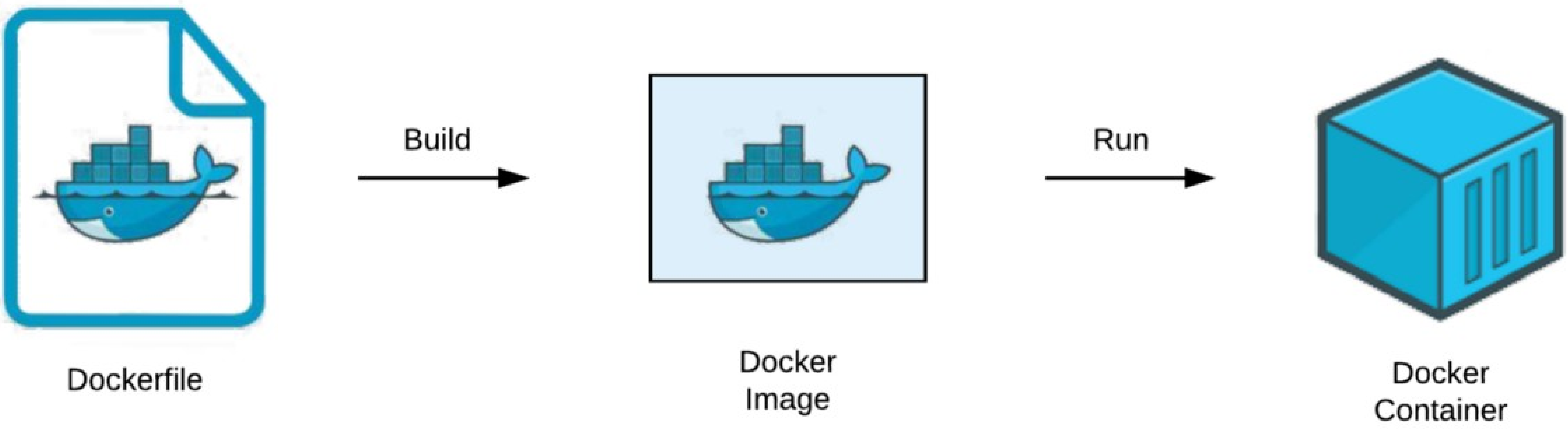


Figure 5.3

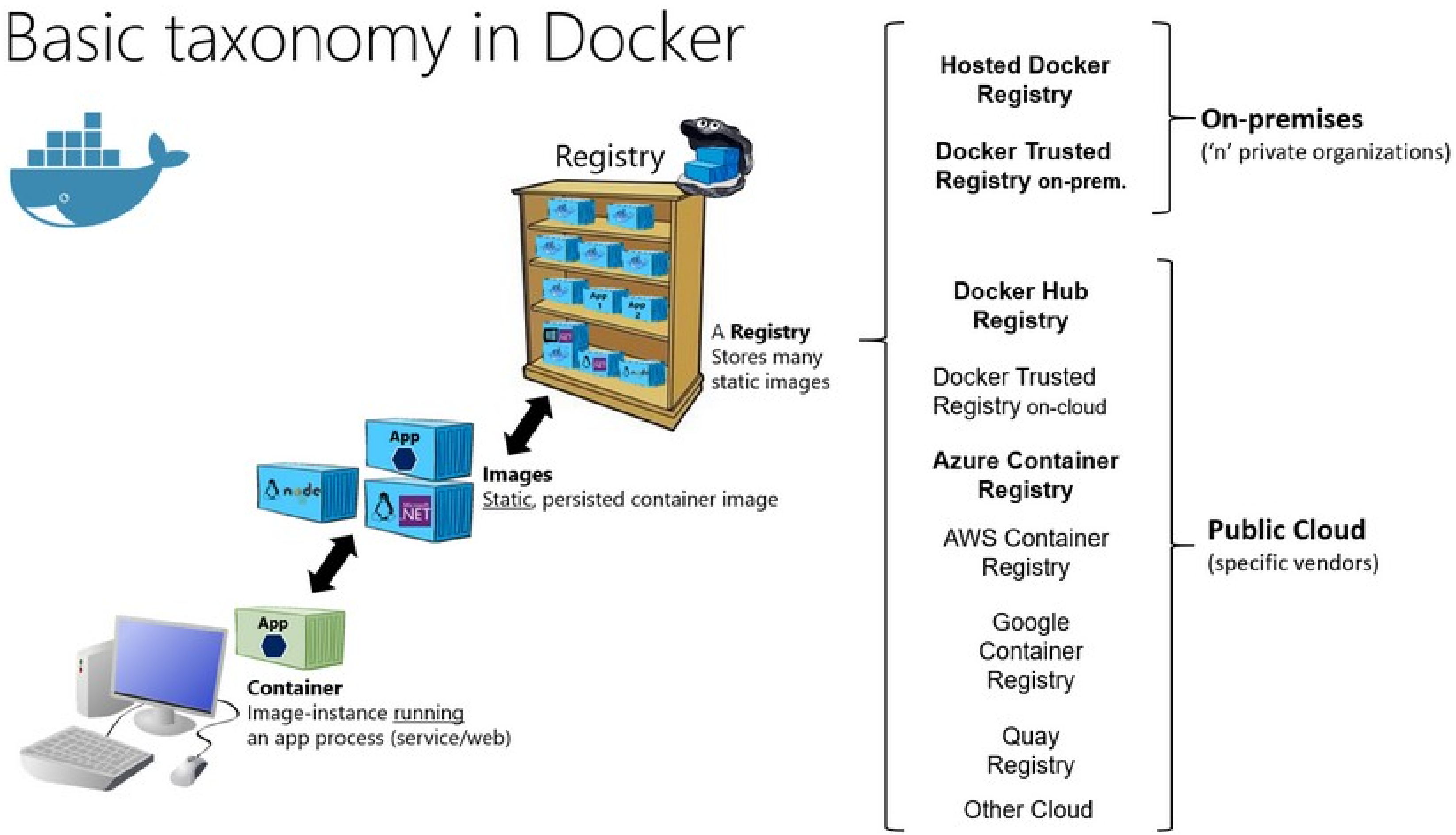
From Dockerfile to container

- The Dockerfile takes the place of the provisioning script. A Docker image can be run as an application. This running application sourced from a Docker image is called a Docker container.



Docker registry

The images can be stored in a registry private or public



Quickstart Docker

- Sign in https://hub.docker.com/
- Install docker https://docs.docker.com/engine/install/
- https://docs.docker.com/engine/install/linux-postinstall/

Basic docker commands

Create a file run.py with the following content:

```
print("Hello Docker - PY")
```

```
FROM python              ← reuse an already existing image
ADD . .                  ← add src code
CMD python run.py        ← execute runtime
```

```
docker build . -t test-python
docker run test-python
docker inspect test-python
```

Basic docker commands (IMAGES)

docker images -> list existing images
docker search ubuntu -> find images in public registry
docker image pull ubuntu:latest -> download image from registry to local

docker info -> get info on the engine
sudo ls /var/lib/docker -> browse docker engine files
docker ps -> list instances

Basic docker commands (BUILD)

ENV: available a runtime
ARG: available only during build

Assignement:
Edit the file run.py adding an env variable MY_VAR

```
import os
my_var =os.environ['MY_VAR']
print("Hello Docker – {my_var}")
```

provide the env var to the dockerfile, build and run the image

```
docker build . testynov2
docker run -e MY_VAR="ynov” testynov2
```

Basic docker commands (RUN)

docker run -it ubuntu:latest -> run an image interactive

docker run -it ubuntu:latest ls -> override default command (bash) with ls

docker run -it --entrypoint ls ubuntu:latest /bin -> override the entrypoint and add CMD at the end

ENTRYPOINT: is used when we want the user to avoid overriding the default executable

CMD: is the default command it can be overrided by user

execution order: ENTRYPOINT + CMD

<u>Assignement:</u>

Modify the Dockerfile to provide arguments at runtime

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument('-H', '--host', default='localhost', dest='host', help='Provide destination host. Defaults to localhost', type=str)
args = parser.parse_args()
print('Quiet mode is %r.' % args.quiet)
```

Basic docker commands (others)

docker run -it -v $(pwd)/datadir:/usr/local/datadir ubuntu:latest -> run a container with datadir available

docker run -it -u 1000 ubuntu:latest -> run a container as user 1000

docker run -n myubuntu -d ubuntu:latest sleep 5000 -> run a container demonized

docker exec -it myubuntu -> exec in a container

docker stop myubuntu -> stop a container

docker rm myubuntu -> rm a container

Dockerfile best practices

- Separation of concern: Ensure each Dockerfile is, as much as possible, focused on one goal. This will make it so much easier to reuse in multiple applications.
- Avoid unnecessary installations: This will reduce complexity and make the image and container compact enough.
- Reuse already built images: There are several built and versioned images on Docker Hub; thus, instead of implementing an already existing image, it's highly advisable to reuse by importing.
- Have a limited number of layers: A minimal number of layers will allow one to have a compact or smaller build. Memory is a key factor to consider when building images and containers, because this also affects the consumers of the image, or the clients.

Dockerfile tuning

1. always use versioning on images:

es. use FROM python:slim-bullseye instead of python

2. reduce size of image

docker image ls python:latest → 921MB

docker image ls python:slim-bullseye → 126MB

docker image ls python:3.10-alpine → 48.7MB

Dockerfile tuning

3. run executables as unprivileged users:

define a USER in the Dockerfile with limited privileges

4. use 2 stages build to separate between build stage and execution stage: this results in lightweight containers

Requirements

- Create SSH key: https://linuxhint.com/generate-ssh-key-ubuntu/
- Add public key to GITHUB
- Git clone ssh repo git@github.com:sinaure/ynov-docker.git
- ADD docker user and password as secrets in the workflow tab

Assignement 1

Divide in groups for language preference

- Nodejs
- Java
- C++

adapt the secure Dockerfile to build and execute a helloworld with the new language

- Optionel: adapter la pipeline github action pour automatiser le build de l’image