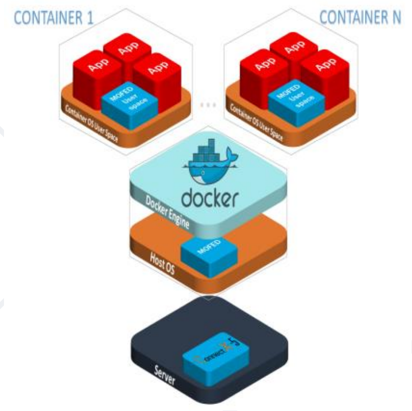
Docker and Containerization Basics

Package App + Dependencies + Configurations as Containers



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#Dev-Ops

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Containerization

Overview, VMs VS Containers, Advantages

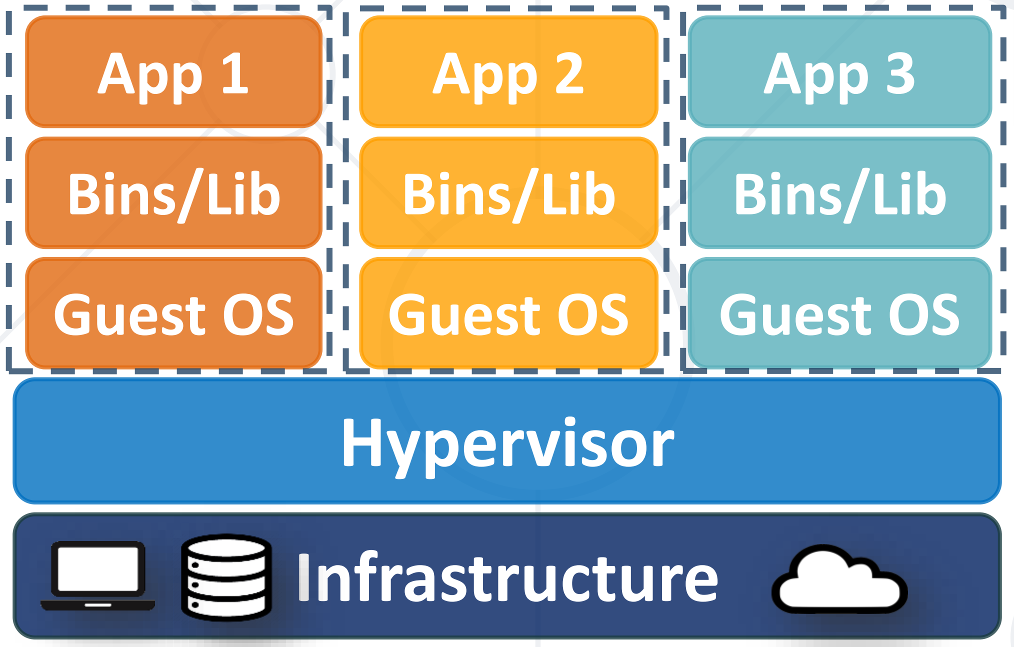
Containerization

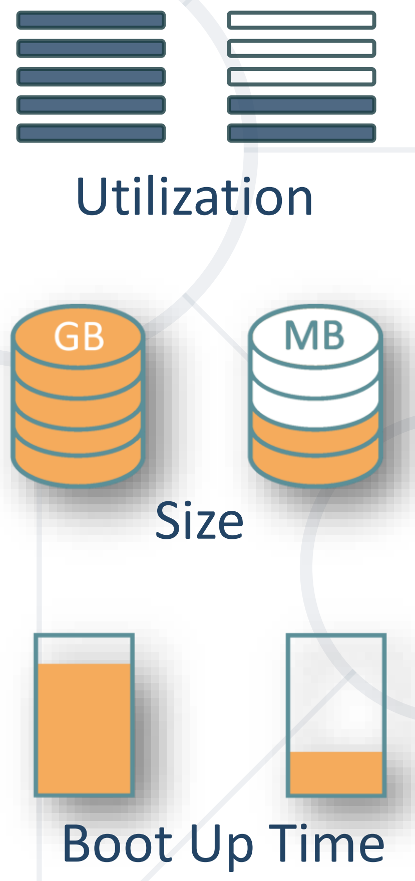
- **Containerization** == approach in which an **app** or **service** is packaged as a **container**
- **Image** == read-only template that contains a set of instructions for creating a container
  - It contains software, packaged with its dependencies and configuration
  - Designed to run in a virtual environment
- **Container** == a runnable instance of an image

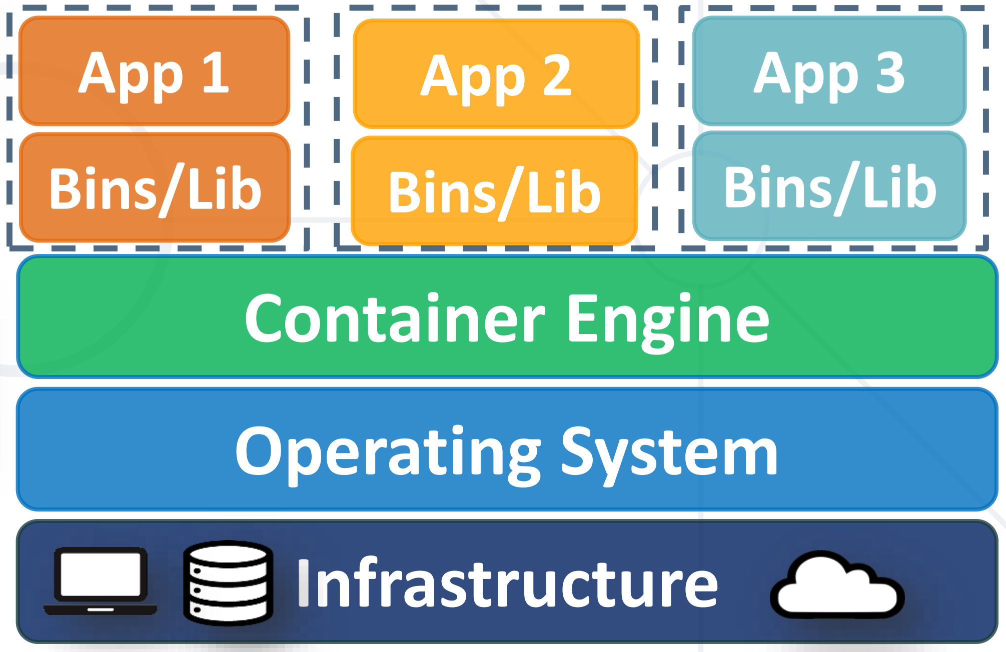
VMs vs Containers

- **VMs** virtualize the hardware
- Complete isolation
- Complete OS installation. Requires more resources

- **Containers** virtualize the OS
- Lightweight isolation
- Shared kernel. Requires fewer resources







Containerization – Advantages

- Easily **deploy across environments** with little or no modification
- **Immutability**
  - Once a container is created, it **doesn't** change
    - To make a change, a new container must be created
  - Ensures **consistency** across **different environments**
- **Portability**
  - Depend of container runtime, not underlying infrastructure
  - Run on any machine that supports the container runtime

Containerization – Advantages

- A containerized app can be **tested** and **deployed** as a **unit** to the host OS
- **Resource-efficient**
  - Share the same OS kernel and isolate applications from each other
- **Scalability**
  - Can be easily scaled up or down
  - Orchestrated by special tools
    - More on that later

Docker

Docker Images, Containers, Software Development

Docker

- **Docker** == lightweight, open-source, secure **containerization platform**
- It simplifies **building**, **shipping** and **running applications**
  - On different environments
- Runs natively on Linux or Windows servers
- Runs on Windows or Mac development machines
- Relies on **images** and **containers**

Docker Image

- **Docker image** == blueprint for a container
  - A **read-only template**, used to create containers
  - If you want to change something, you should create a new image
  - Holds app/service/other software
  - **Framework**, **dependencies** and **code** are "described" here
- **Docker registry** == a repository for images

Docker Container

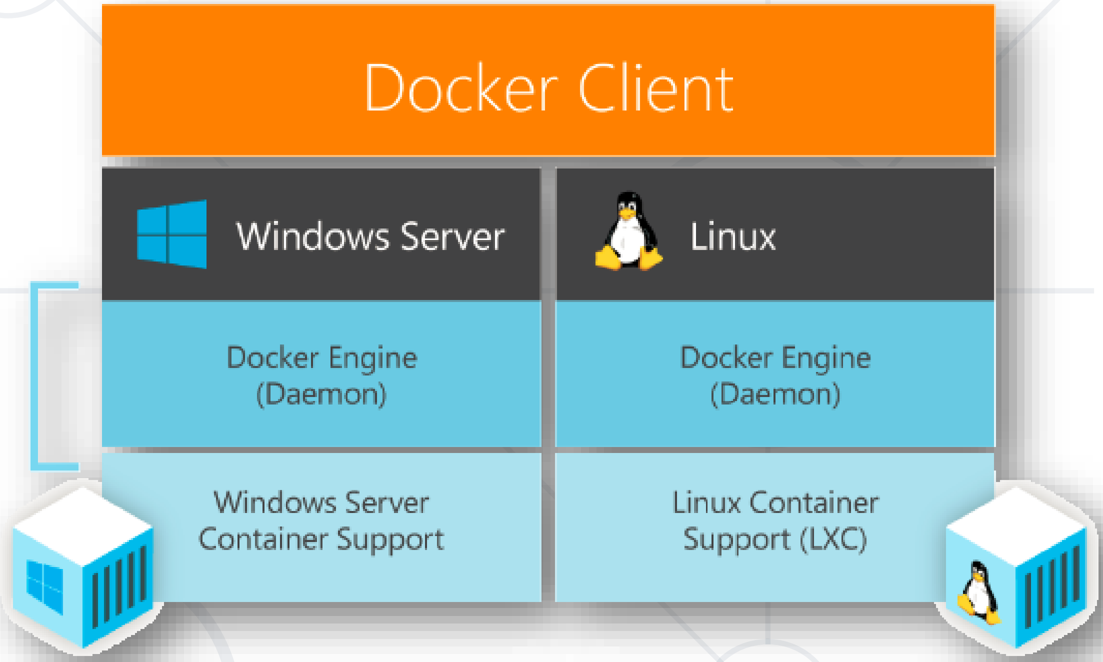
- Built **from the image**
  - Images become containers at **runtime**
- It is the actual **running environment** for your app
- **Isolated** and **secured**
- It can be started/stopped/deleted
- Different app components may reside in separate containers
  - Database, back-end, front-end, caching, messaging, etc.

Docker Desktop

- Out-of-the-box containerization software
- Runs on Windows or Mac development machines
- Includes **Docker Engine**, **CLI** and **Kubernetes**
- Complete Docker **development environment**
- Containerize any application
  - Build
  - Share
  - Run

Docker Desktop

- On Windows
  - Ability to switch between **Linux** and **Windows Server environments**
  - Typically runs Linux containers through **WSL2** technology (Windows Subsystem for Linux)
  - https://docs.docker.com/desktop/install/windows-install
- There are third-party solutions for Linux – DockStation, CairoDock, and more…



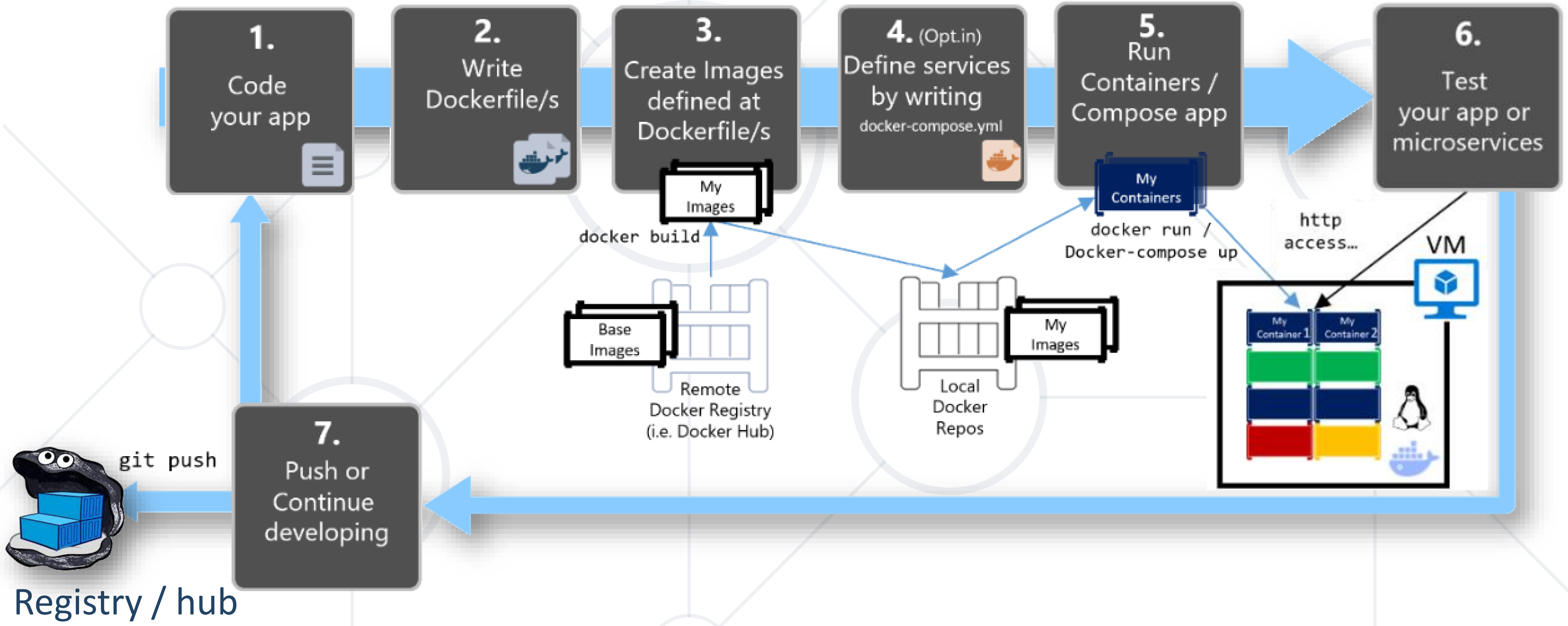
Docker Hub

- Docker Hub == cloud-based **image repository** (registry)
- Used for easy **finding** and **sharing images**
- Supports **public and private repositories**
- Automated builds and webhooks
- For every tool we use in Docker, it is recommended that we **read its documentation** first
  - As sometimes we need to perform configurations to work with the tool

Docker Compose

- Some apps combine multiple components
  - e.g., WordPress requires Linux + NGINX + PHP + MySQL
  - Each component may run in a separate Docker container
- To run **multiple connected containers**, we use **Docker Compose**

Development Workflow for Docker Apps



1. Code your app
2. Write Dockerfile/s
3. Create Images defined at Dockerfile/s
My Images
4. (Opt.in) Define services by writing docker-compose.yml
5. Run Containers / Compose app
My Containers
6. Test your app or microservices
docker build
Base Images
Remote Docker Registry (i.e. Docker Hub)
Local Docker Repos
My Images
docker run / Docker-compose up
http access…
VM
My Container 1
My Container 2
7. Push or Continue developing
git push
Registry / hub

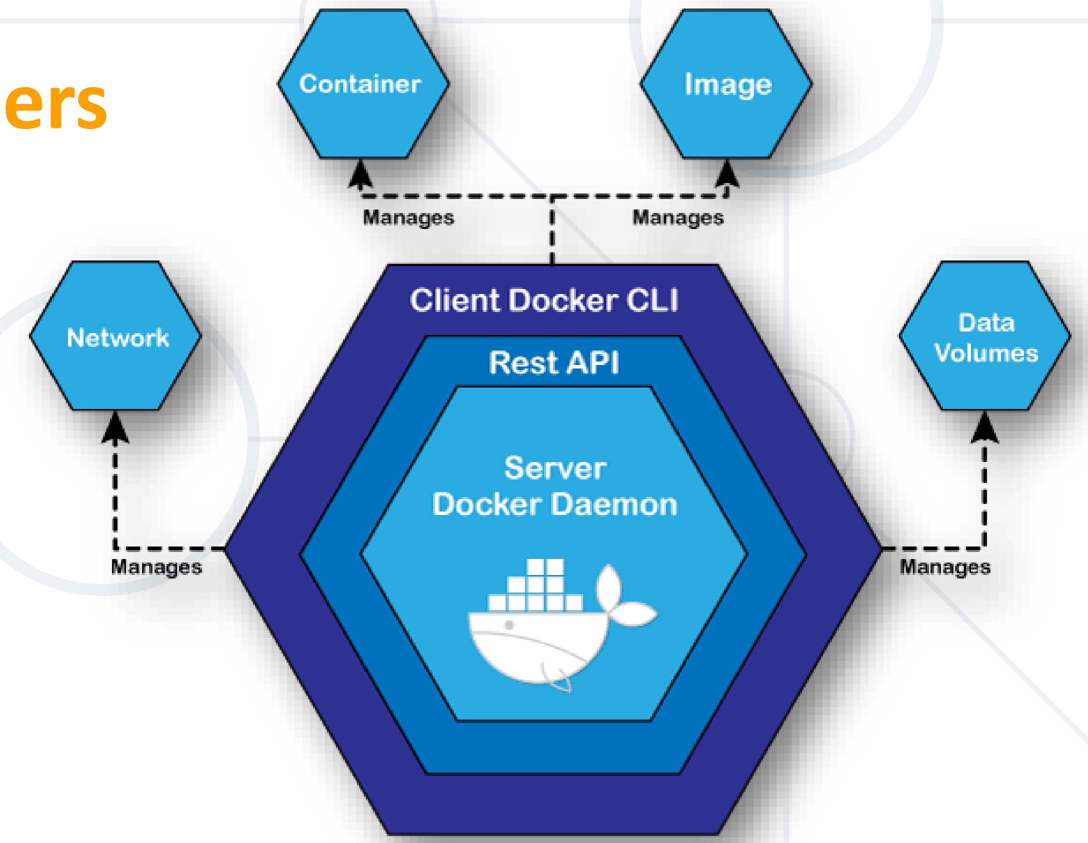
Docker CLI

Command Line Tool to Talk to the Docker Daemon

Docker CLI

- **Docker CLI** allows working with the **Docker Engine**
  - Build and manage **images**
  - Run and manage **containers**
- Example commands

```
docker pull [image]
docker run [image]
docker images
docker ps
docker logs [container]
```



Live Demo

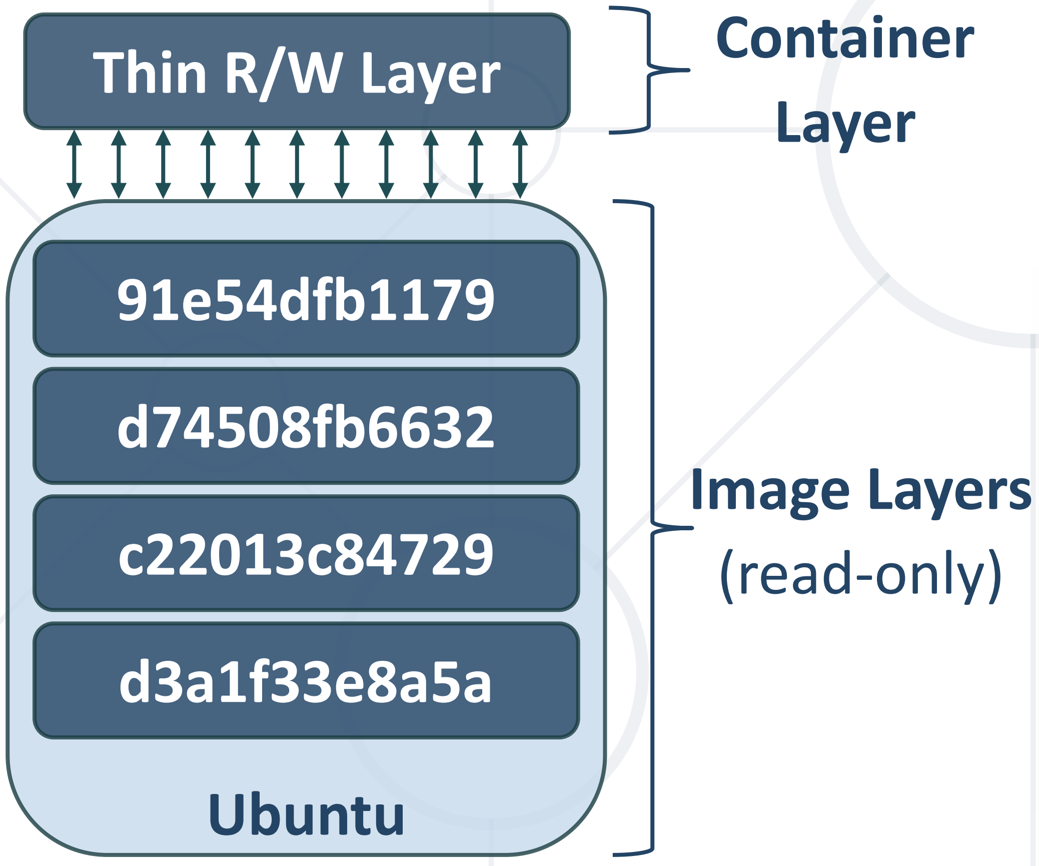
NGINX Server Container

File System and Volume

Data in Docker Containers

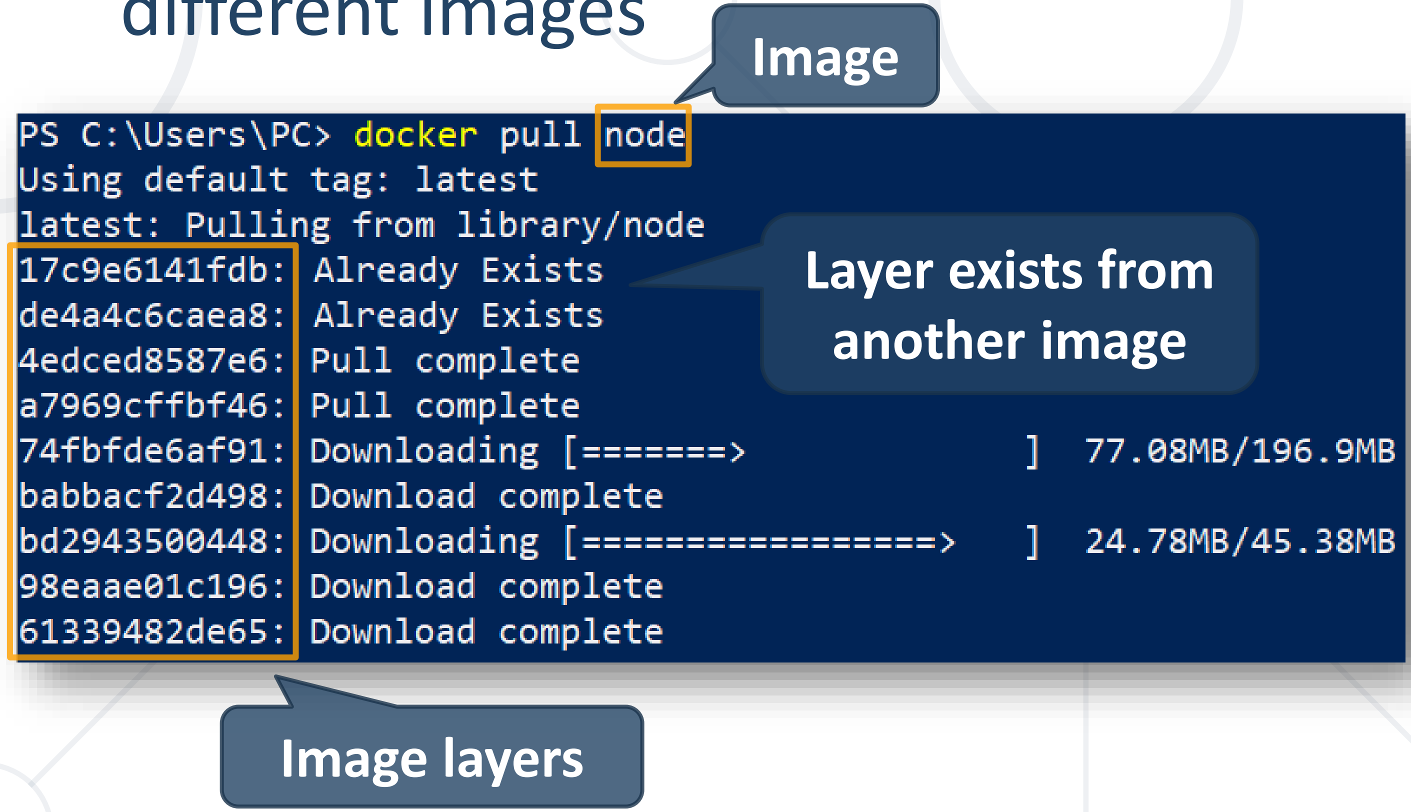
Layered File System

- Each **image** has **file system layers**, which are read-only and isolated



Container, based on Ubuntu

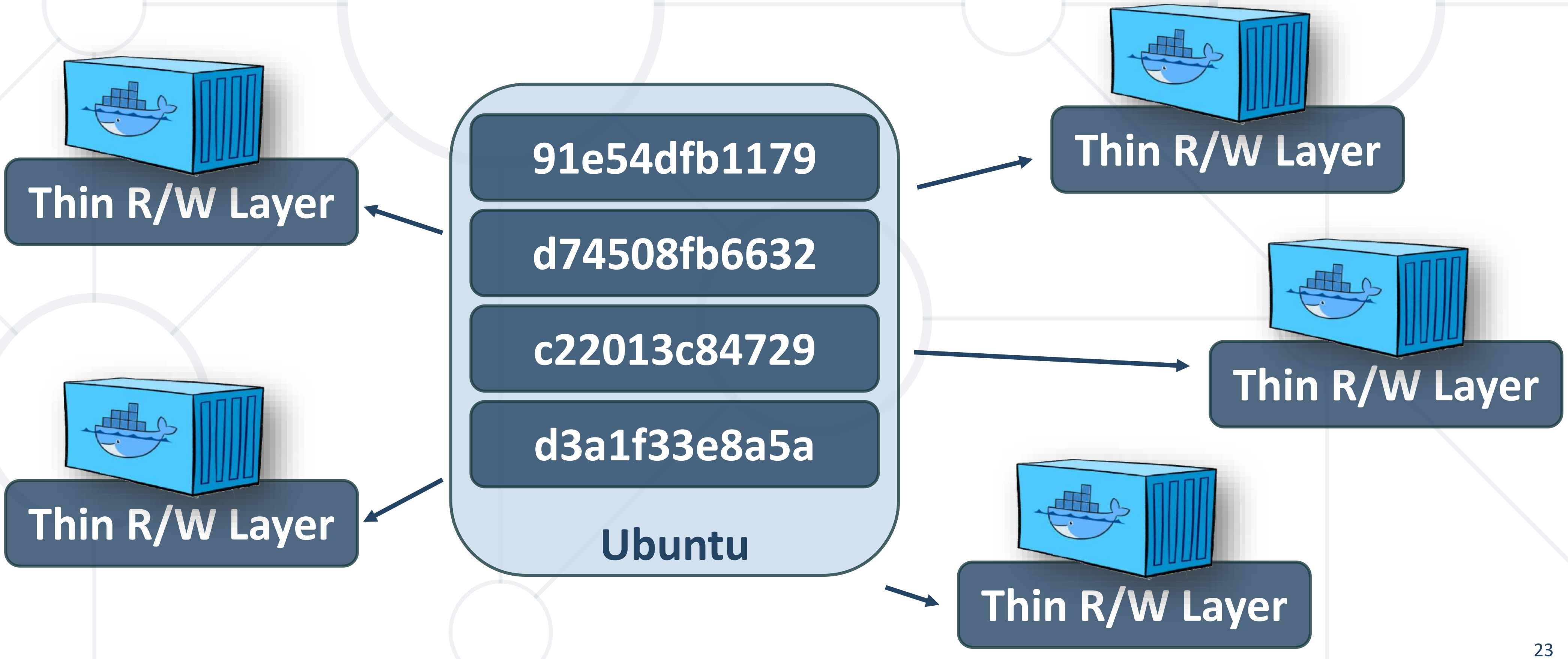
- Image layers are **reused** in different images



```
PS C:\Users\PC> docker pull node
Using default tag: latest
latest: Pulling from library/node
17c9e6141fdb: Already Exists
de4a4c6caea8: Already Exists
4edced8587e6: Pull complete
a7969cffbf46: Pull complete
74fbfde6af91: Downloading [=======>              ]  77.08MB/196.9MB
babbacf2d498: Download complete
bd2943500448: Downloading [=================>    ]  24.78MB/45.38MB
98eaae01c196: Download complete
61339482de65: Download complete
```

Layered File System

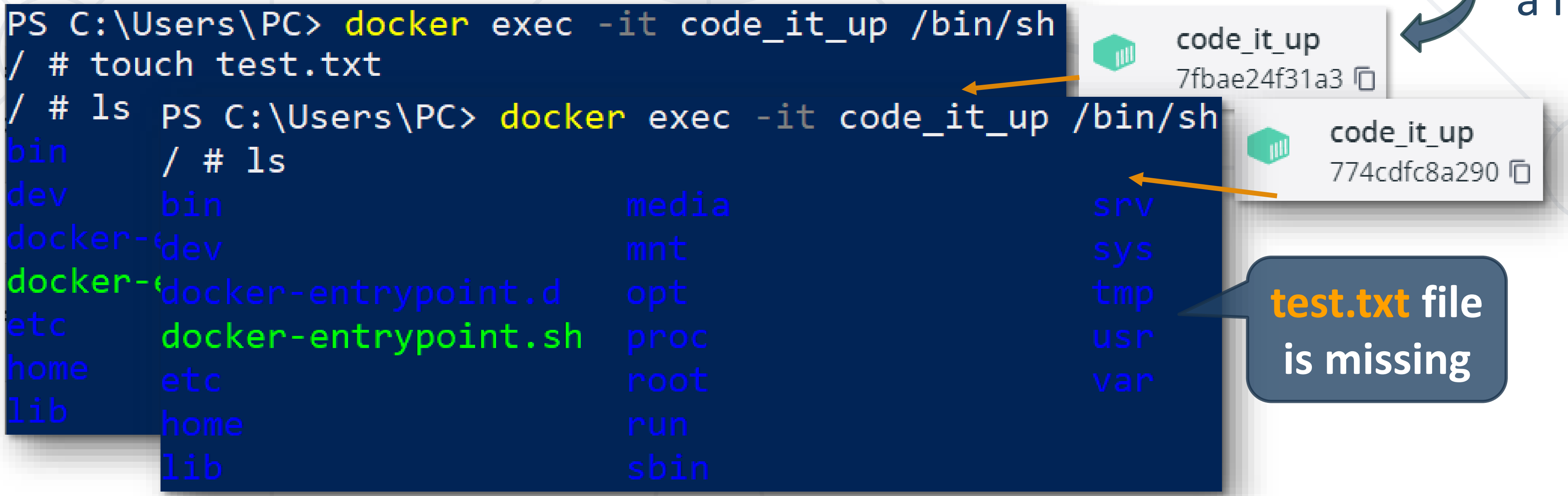
- **Images** share **layers**
  - Therefore they load faster once you have them



Container Isolation

- Each container is **isolated** and has its **own writable file system**
  - By default, file system is deleted after you delete the container
  - Which is not very suitable for persistence operations

Delete old container and **create** a new one



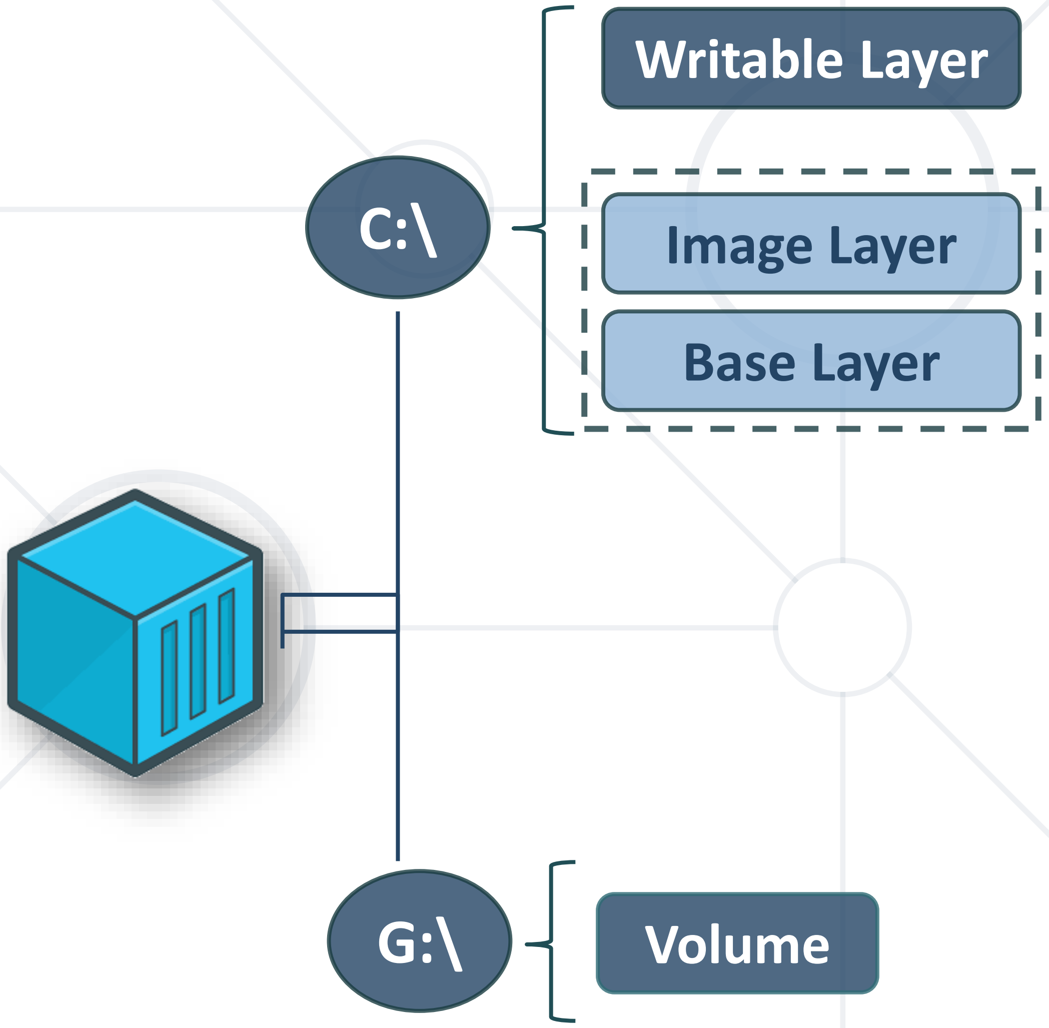
```
PS C:\Users\PC> docker exec -it code_it_up /bin/sh
/ # touch test.txt
/ # ls
bin
dev
docker-
docker-
etc
home
lib
```

```
PS C:\Users\PC> docker exec -it code_it_up /bin/sh
/ # ls
bin                     media                   srv
dev                     mnt                     sys
docker-entrypoint.d     opt                     tmp
docker-entrypoint.sh    proc                    usr
etc                     root                    var
home                    run
lib                     sbin
```

test.txt file is missing

Volumes

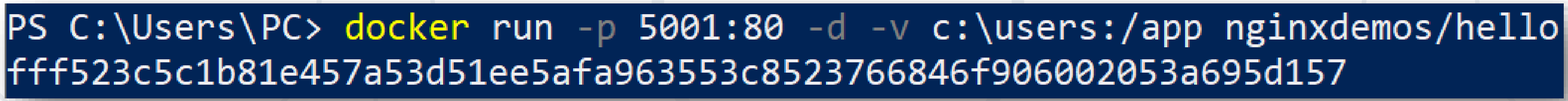
- To persist data, use **volumes**
  - Special type of **directory on the host**
  - Mapped to the real file system
  - Can be shared and reused among containers
  - Image updates won't affect volumes
  - Persisted even after the container is deleted
  - You have full control over them



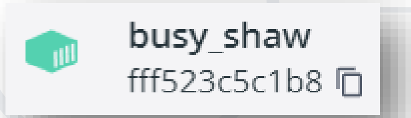
Attach Local Folder as Volume

- Attach **local folder as volume** to a container

```
docker run -p 5001:80 -d -v c:\users:/app nginxdemos/hello
```

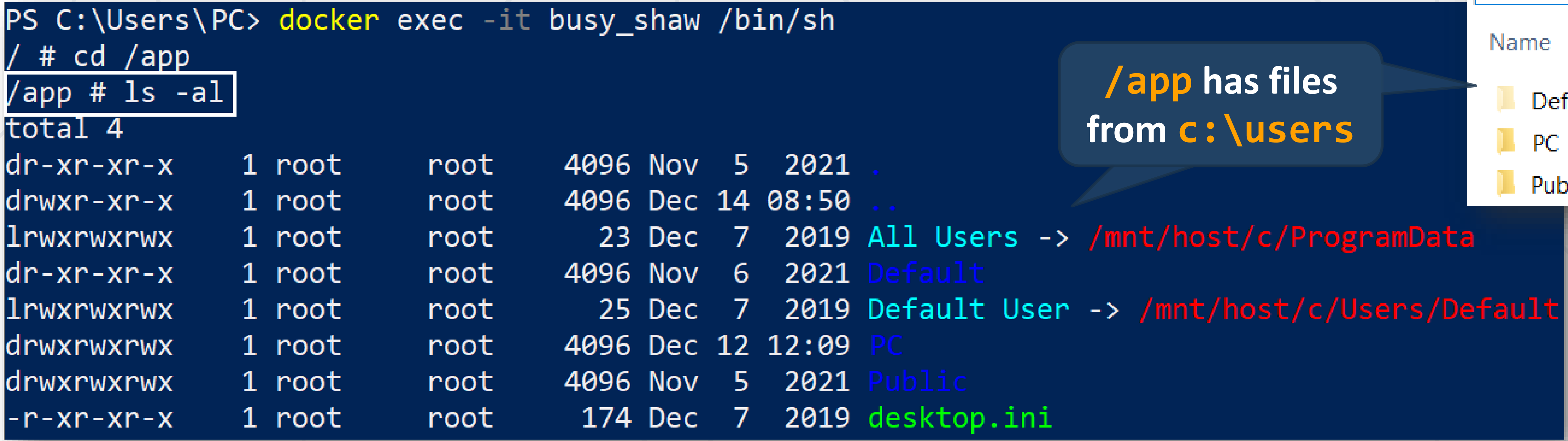


```
PS C:\Users\PC> docker run -p 5001:80 -d -v c:\users:/app nginxdemos/hello
fff523c5c1b81e457a53d51ee5afa963553c8523766846f906002053a695d157
```



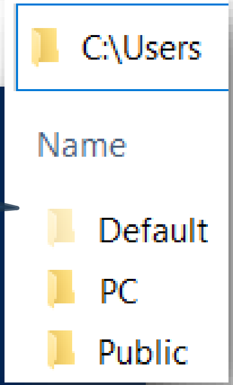
busy_shaw
fff523c5c1b8

- Examine mapped container's **/app** folder



```
PS C:\Users\PC> docker exec -it busy_shaw /bin/sh
/ # cd /app
/app # ls -al
total 4
dr-xr-xr-x    1 root     root      4096 Nov  5  2021 .
drwxr-xr-x    1 root     root      4096 Dec 14 08:50 ..
lrwxrwxrwx    1 root     root        23 Dec  7  2019 All Users -> /mnt/host/c/ProgramData
dr-xr-xr-x    1 root     root      4096 Nov  6  2021 Default
lrwxrwxrwx    1 root     root        25 Dec  7  2019 Default User -> /mnt/host/c/Users/Default
drwxrwxrwx    1 root     root      4096 Dec 12 12:09 PC
drwxrwxrwx    1 root     root      4096 Nov  5  2021 Public
-r-xr-xr-x    1 root     root       174 Dec  7  2019 desktop.ini
```

/app has files from **c:\users**

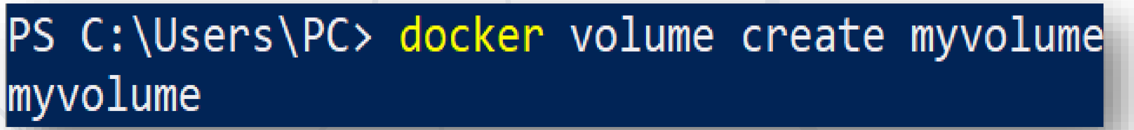


C:\Users
Name
Default
PC
Public

Creating and Using Volumes

- **Create** a volume

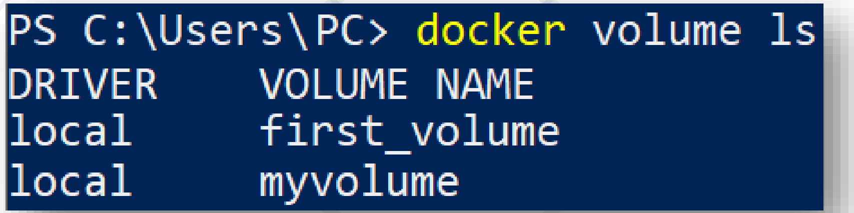
```
docker volume create myvolume
```



```
PS C:\Users\PC> docker volume create myvolume
myvolume
```

- **List** all volumes

```
docker volume ls
```

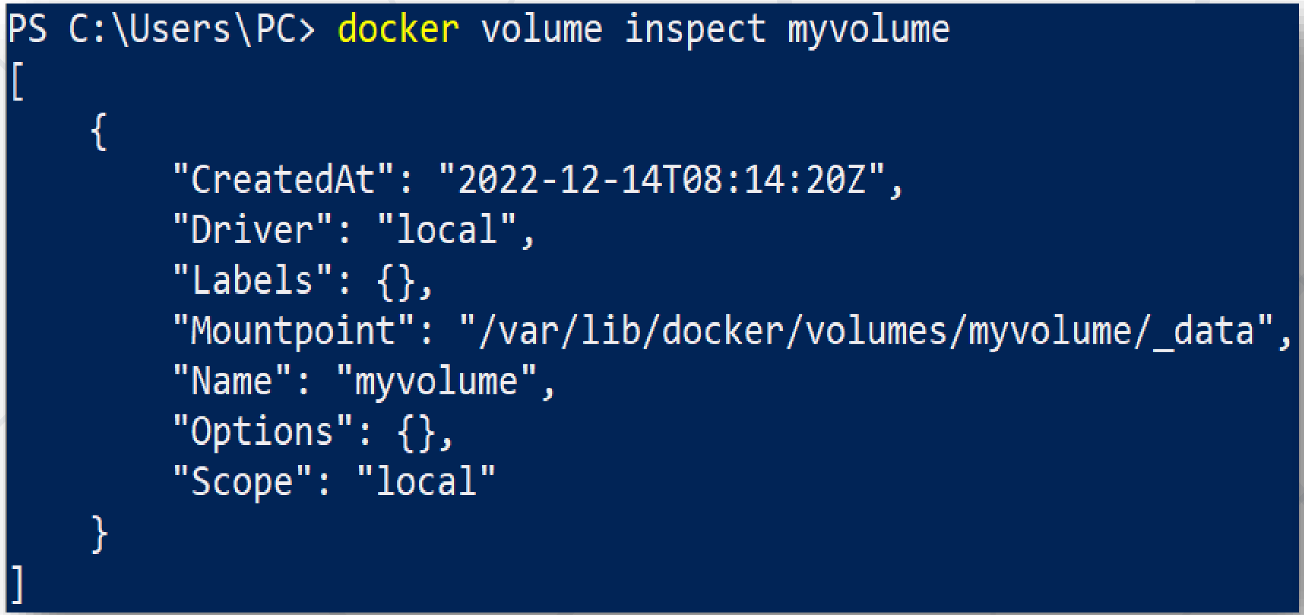


```
PS C:\Users\PC> docker volume ls
DRIVER    VOLUME NAME
local     first_volume
local     myvolume
```

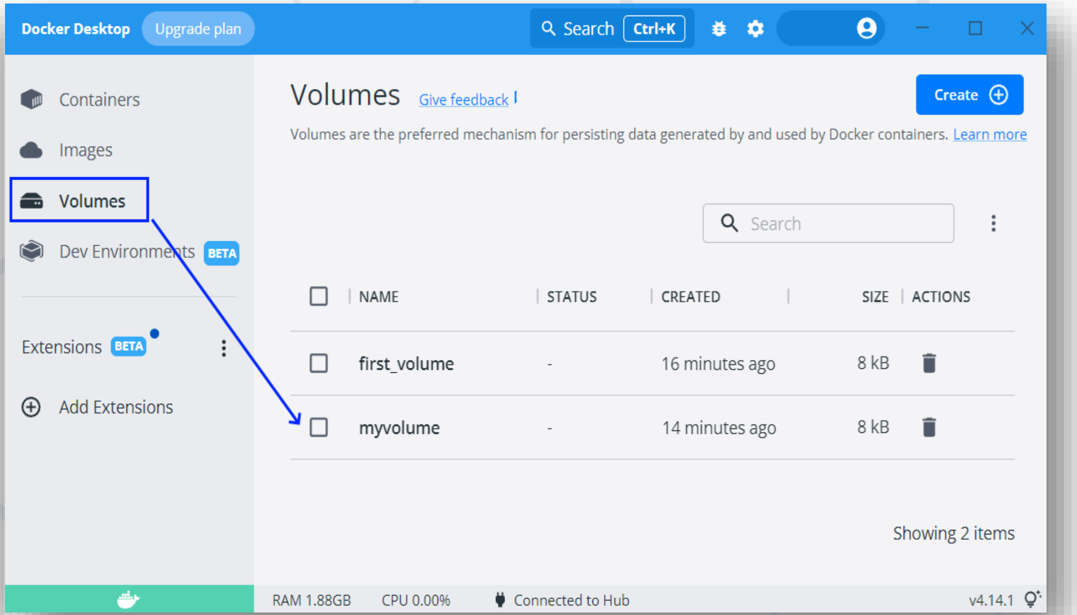
Creating and Using Volumes

- **Inspect** volume

```
docker volume inspect myvolume
```



```
PS C:\Users\PC> docker volume inspect myvolume
[
    {
        "CreatedAt": "2022-12-14T08:14:20Z",
        "Driver": "local",
        "Labels": {},
        "Mountpoint": "/var/lib/docker/volumes/myvolume/_data",
        "Name": "myvolume",
        "Options": {},
        "Scope": "local"
    }
]
```



Volumes Give feedback

Volumes are the preferred mechanism for persisting data generated by and used by Docker containers. Learn more

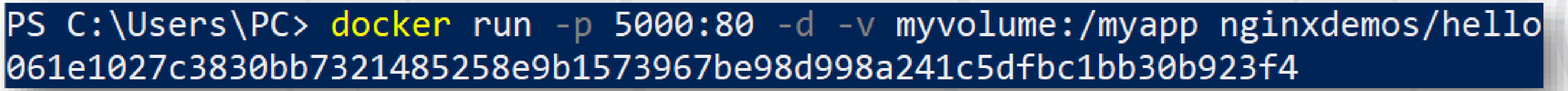
NAME	STATUS	CREATED	SIZE	ACTIONS
first_volume	-	16 minutes ago	8 kB	
myvolume	-	14 minutes ago	8 kB	

Showing 2 items

Creating and Using Volumes

- **Mount volume** to container

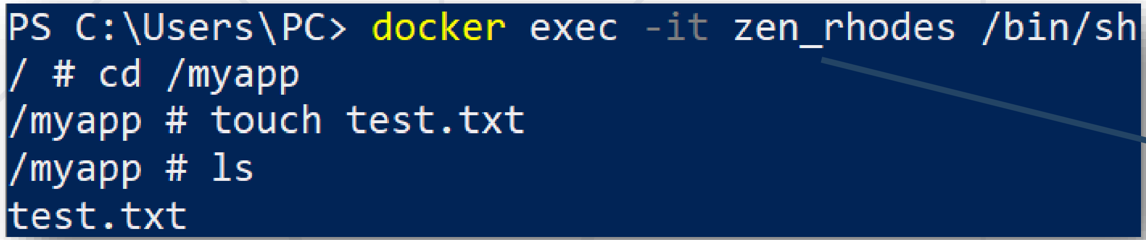
```
docker run -p 5000:80 -d -v myvolume:/myapp nginxdemos/hello
```



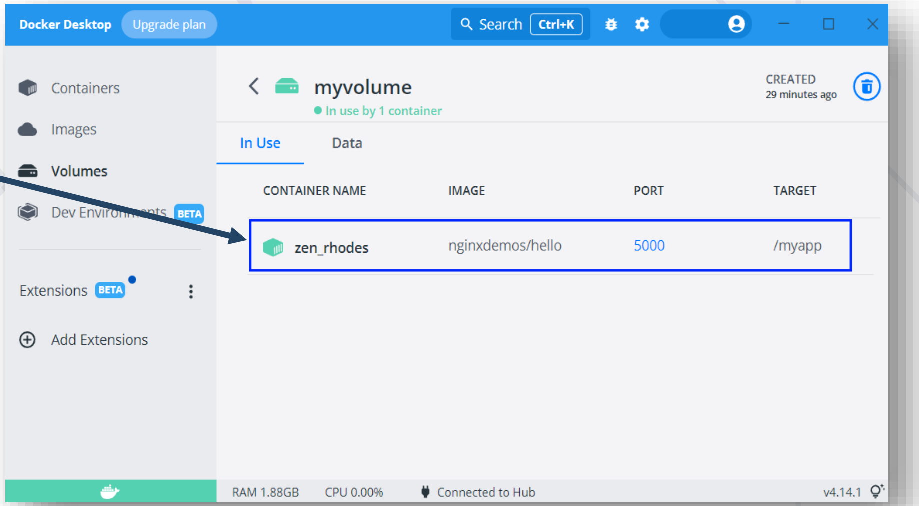
```
PS C:\Users\PC> docker run -p 5000:80 -d -v myvolume:/myapp nginxdemos/hello
061e1027c3830bb7321485258e9b1573967be98d998a241c5dfbc1bb30b923f4
```

zen_rhodes
061e1027c383

- Create a file in the /myapp folder



```
PS C:\Users\PC> docker exec -it zen_rhodes /bin/sh
/ # cd /myapp
/myapp # touch test.txt
/myapp # ls
test.txt
```



myvolume
In use by 1 container
CREATED 29 minutes ago

In Use | Data

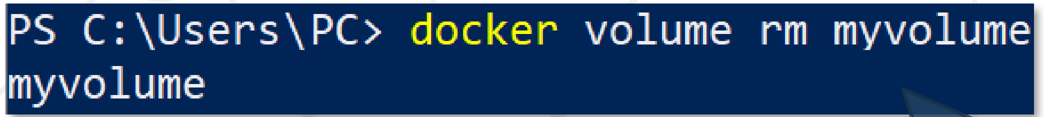
CONTAINER NAME	IMAGE	PORT	TARGET
zen_rhodes	nginxdemos/hello	5000	/myapp

RAM 1.88GB CPU 0.00% Connected to Hub v4.14.1

Creating and Using Volumes

- **Remove** volume
  - A volume that is in use cannot be removed
  - You can remove multiple volumes simultaneously

```
docker volume rm myvolume
```



```
PS C:\Users\PC> docker volume rm myvolume
myvolume
```

Should not be in use

Live Demo

Vue.js App in a Container

Live Demo

Docker Container with MongoDB

Summary

- With **Docker** we can create and manage **images**, **containers**, **volumes**, etc.
  - **Image** == read-only template with instructions for creating a Docker container
  - **Container** == a runnable instance of an image
  - **Volumes** == the preferred mechanism for persisting data
- We can **run apps in containers**
- We can also have a working **database in a container**

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