Course:
Dockers for Web Developers

4/2021

Who am I

AGENDA DAY 1 - DOCKER

- What is docker?
- Containers VS. VMs
- Docker Architecture
- IMAGES
- Registries
- INSTALLING DOCKER
- Docker Tool
- Docker file
- Logging
- Volumes

AGENDA DAY 2 - DOCKER

- network
- Docker compose
- Docker on visual studio

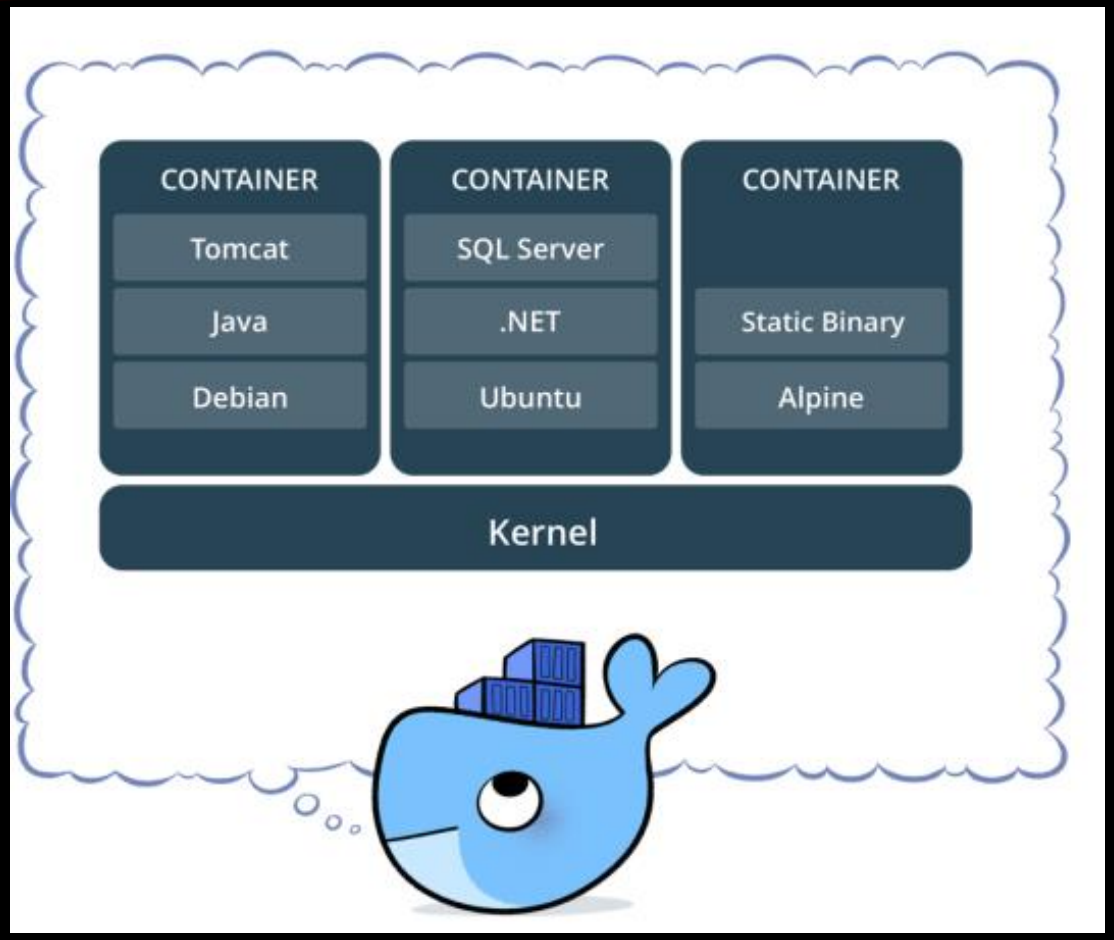
QUESTIONS FOR YOU…

- What Do You Know About Docker?
- Who Used Docker For Development / QA / STG / PROD?
- Who Tried & Failed Implementing Docker

WHAT IS DOCKER?

- ✓Developed by DotCloud Inc. (Currently Docker Inc.)
- ✓open platform for developing, shipping, and running applications on containers
- ✓Released it as open source 7+ years back
- ✓written in the GO programming language
- ✓Possible to set up in any OS, be it Windows, OSX, Linux - It work the same way
- ✓Guaranteed to run the same way - Your development desktop, a bare-metal server, virtual machine, data center, or cloud

WHAT IS DOCKER?

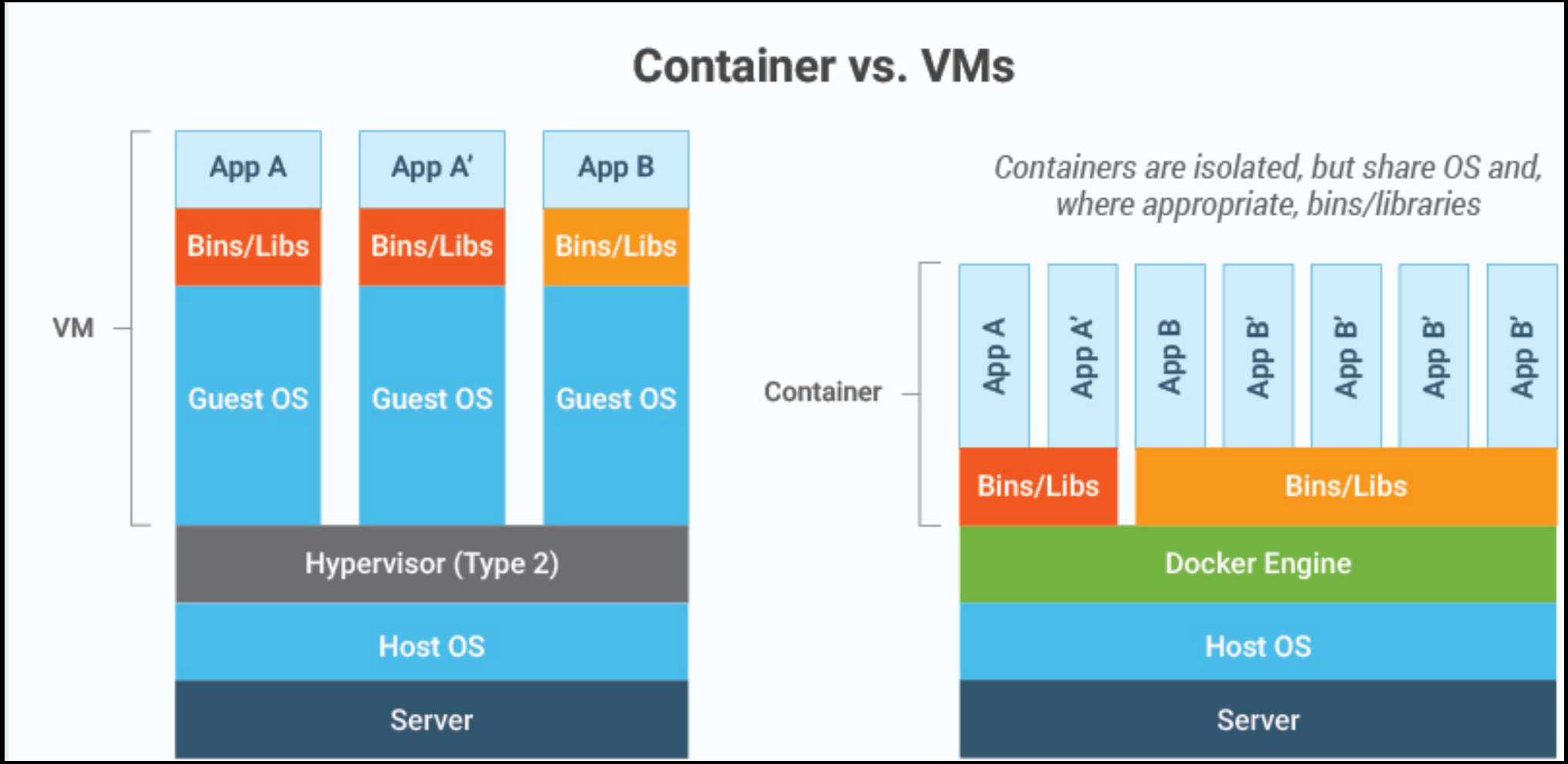


- Standardized packaging for software and dependencies
- Isolate apps from each other
- Share the same OS kernel
- Works for all major Linux distributions
- Containers native to win Server 2016

WHAT IS DOCKER?

- **Flexible**: Even the most complex applications can be containerized.
- **Lightweight**: Containers leverage and share the host kernel.
- **Interchangeable**: You can deploy updates and upgrades on-the-fly.
- **Portable**: You can build locally, deploy to the cloud, and run anywhere.
- **Scalable**: You can increase and automatically distribute container replicas.
- **Stackable**: You can stack services vertically and on-the-fly.

CONTAINERS VS. VMS



Virtual Machines

Containers

VM VS DOCKER - SIMILARITY

Virtual Machines	Docker
Process in one VM can't see processes in other VMs	Process in one container can't see processes in other container
Each VM has its own root filesystem	Each container has its own root file system(Not Kernel)
Each VM gets its own virtual network adapter	Docker can get virtual network adapter. It can have separate IP and ports
VM is a running instance of physical files(.VMX and .VMDK)	Docker containers are running instances of Docker Image
Host OS can be different from guest OS	Host OS can be different from Container OS

VM VS DOCKER - DIFFERENCE

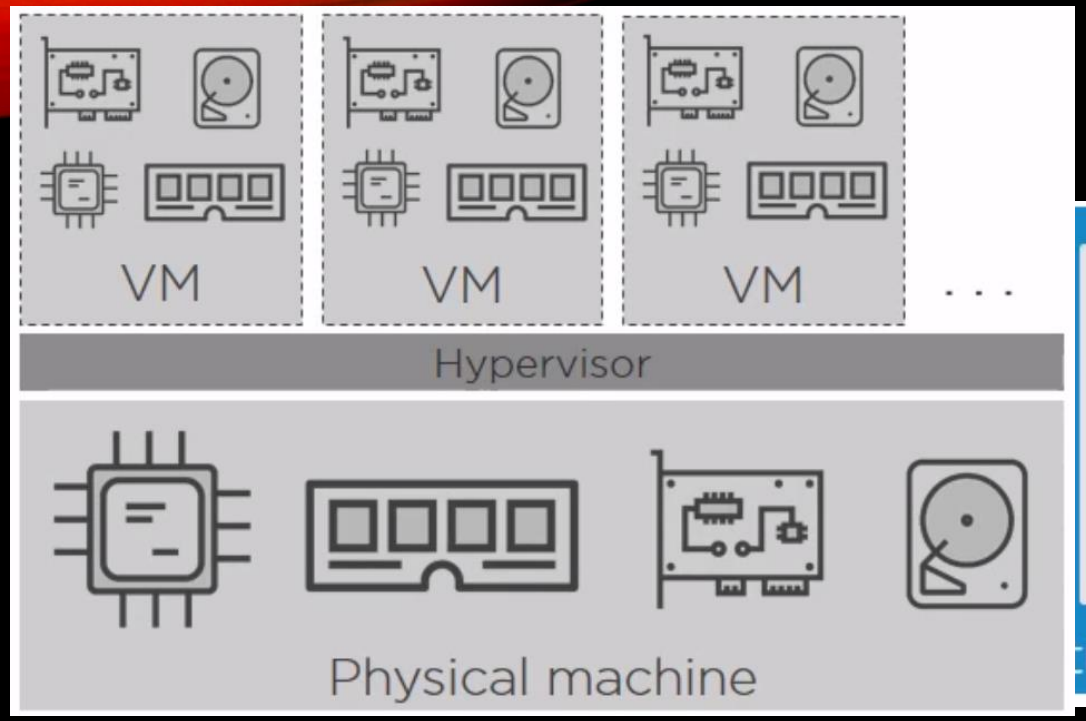
Virtual Machines	Docker
Each VM runs its own OS	All containers share the same Kernel of the host
Boot up time is in minutes	Containers instantiate in seconds
VMs snapshots are used sparingly	Images are built incrementally on top of another like layers. Lots of images/snapshots
Not effective diffs. Not version controlled	Images can be diffed and can be version controlled. Dockerhub is like GITHUB
Cannot run more than couple of VMs on an average laptop	Can run many Docker containers in a laptop.
Only one VM can be started from one set of VMX and VMDK files	Multiple Docker containers can be started from one Docker image

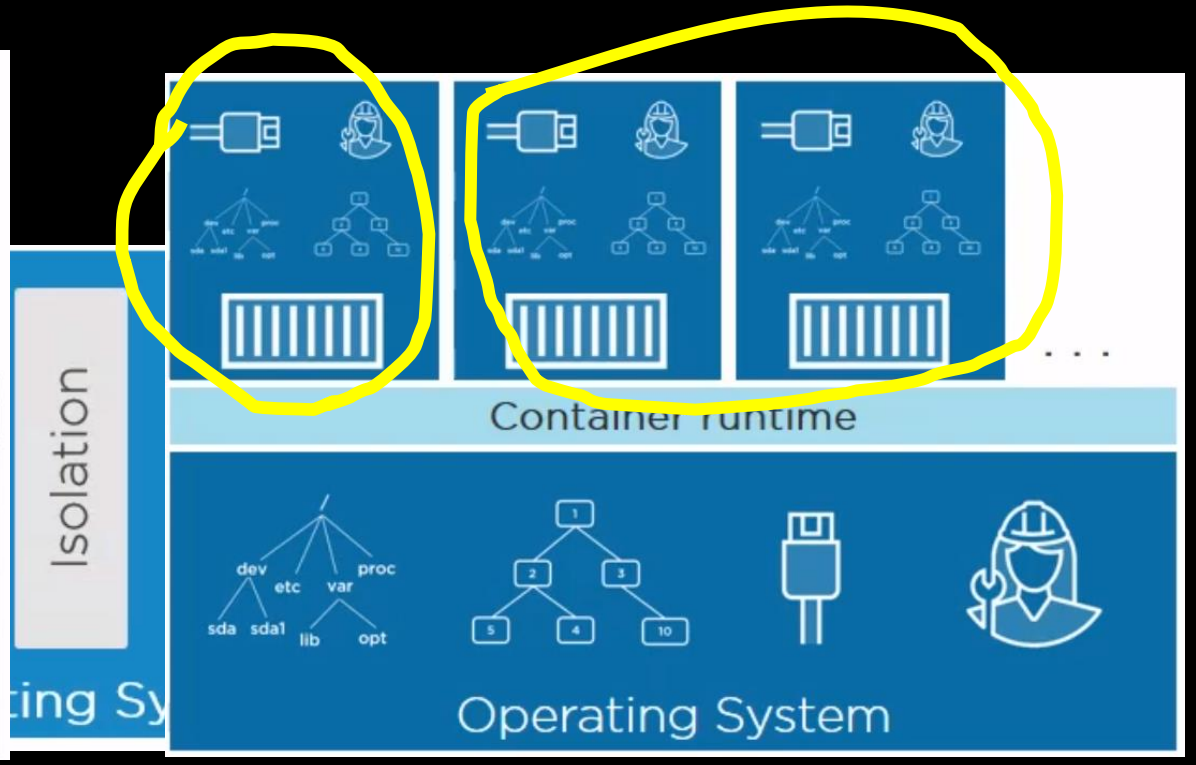
CONTAINERS VS. VMS

VMs

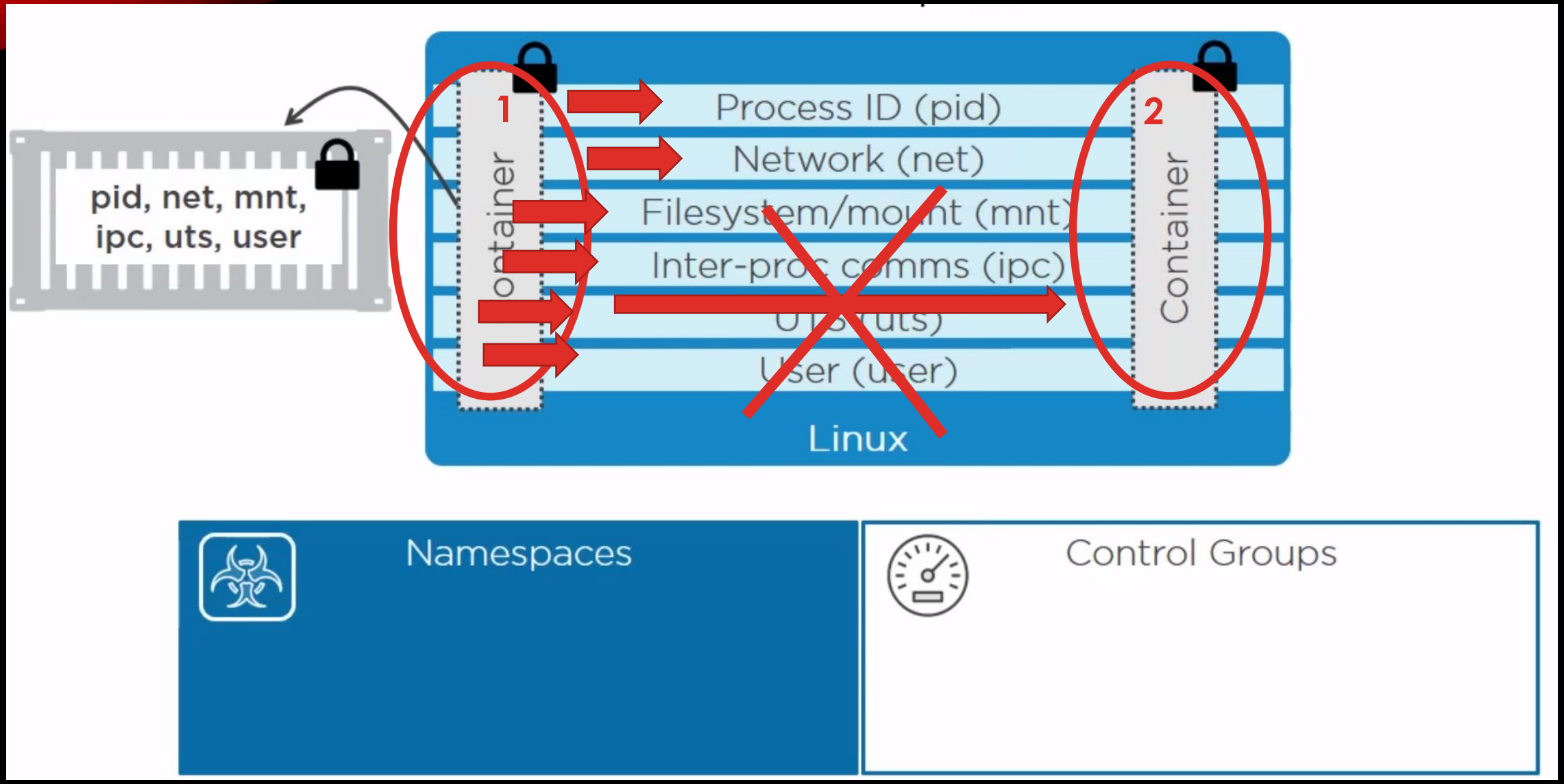
Containers

DOCKER ARCHITECTURE - DOCKER ENGINE

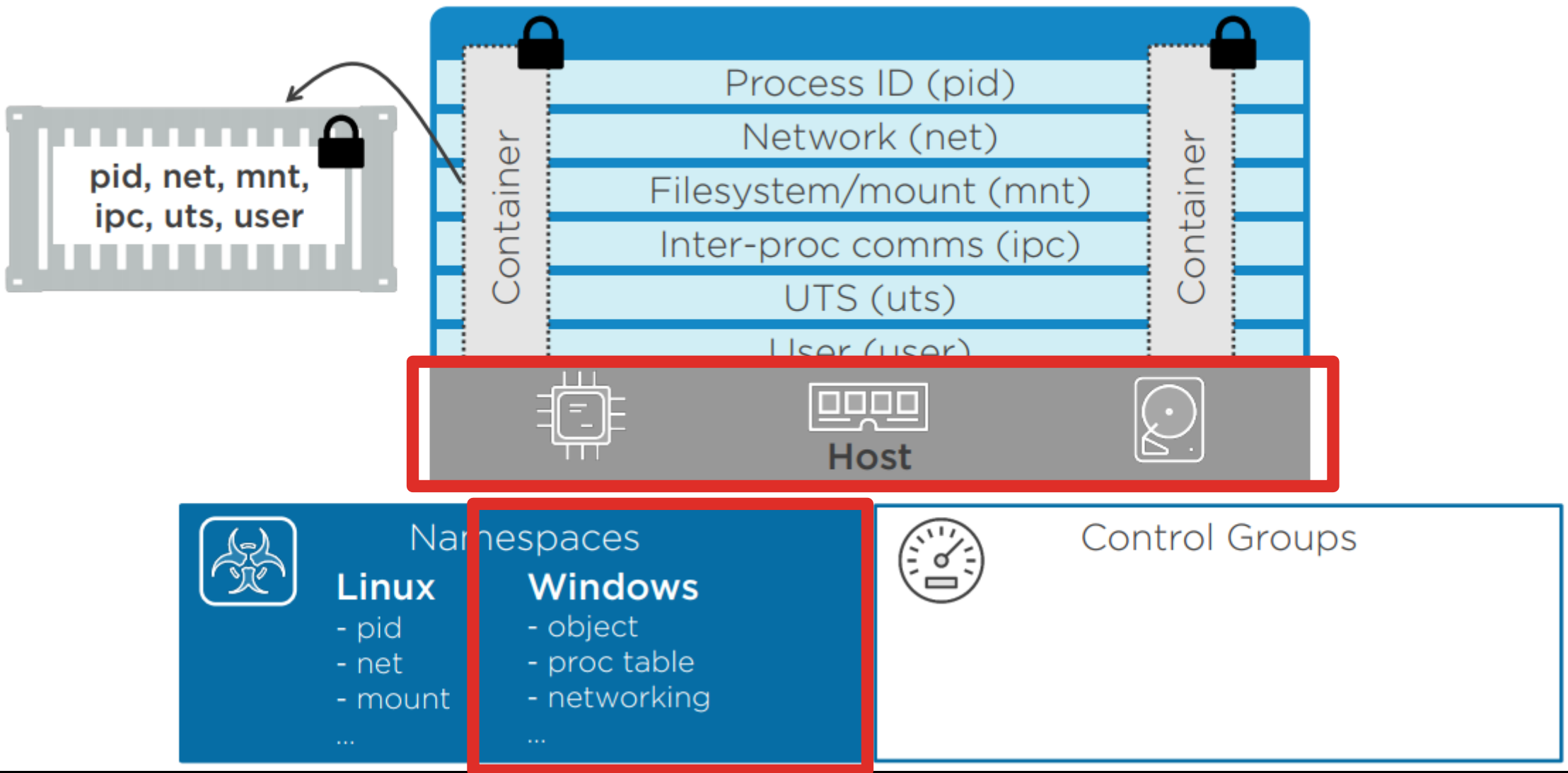




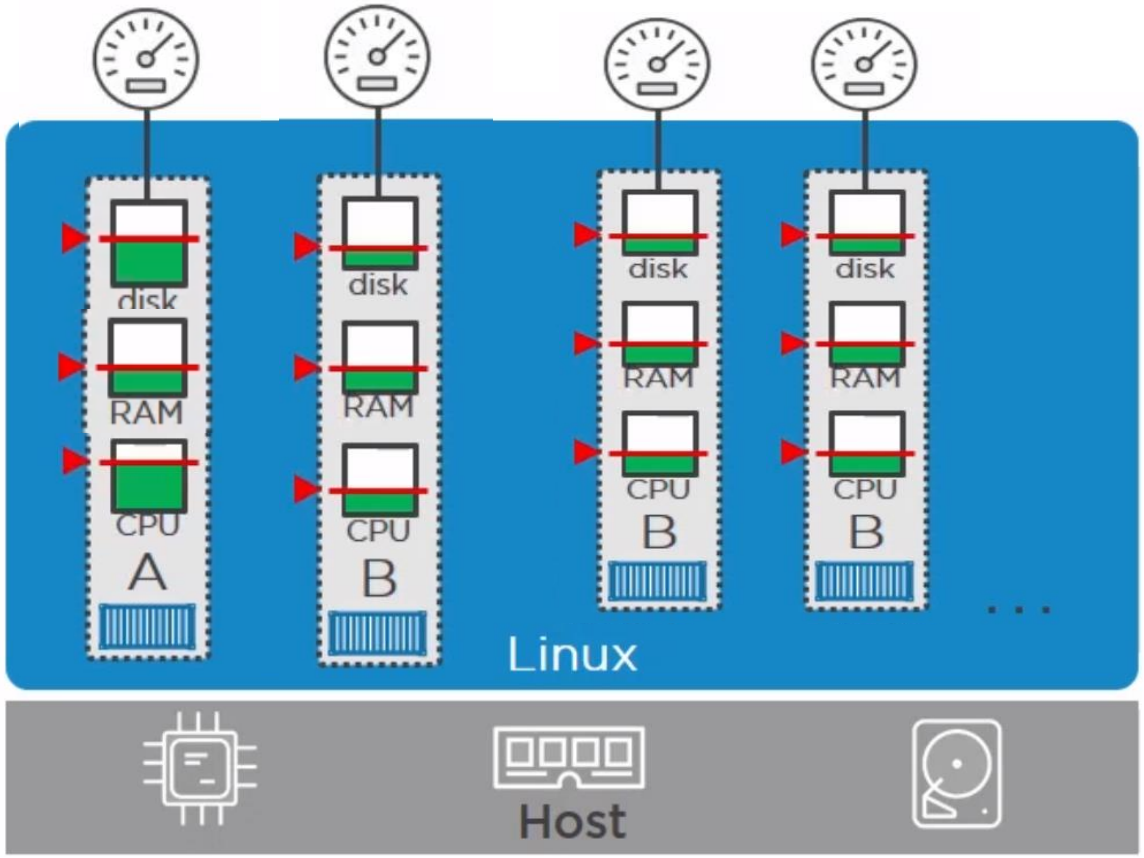
DOCKER ARCHITECTURE - LINUX NAMESPACE



DOCKER ARCHITECTURE - NAMESPACE



DOCKER ARCHITECTURE - CONTROL GROUPS



Namespaces

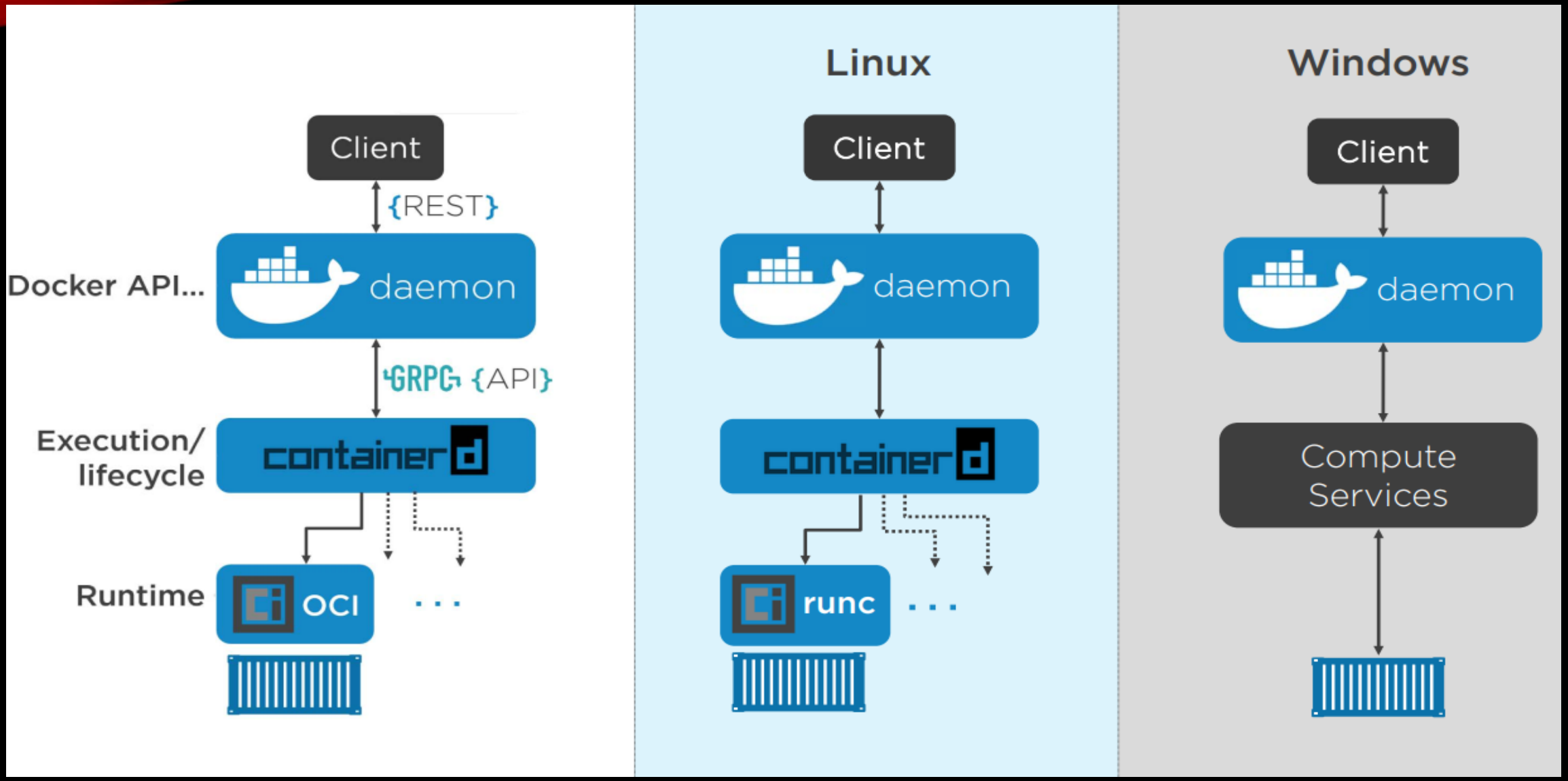
Linux	Windows
- pid	- object
- net	- proc table
- mount	- networking
...	...

linux

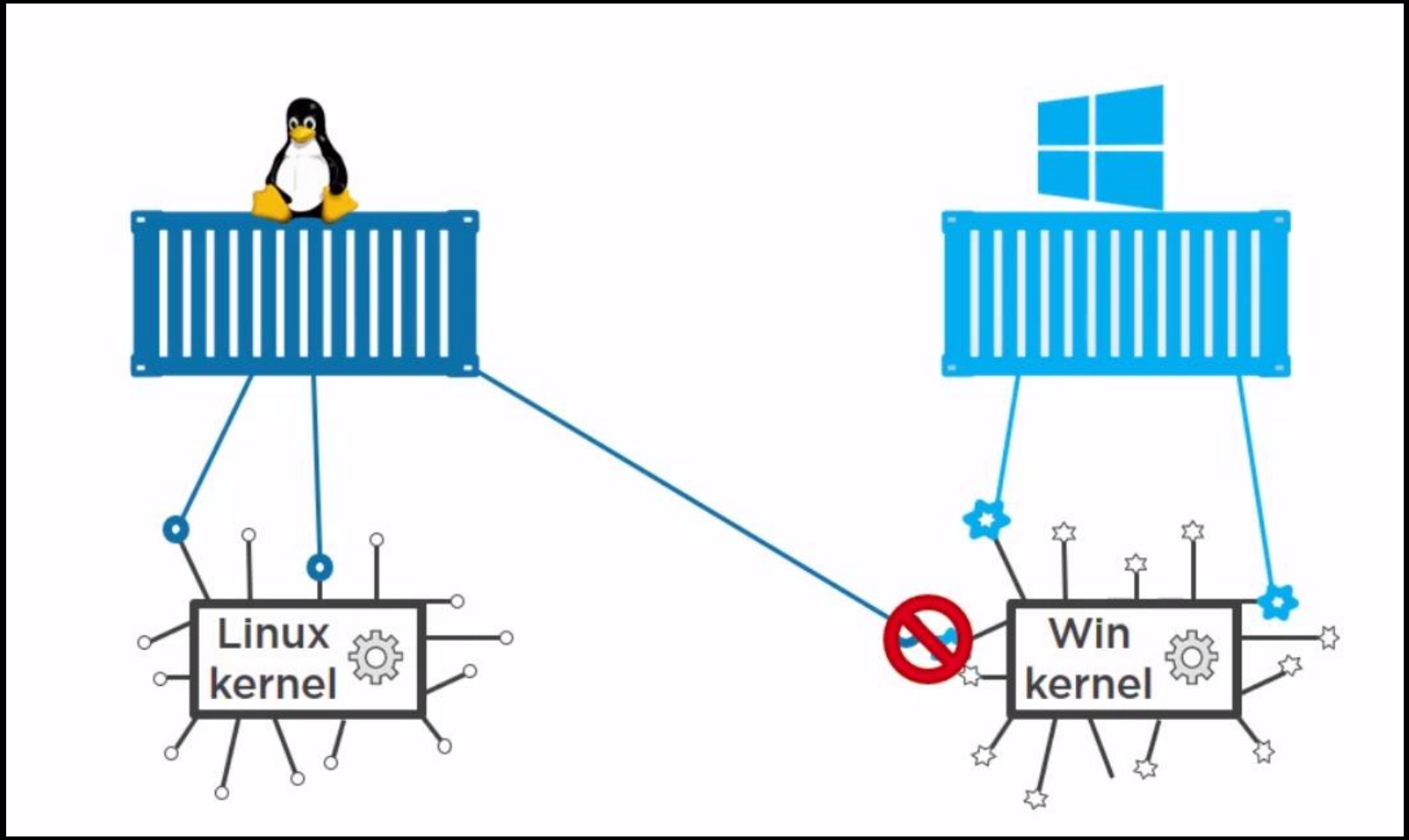
windows

Control Groups
(Windows a.k.a. Job Objects)

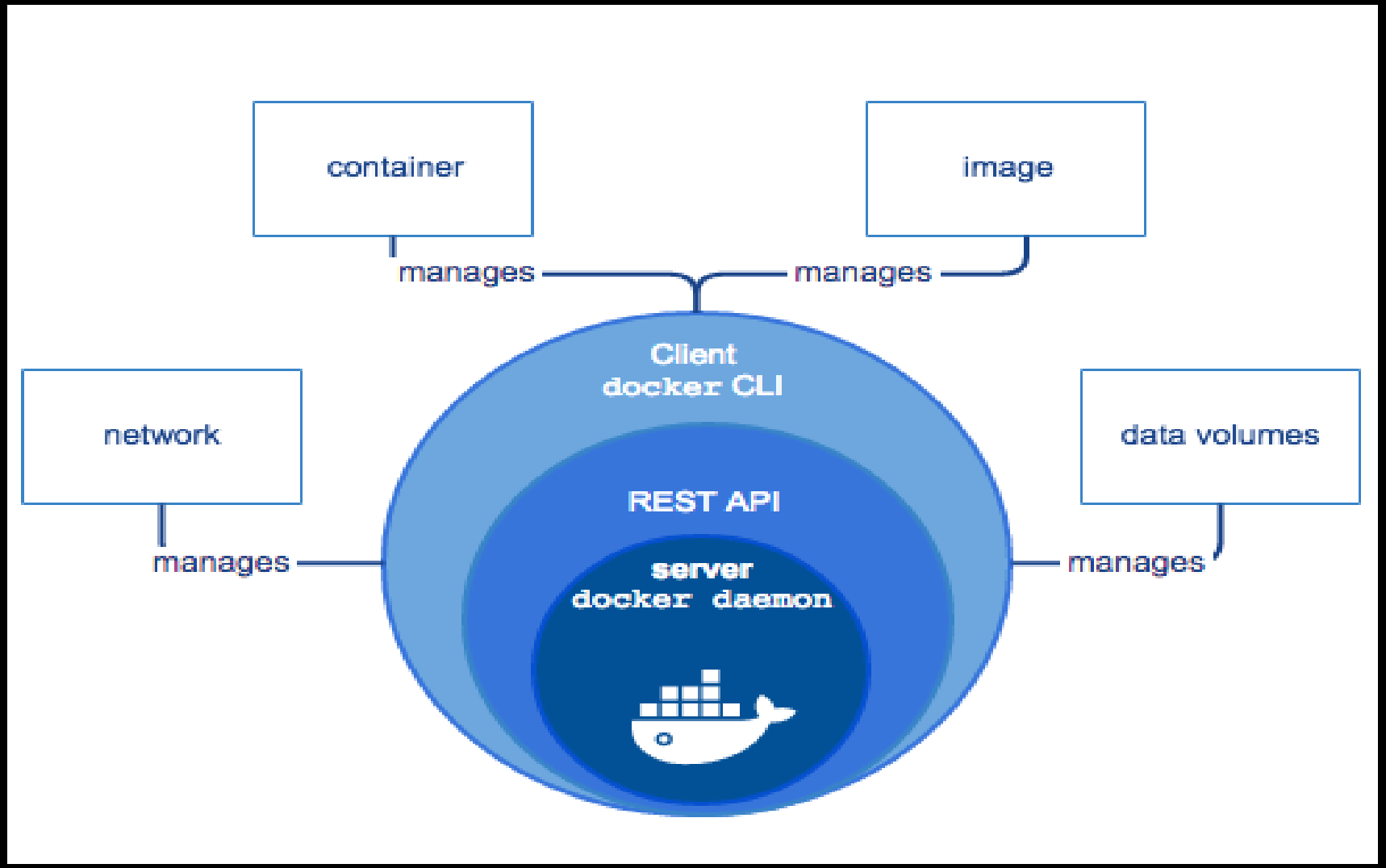
DOCKER ARCHITECTURE - WINDOWS CONTAINERS



DOCKER ARCHITECTURE - WINDOWS CONTAINERS



DOCKER ARCHITECTURE –BIG PICTURE



DOCKER ARCHITECTURE

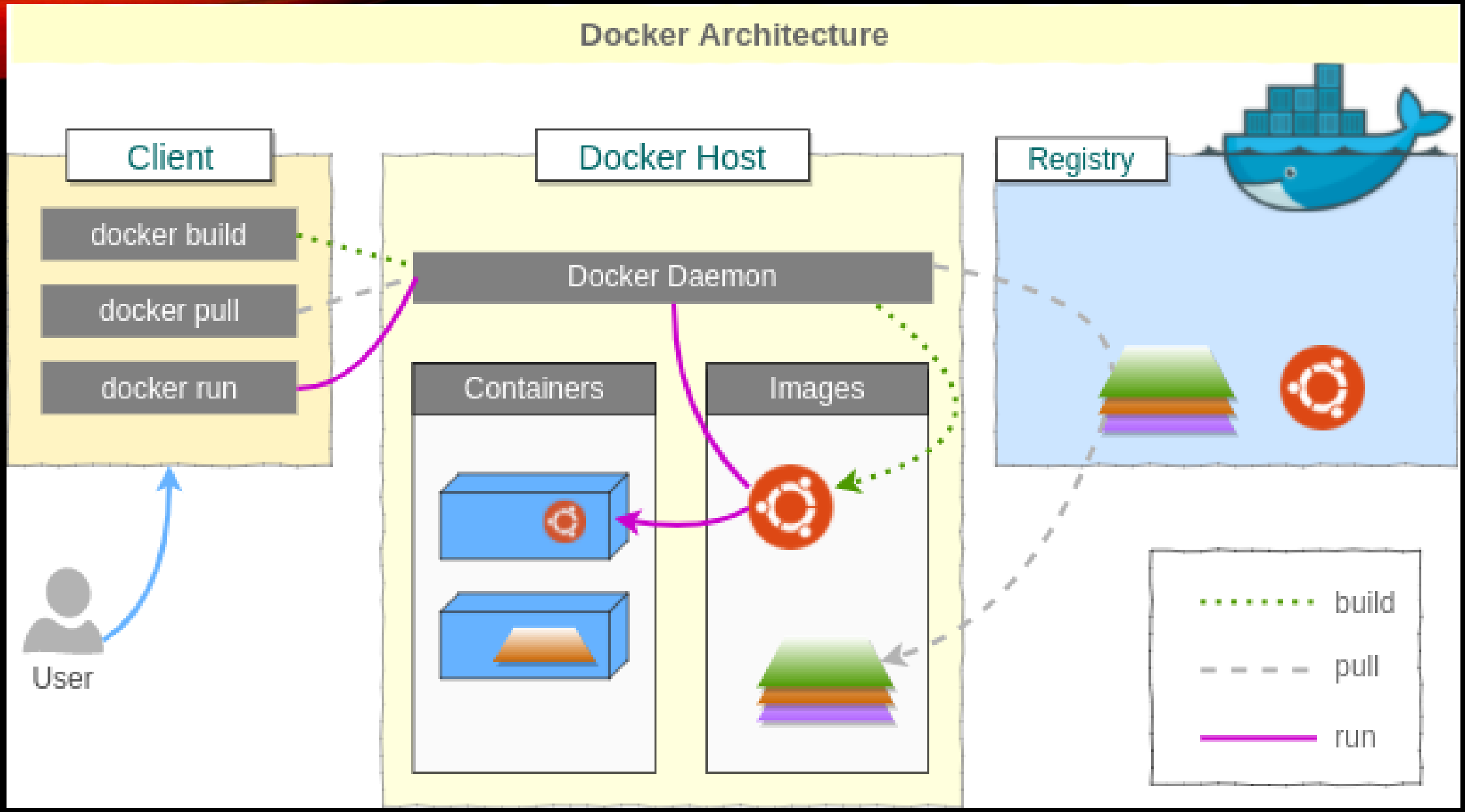
Docker uses a client-server architecture.

The Docker client talks to the Docker daemon, which does the heavy lifting of building, running, and distributing your Docker containers.

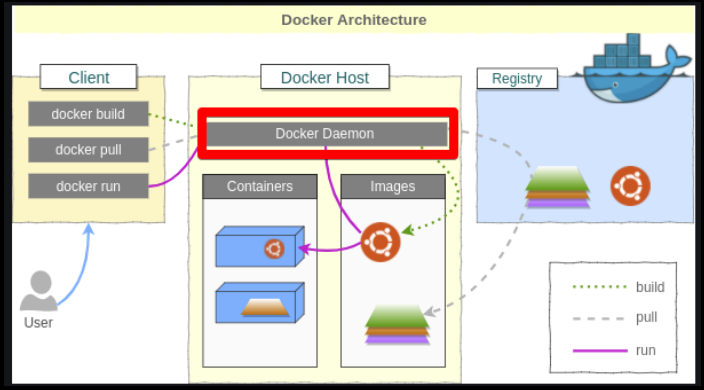
The Docker client and daemon can run on the same system, or you can connect a Docker client to a remote Docker daemon.

The Docker client and daemon communicate using a REST API, over UNIX sockets or a network interface.

DOCKER ARCHITECTURE

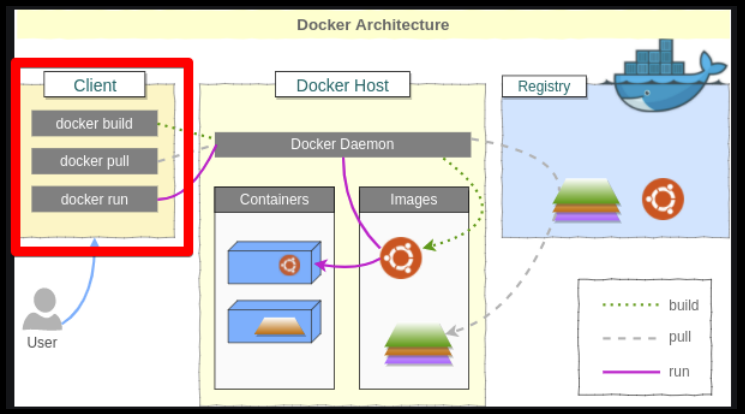


DOCKER DAEMON

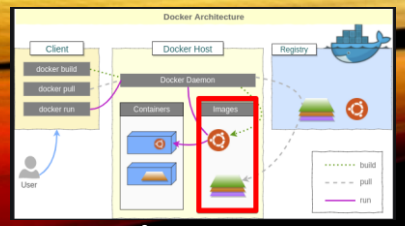


- Name: dockerd
- listens for Docker API requests
- manages Docker objects such as images, containers, networks, and volumes.
- A daemon can also communicate with other daemons to manage Docker services.

DOCKER CLIENT



- Name: from cli docker
- is the primary way that many Docker users interact with Docker.
- When you use commands such as docker run, the client sends these commands to docker daemon , which carries them out.
- The docker command uses the Docker API.
- The Docker client can communicate with more than one daemon.



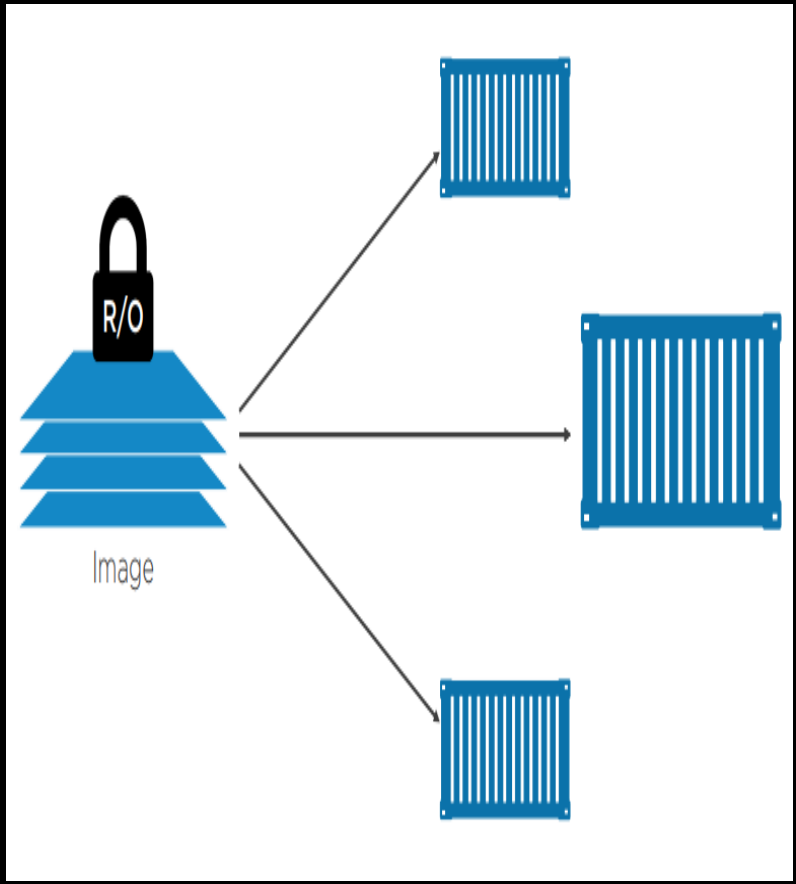
DOCKER OBJECTS - **IMAGES**

- An image is a read-only template with instructions for creating a Docker container. Often, an image is based on another image, with some additional customization.

- You might create your own images or you might only use those created by others and published in a registry. To build your own image, you create a Dockerfile with a simple syntax for defining the steps needed to create the image and run it.

- Each instruction in a Dockerfile creates a layer in the image. When you change the Dockerfile and rebuild the image, only those layers which have changed are rebuilt. This is part of what makes images so lightweight, small, and fast, when compared to other virtualization technologies.

DOCKER OBJECTS - **IMAGES**



Administrator: C:\Windows\System32\cmd.exe

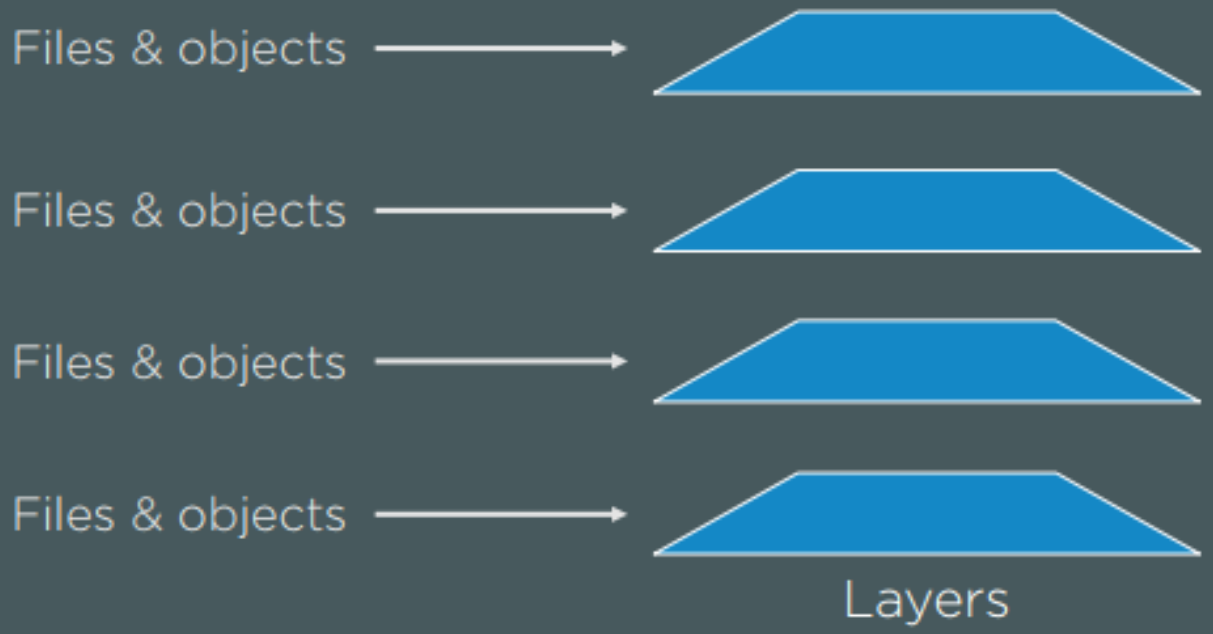
```
Z:\>docker image pull redis
Using default tag: latest
latest: Pulling from library/redis
8ec398bc0356: Pull complete
da01136793fa: Pull complete
cf1486a2c0b8: Pull complete
a44f7da98d9e: Pull complete
c677fde73875: Pull complete
727f8da63ac2: Pull complete
Digest: sha256:90d44d431229683cadd75274e6fcb22c3e0396d149a8f8b7da9925021ee75c30
Status: Downloaded newer image for redis:latest
docker.io/library/redis:latest

Z:\>docker image ls
REPOSITORY          TAG                 IMAGE ID            CREATED             SIZE
redis               latest              9b188f5fb1e6        2 weeks ago         98.2MB
```

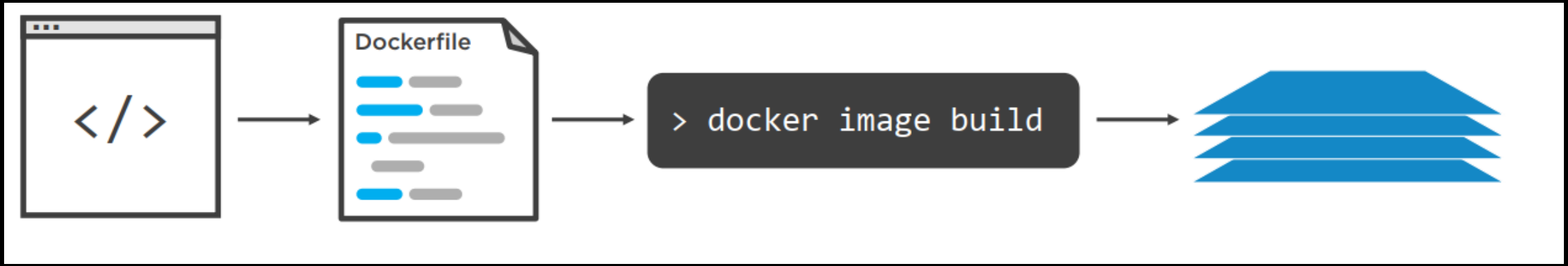
docker image pull redis

layers

DOCKER OBJECTS - **IMAGES**

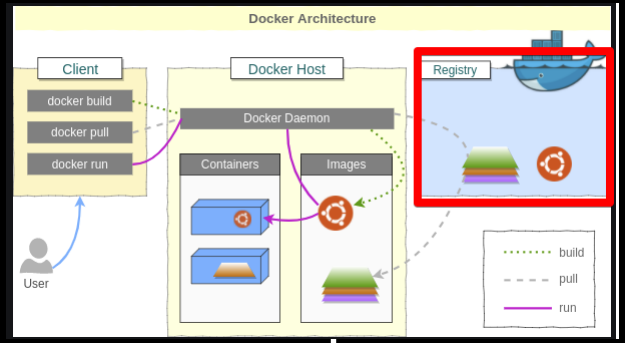


DOCKER OBJECTS - **IMAGES**



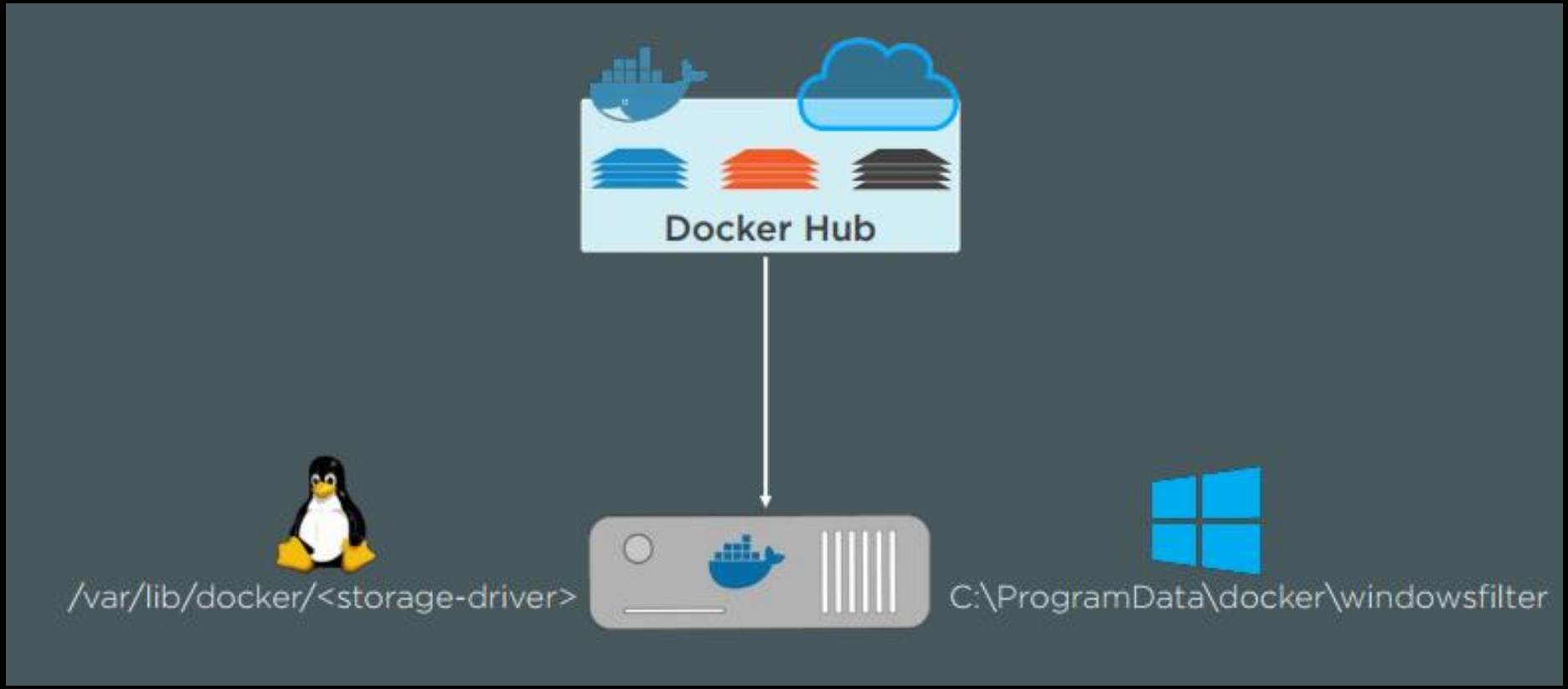
DOCKER REGISTRIES

- stores Docker images.
- Docker Hub is a public registry that anyone can use, and Docker is configured to look for images on Docker Hub by default.

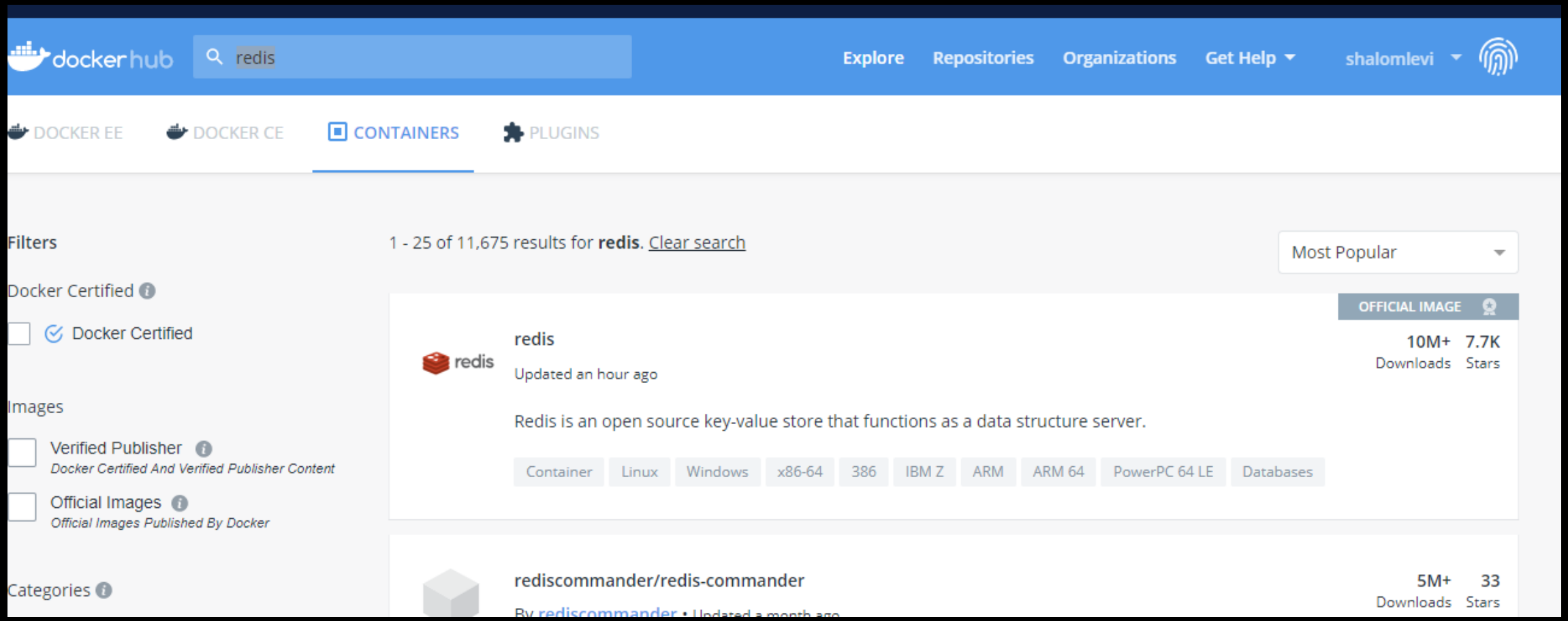


- You can even run your own private registry.
- When you use the docker pull or docker run commands, the required images are pulled from your configured registry.
- When you use the docker push command, your image is pushed to your configured registry.

DOCKER REGISTRIES



DOCKER REGISTRIES



DOCKER REGISTRIES

REGISTRY / REPO / IMAGE (TAG)

docker.io/redis/latest

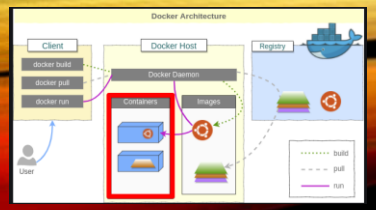
docker.io/nginx/1.13.5

docker.io/<repo>/**latest**

(default) (default)

IMAGE BEST PRACTICE

- use official images
- images small
- for external images not use latest tag, use explicit version



DOCKER OBJECTS - **CONTAINERS**

- A container is a runnable instance of an image. You can create, start, stop, move, or delete a container using the Docker API or CLI. You can connect a container to one or more networks, attach storage to it, or even create a new image based on its current state.
- By default, a container is relatively well isolated from other containers and its host machine. You can control how isolated a container's network, storage, or other underlying subsystems are from other containers or from the host machine.
- A container is defined by its image as well as any configuration options you provide to it when you create or start it. When a container is removed, any changes to its state that are not stored in persistent storage disappear.

INSTALLING DOCKER

- https://docs.docker.com/docker-for-windows/install/

CHECK FUNCTIONALITY

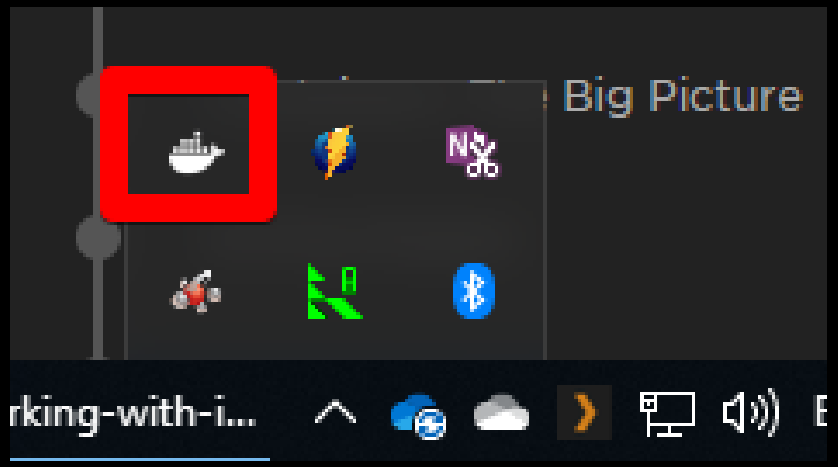
```
Z:\>docker ps
                    IMAGE                    COMMAND
NAMES

Z:\>
```

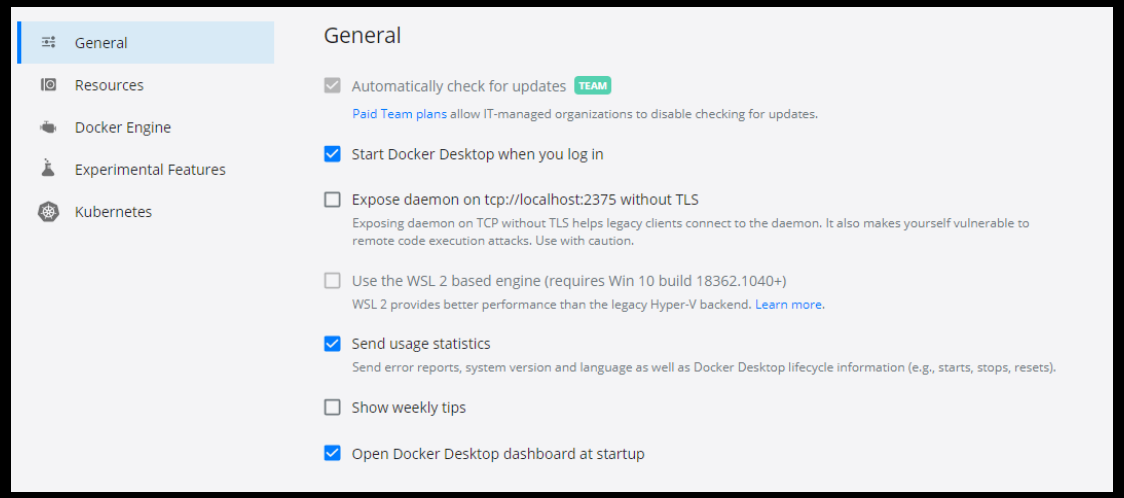
```
Administrator: C:\Windo
C:\Users\Administrator>docker version
Client: Docker Engin
 Version:           19.03.5
 API version:       1.40
 Go version:        go1.12.12
 Git commit:        633a0ea
 Built:             Wed Nov 13 07:22:37 2019
 OS/Arch:           windows/amd64
 Experimental:      false

Server: Docker Engine - Community
 Engine:
  Version:          19.03.5
  API version:      1.40 (minimum version 1.12)
  Go version:       go1.12.12
```

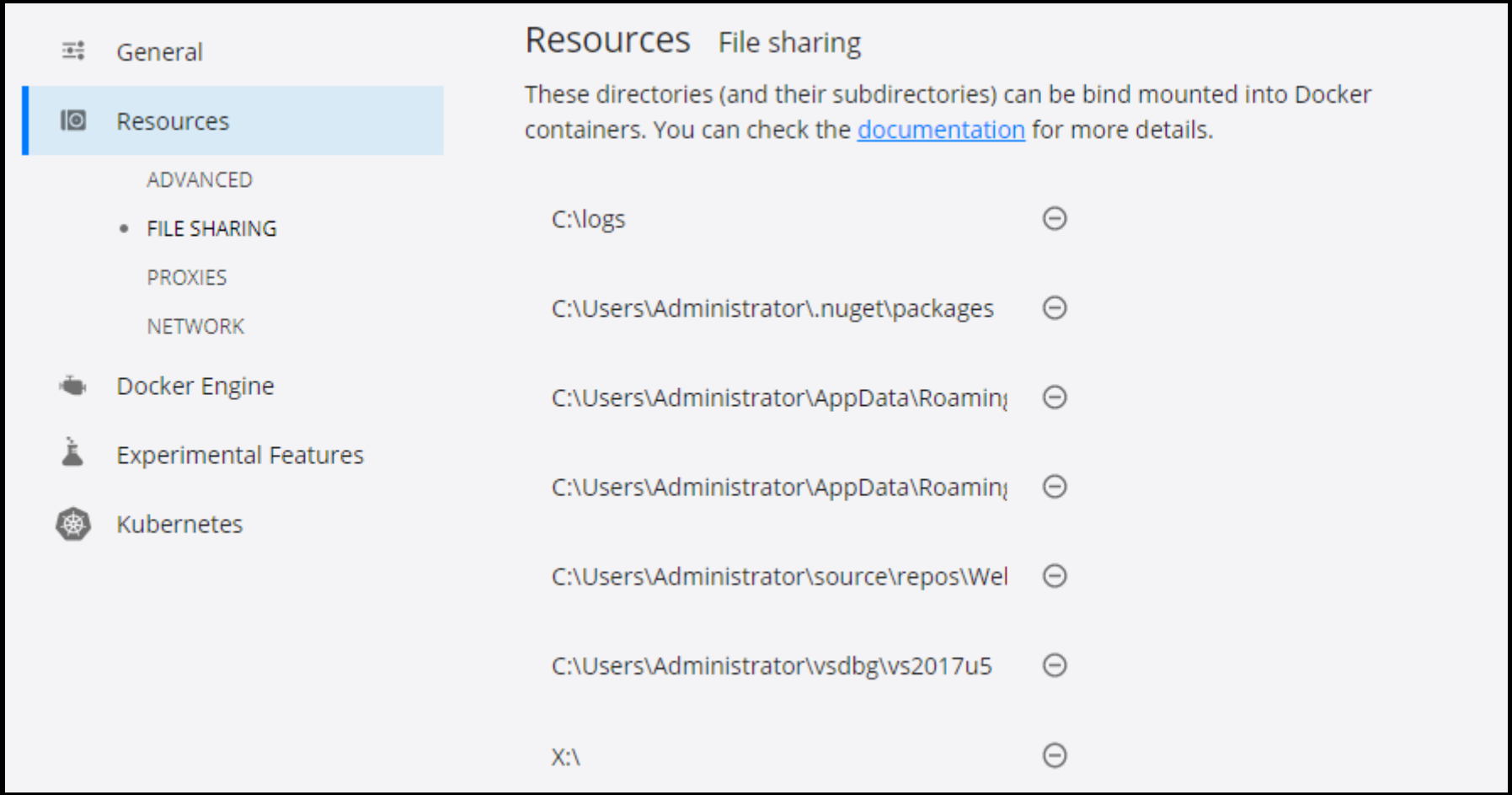
DOCKER TOOL



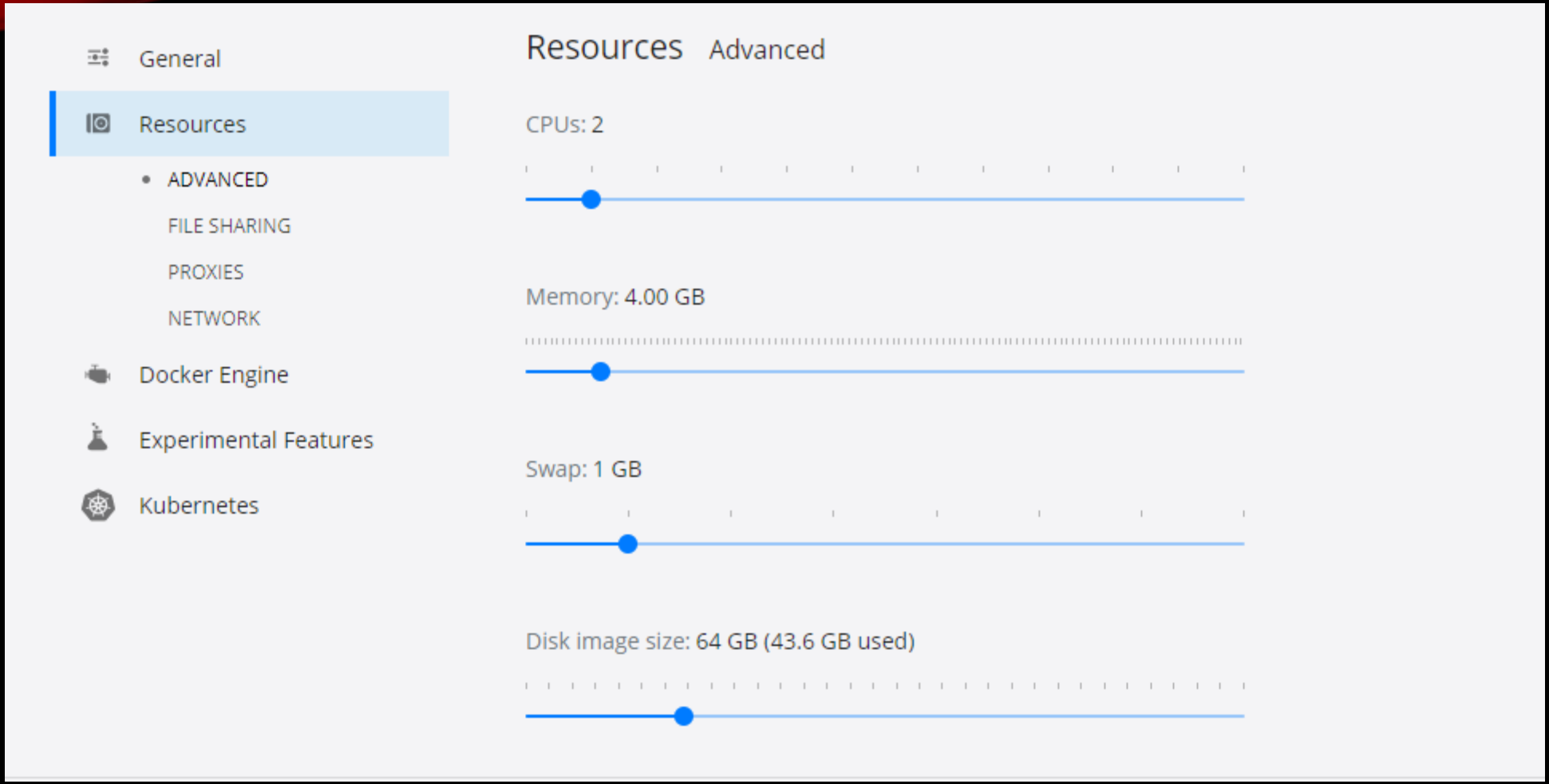
settings



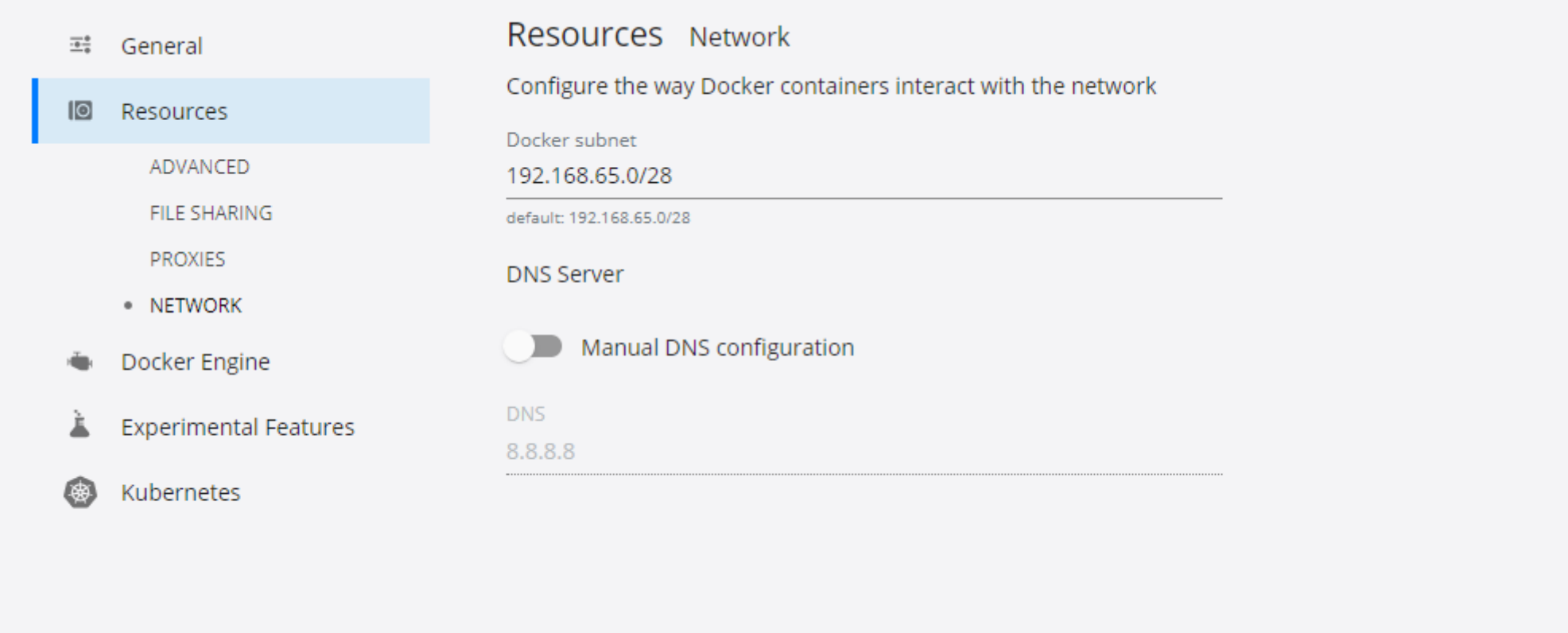
DOCKER TOOL - SETTINGS



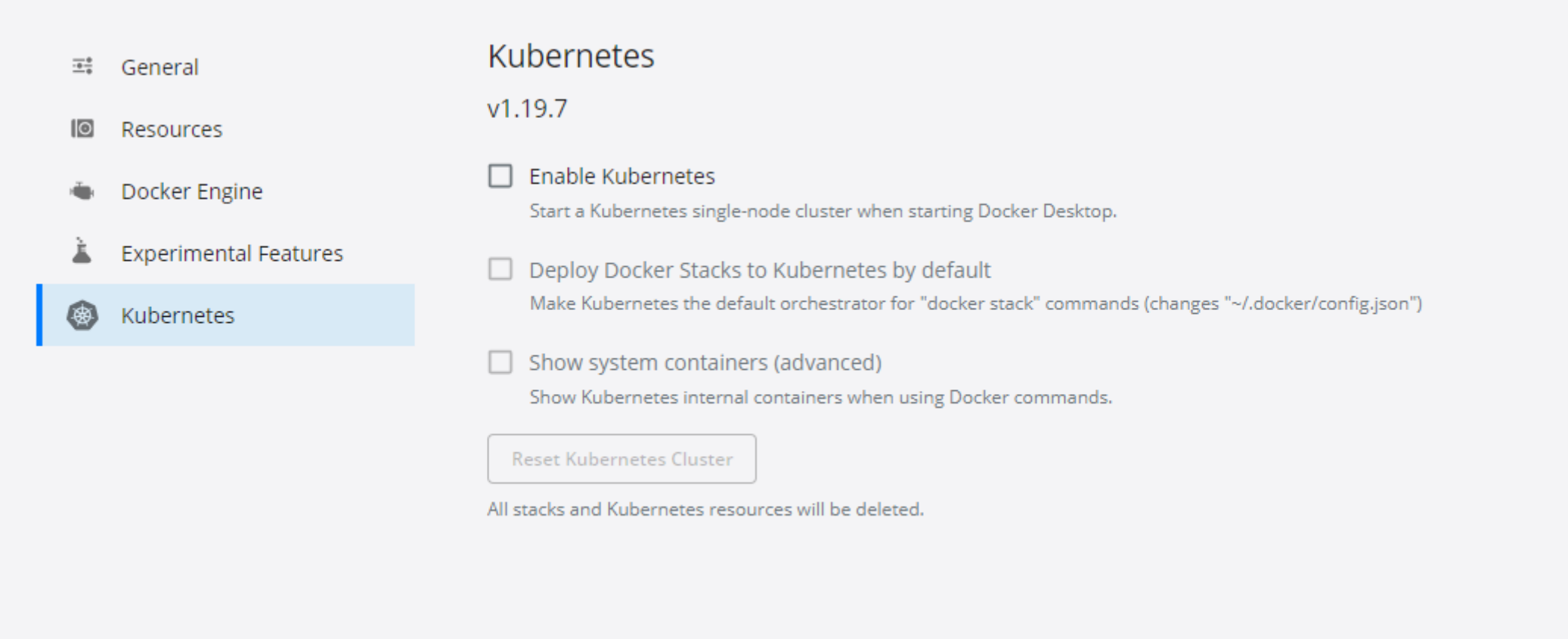
DOCKER TOOL - SETTINGS



DOCKER TOOL - SETTINGS

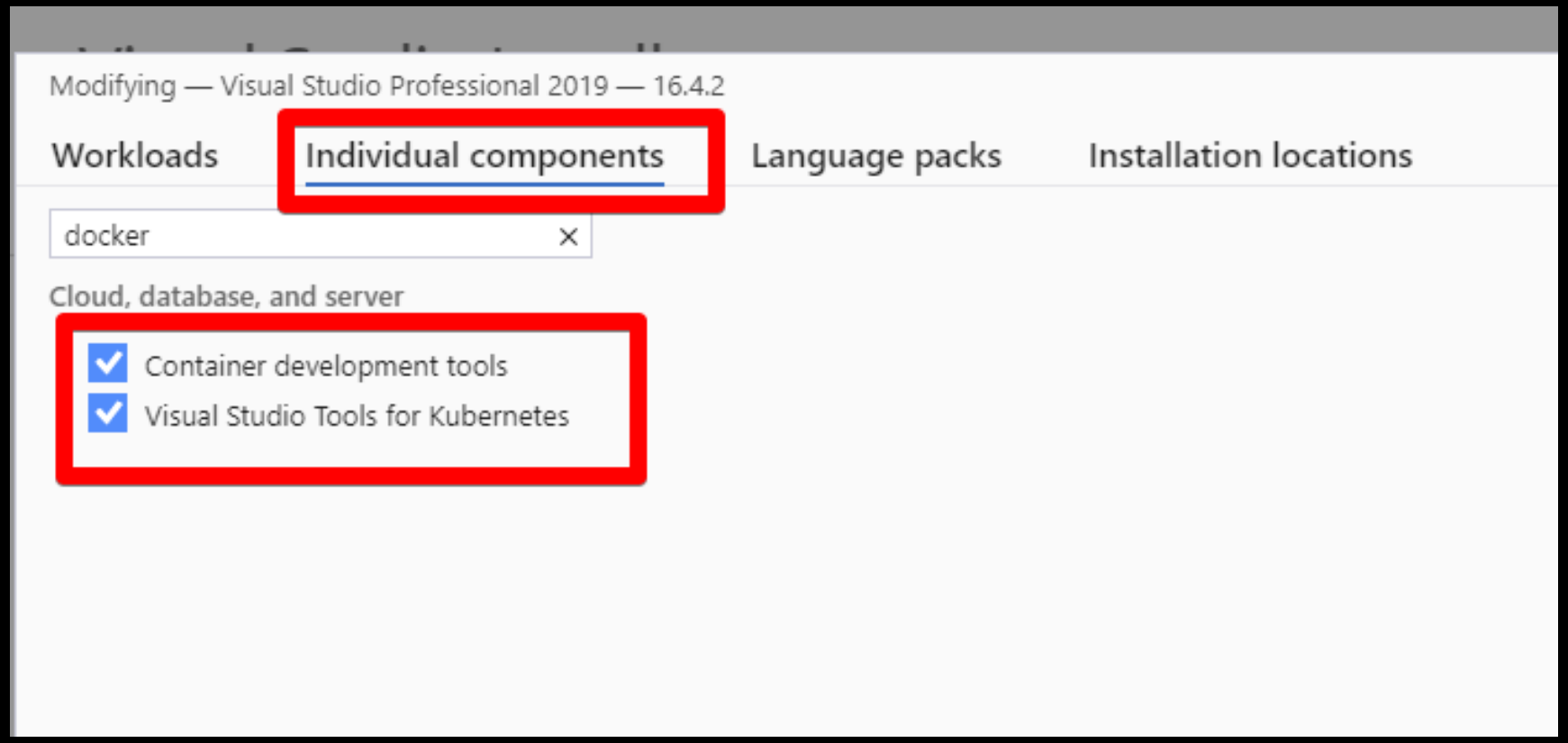


DOCKER TOOL - SETTINGS



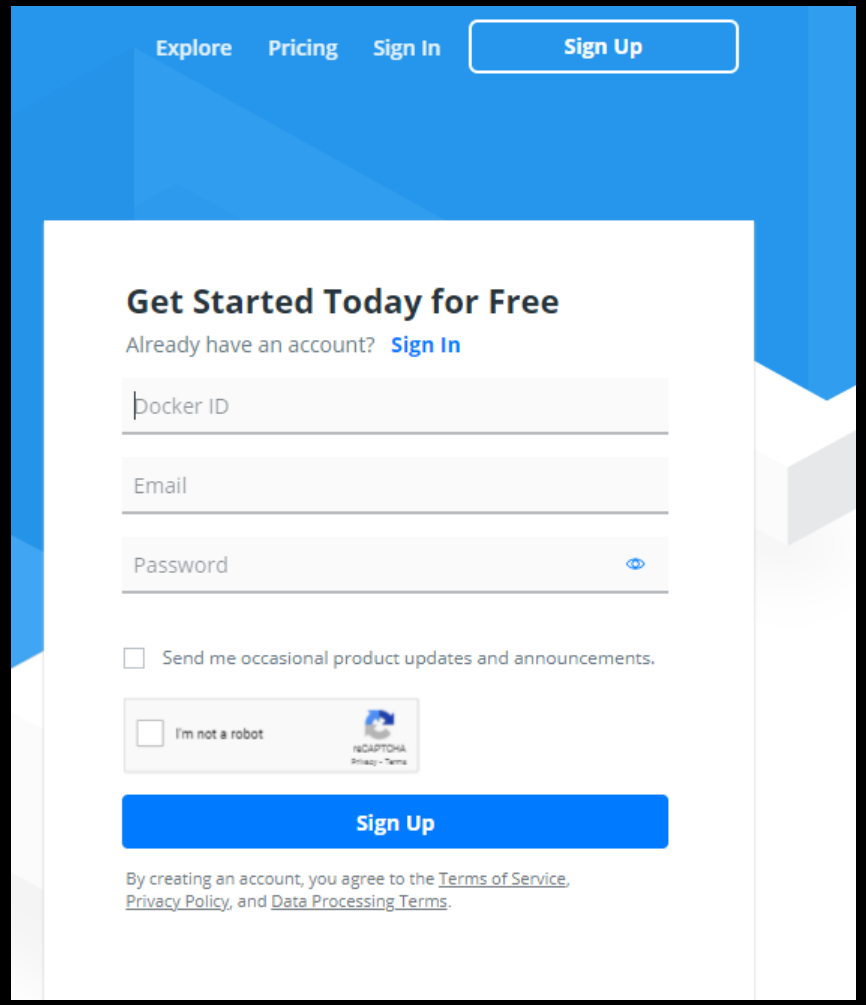
DOCKER TOOL - VISUAL STUDIO

Open Microsoft visual studio installer

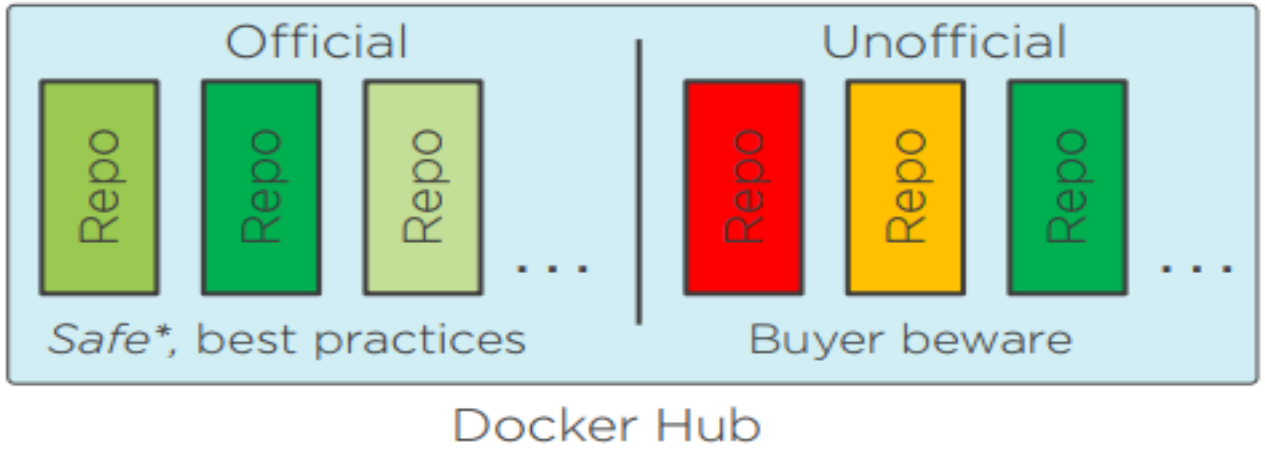


REGISTRY - DOCKER HUB

- https://hub.docker.com/



REGISTRY - DOCKER HUB




```
$ docker image push
```

```
$ docker image pull
```

```
$ docker image inspect
```

```
$ docker image rm
```

BASIC DOCKER COMMANDS

- **Pulling Docker Image**
  $ docker pull mcr.microsoft.com/dotnet/core/samples
- **Listing out Docker Images**
  $ docker image ls
- **Running Docker Containers**
  $ docker run -itd --rm -p 8000:80 --name aspnetcore_sample mcr.microsoft.com/dotnet/core/samples:aspnetapp

  $ docker run --rm -it mcr.microsoft.com/dotnet/core/runtime:3.1 dotnet --list-runtimes

  $ docker run --rm -it mcr.microsoft.com/dotnet/core/runtime:3.1 sh

- **Run shell on running container**

  docker container exec -it 6a25541cb9d8 sh
- **Stopping the container**
  $ docker container stop mcr.microsoft.com/dotnet/core/samples (or <container id>)
- **remove container**
  $ docker rm –f mcr.microsoft.com/dotnet/core/samples (or <container id>)
- **Docker image build**

  docker image build -t shalom-test .

Docker continuers running

docker ps

DOCKER RUN

- **Running Docker Containers**
- docker run [OPTIONS] IMAGE [COMMAND] [ARG...]

$ docker run -itd --rm -p 8000:80 --name aspnetcore_sample mcr.microsoft.com/dotnet/core/samples:aspnetapp

-I	--interactive	Keep STDIN open even if not attached
-t	--tty	Allocate a pseudo-TTY
-d	--detach	Run container in background and print container ID

תרגיל 1

1. צור משתמש ב docker hub
2. התקן סביבת docker על מחשב המעבדה.
3. הפעל תצורת Linux , ניתן להיעזר בפקודה docker info כדי לבדוק באיזה תצורה הסביבה עובדת
4. בדוק שסביבת ה docker תקינה
5. חפש ב docker hub את ה "alpine" image
6. הרץ את alpine כ container שיפעיל את הפקודה "ls /bin", מה קיבלת?
7. בדוק איזה images מותקנים.
8. הפעל את הפקודה הבאה:

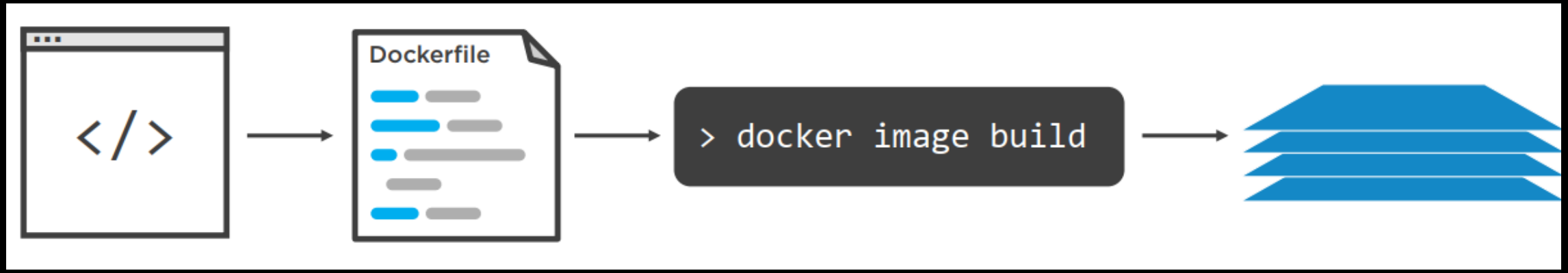
```
docker run  –itd--  rm -p ppatenpsa:selpmas/eroc/tentod/moc.ftosorcim.rcm elpmas_eroctenpsa  eman--8000:80
```

9. בדוק את היישום בדפדפן בפורט 8000
10. בדוק איזה container רצים כרגע
11. מחק את ה container.
12. בנה image מהפקודה הבאה:

```
docker image build -t shalom-node https://github.com/shaloml/node-docker-sample.git
```

12. הרץ את ה image שנוצר בפורט 888
13. בדוק את היישום בדפדפן בפורט 888

DOCKER FILE



DOCKER FILE

Name of file: Dockerfile

Base image layer-1 →

```
FROM alpine
```

Good practice to list maintainer →

```
LABEL maintainer="shaloml@gmail.com"
```

execute command and create layer-2 →

```
RUN apk add --update nodejs nodejs-npm
```

copy code into image as new layer-3 →

```
COPY . /src
```

Some instructions add metadata instead of layers →

```
WORKDIR /src
```

execute command and create layer-4 →

```
RUN  npm install
```

Expose port from image →

```
EXPOSE 8080
```

default app for image/container →

```
ENTRYPOINT ["node", "./app.js"]
```

LAYER

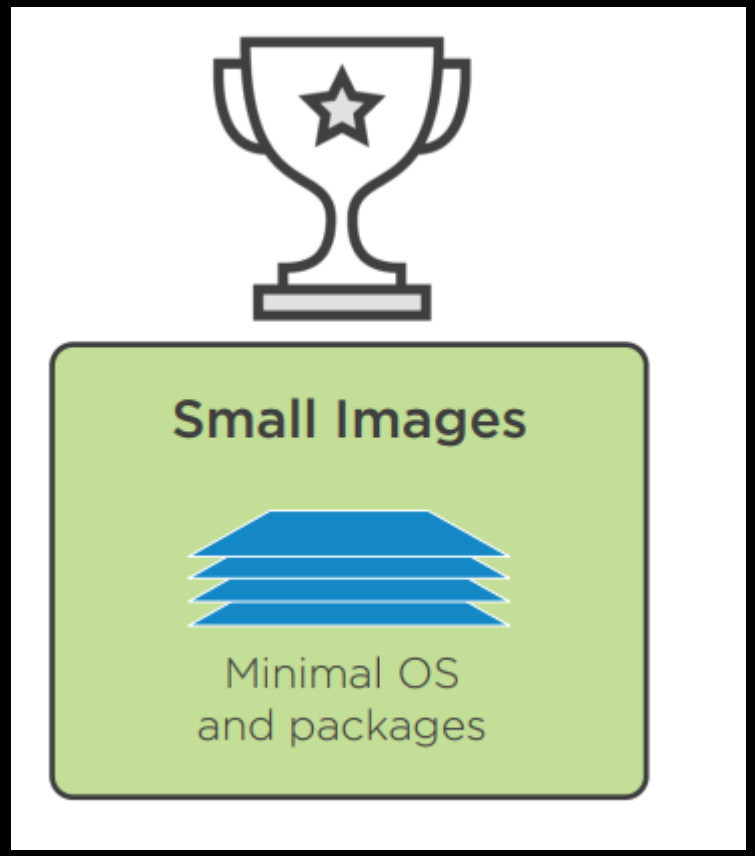
$docker image history [image-name]

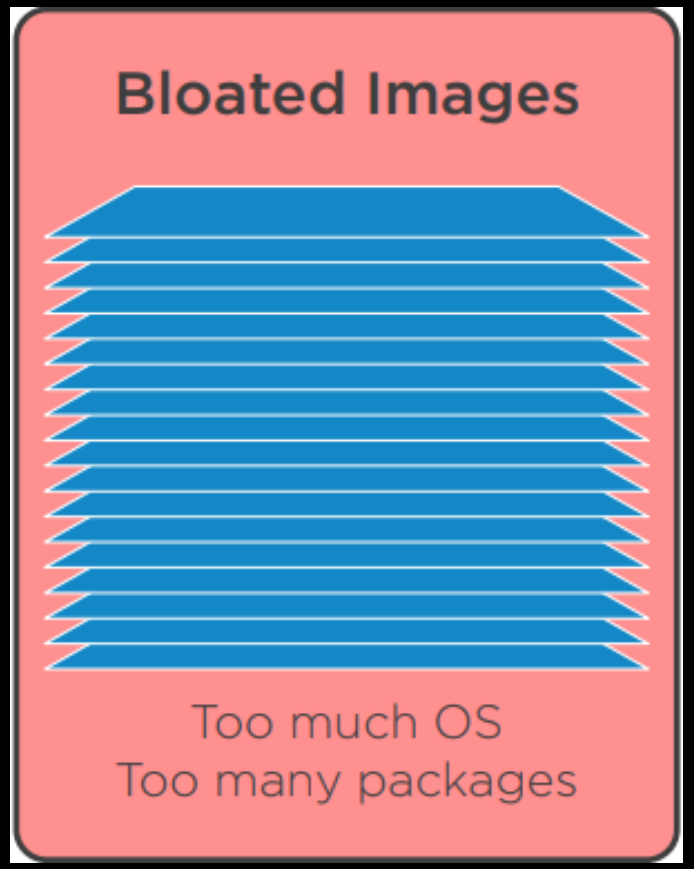
```
IMAGE          CREATED        CREATED BY                                      SIZE
ad50ba62c029   3 minutes ago  /bin/sh -c #(nop)  ENTRYPOINT ["node" "./a...   0B
c55fbce13408   3 minutes ago  /bin/sh -c #(nop)  EXPOSE 8080/tcp              0B
3e958d9a9321   3 minutes ago  /bin/sh -c npm install                          18.4MB
91d611eaa0b9   3 minutes ago  /bin/sh -c #(nop) WORKDIR /src                  0B
d1e85b579cc6   3 minutes ago  /bin/sh -c #(nop) COPY dir:441bd548f7cd704...   21.4kB
89188337f5ca   3 minutes ago  /bin/sh -c apk add --update nodejs nodejs-npm   32.9MB
ff978f010983   3 minutes ago  /bin/sh -c #(nop)  LABEL maintainer=nigelp...   0B
76da55c8019d   13 days ago    /bin/sh -c #(nop)  CMD ["/bin/sh"]              0B
<missing>      13 days ago    /bin/sh -c #(nop) ADD file:4583e12bf5caec4...   3.97MB
```

$docker image inspect [image-name]

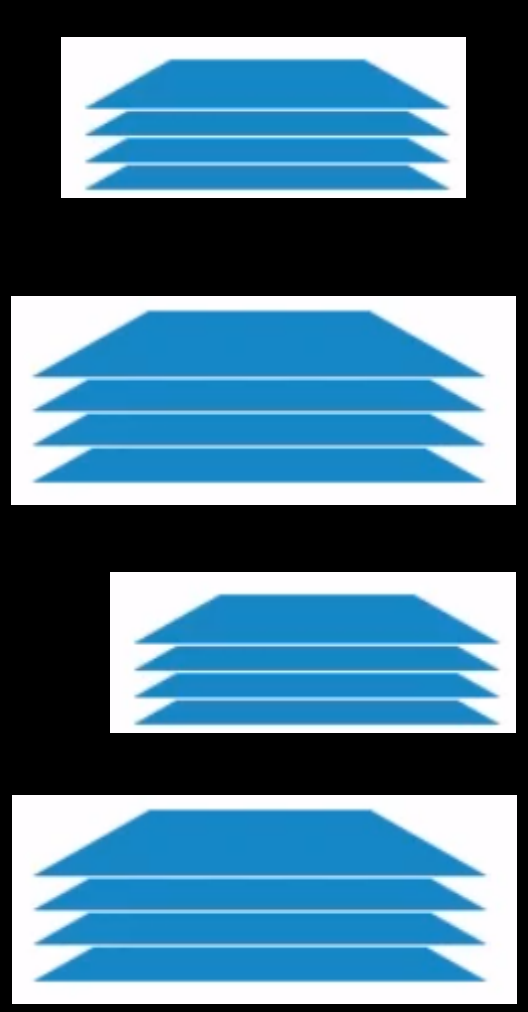
```
"RootFS": {
    "Type": "layers",
    "Layers": [
        "sha256:5bef08742407efd622d243692b79ba0055383bbce12900324f75e56f589aedb0",
        "sha256:b698ddd3252db48462ee329955afe3bc410d0020fff1fc8587dd073f62c3dcf0",
        "sha256:d11ba22daaa3952cd43f56c16f2d0fe4f90cbe62b3e2caca92ef856538b6cce9",
        "sha256:f0a7ce91571fbc9631b9cd9bef8548861acaee77f447d87b21de18861f96862d"
    ]
}
```

MULTI STAGE BUILDS





MULTI STAGE BUILDS



[Stage 0]

```
FROM mcr.microsoft.com/dotnet/core/aspnet:3.1-buster-slim AS base
WORKDIR /app
EXPOSE 80
EXPOSE 443
```

[Stage 1]

```
FROM mcr.microsoft.com/dotnet/core/sdk:3.1-buster AS build
WORKDIR /src
COPY ["WebApplication6.csproj", ""]
RUN dotnet restore "./WebApplication6.csproj"
COPY . .
WORKDIR "/src/."
RUN dotnet build "WebApplication6.csproj" -c Release -o /app/build
```

[Stage 2]

```
FROM build AS publish
RUN dotnet publish "WebApplication6.csproj" -c Release -o /app/publish
```

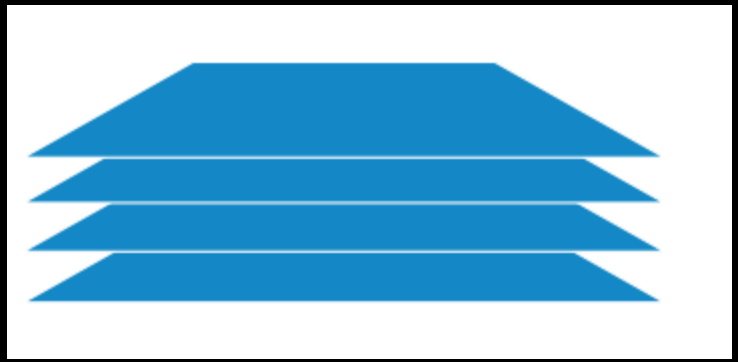
[Stage 3]

```
FROM base AS final
WORKDIR /app
COPY --from=publish /app/publish .
ENTRYPOINT ["dotnet", "WebApplication6.dll"]
```

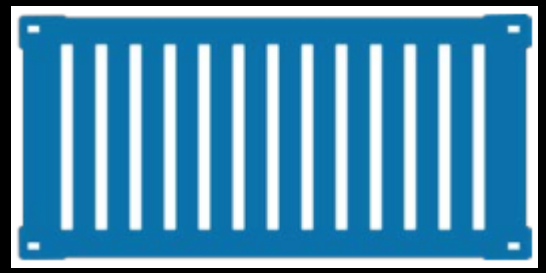
MULTI STAGE BUILDS

```
C:\Users\Administrator\Source\Repos\WebApplication6>docker images
REPOSITORY                                TAG                 IMAGE ID            CREATED             SIZE
shalom-net1                               latest              19243d266418        7 minutes ago       208MB
<none>                                    <none>              c23a5796ea9a        7 minutes ago       694MB
alpine                                    latest              e7d92cdc71fe        5 days ago          5.59MB
mcr.microsoft.com/dotnet/core/samples     aspnetapp           dedaa3c9ce5f        8 days ago          212MB
mcr.microsoft.com/dotnet/core/sdk         3.1-buster          2fe8fe202baf        9 days ago          689MB
mcr.microsoft.com/dotnet/core/aspnet      3.1-buster-slim     5b704ff3cb6b        9 days ago          207MB
mcr.microsoft.com/dotnet/core/runtime     3.1                 a708cda756ab        9 days ago          190MB
```

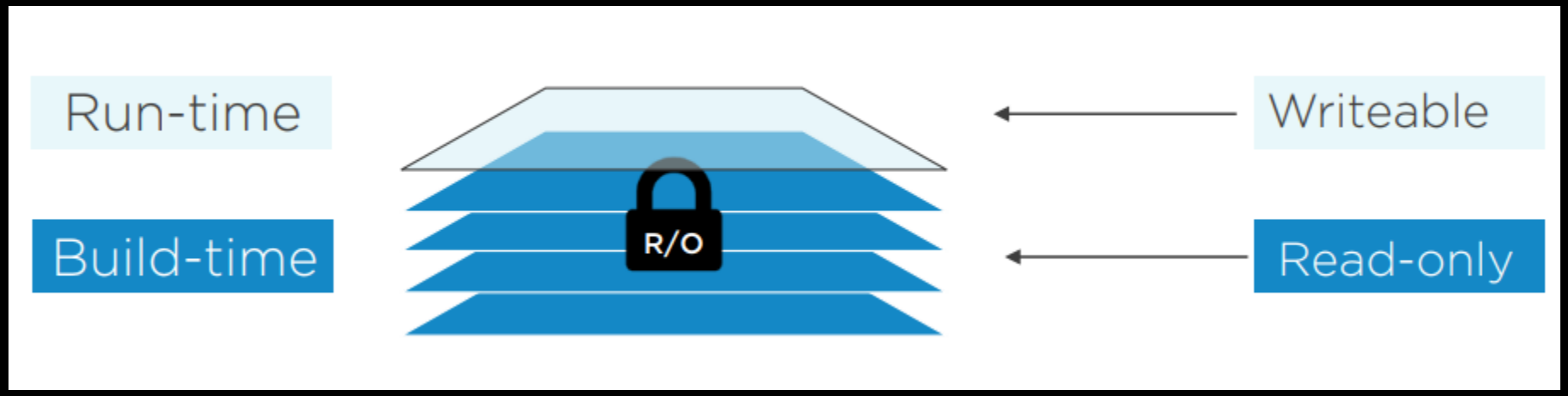
CONTAINER



Build-time



Run-time



CONTAINER BASIC COMMAND

- Show container running
  $Docker ps / docker container ls
- Show all containers
  $Docker ps -a
- Delete container
  $Docker rm –f [container Id / container name]
- Delete container Start
  $Docker container [container Id / container name] start
- container exec
  $Docker container exec –it [container Id / container name] sh
- Delete all (only on power shell)
  $docker container rm $(docker container ls -aq) -f

LOGGING

Engine/daemon

Linux

- **systemd:**

  `journalctl -u docker.service`

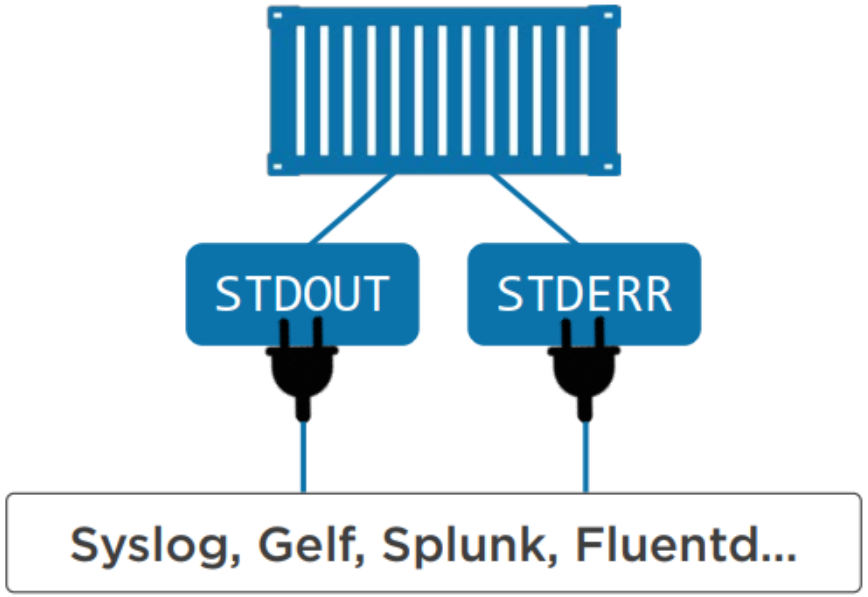
- **Non-systemd:**

  Try `/var/log/messages`

Windows:

`~/AppData/Local/Docker`

Container/App



Set default logging driver in `daemon.json`

Override per-container with

`--log-driver --log-opts`

Inspect logs with `docker logs <container>`

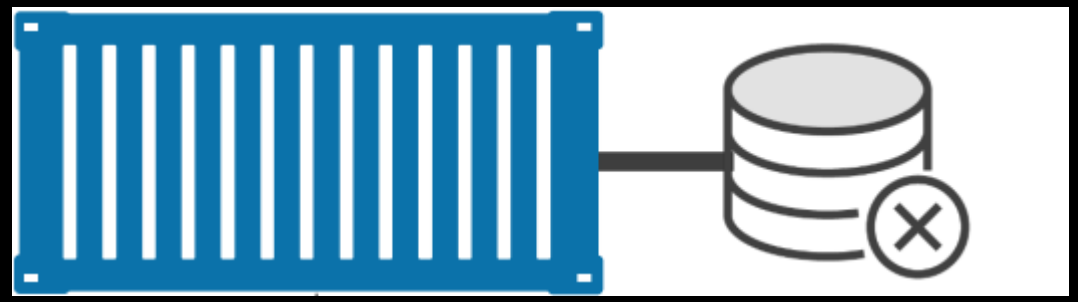
- Doesn't work with all drivers

תרגיל 2

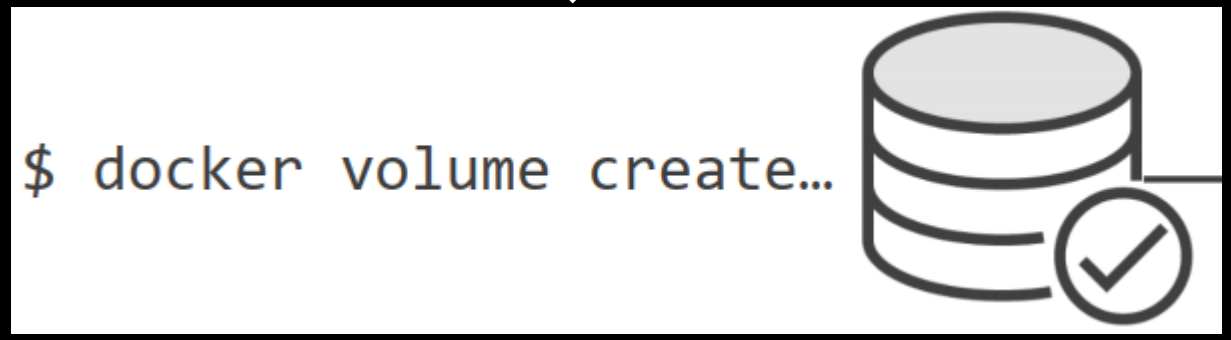
1. צור פרויקט מסוג api.net core
   1. צור את הפרויקט עם תמיכה ב docker
2. פתח את Dockerfile ונסה להבין את השורות.
3. הרץ את הפרויקט דרך visual studio לוודא שהקוד תקין
5. פתח CLI
   1. בנה image בשם my-first-container
6. בדוק שנוצר image
7. הראה שכבות image באמצעות history
8. הפעל inspect על ה image, נסה להבין מה אתה רואה.

VOLUMES

Not persistent



persistent



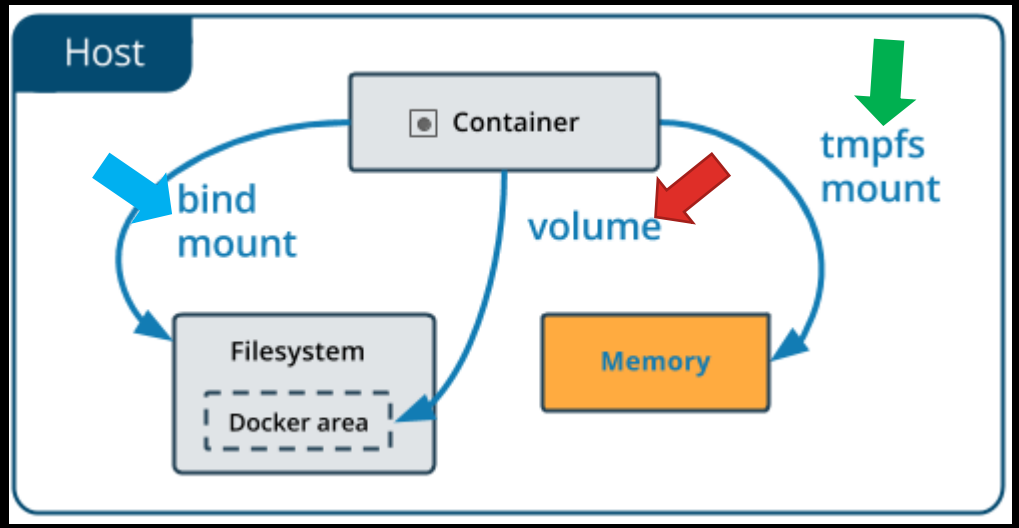
Out side of container

USE VOLUMES

- Volumes are easier to back up or migrate than bind mounts.
- You can manage volumes using Docker CLI commands or the Docker API.
- Volumes work on both Linux and Windows containers.
- Volumes can be more safely shared among multiple containers.
- Volume drivers let you store volumes on remote hosts or cloud providers, to encrypt the contents of volumes, or to add other functionality.
- New volumes can have their content pre-populated by a container.

VOLUMES

- An easy way to visualize the difference among volumes, bind mounts, and tmpfs mounts is to think about where the data lives on the Docker host.
- Volumes are stored in a part of the host filesystem which is managed by Docker (/var/lib/docker/volumes/ on Linux). Non-Docker processes should not modify this part of the filesystem. Volumes are the best way to persist data in Docker.
- Bind mounts may be stored anywhere on the host system
- tmpfs mounts are stored in the host system's memory only



VOLUMES

RUN

```
docker run -dti --name alpine1 --mount target=/app alpine ash
```

INSPECT

```
docker inspect alpine1
```


```
},
"Mounts": [
    {
        "Type": "volume",
        "Name": "e2c79e12b3f8b90888688da603cca4c2297ee96f2b914a601378e5d944f17214",
        "Source": "/var/lib/docker/volumes/e2c79e12b3f8b90888688da603cca4c2297ee96f2b914a601378e5d944f17214/_data",
        "Destination": "/app",
        "Driver": "local",
        "Mode": "z",
        "RW": true,
        "Propagation": ""
    }
],
```


STOP AND DELETE CONTAINER

```
docker stop alpine1 && docker rm alpine1
```

VOLUMES

Creating a VOLUME managed by docker FS and share it with multiple containers

RUN

```
docker volume create fs_shared
```

LIST VOLUMES

```
docker volume ls
```

```
local               fs_shared
```

RUN AND MOUNT

```
docker run --rm -tdi --name alpine1 --mount source=fs_shared,target=/app alpine ash
```

```
docker run --rm -tdi --name alpine2 --mount source=fs_shared,target=/app alpine ash
```

```
docker run --rm -tdi --name alpine3 --mount source=fs_shared,target=/app alpine ash
```

https://docs.docker.com/storage/volumes/

VOLUMES

- The -v and --mount examples below produce the same result. You can't run them both unless you remove the devtest container and the myvol2 volume after running the first one.

-v

```
docker run --rm -tdi -v "$(pwd)"/source:/app [image] [CMD]
docker run -d  --name devtest  -v myvol2:/app  nginx:latest
```

--mount

```
docker run --rm -tdi -v "$(pwd)"/source:/app [image] [CMD]
docker run -d  --name devtest  --mount source=myvol2,target=/app \ nginx:latest
```

VOLUMES

WINDOWS MAP VOLUME BIND

-v

```
docker run --rm -tdi -v C:/folder/name:/data [image] [CMD]
```

example

docker run --rm -it --name alpine1-windows -v c:/temp:/app alpine sh

VOLUMES
BIND MOUNTS USING -V OR –MOUNT ?

- all options for volumes are available for both --mount and -v flags.
- When using volumes with services, only --mount is supported.
- What should I use?
  - What you want to use comes mostly down to either preference or your management. If you want to keep everything in the "docker area" (/var/lib/docker) you can use volumes. If you want to keep your own directory-structure, you can use binds.
  - Docker recommends the use of volumes over the use of binds, as volumes are created and managed by docker and binds have a lot more potential of failure (also due to layer 8 problems).
  - If you use binds and want to transfer your containers/applications on another host, you have to rebuild your directory-structure, where as volumes are more uniform on every host.

MANAGE VOLUMES

$docker volume [commands]

Ls

List volumes

Create

docker volume create [volume name]

Info

docker volume inspect [volume name]

Remove

Docker volume rm [volume name]

On Linux volume store: /var/lib/docker/volumes

תרגיל 3

1. ייצר volume חדש בשם my_shared
2. בצע ls לכל ה volumes , בדוק שנוצר my_shared
3. הרץ שני container מסוג alpine עם CLI (הוספת sh בסוף הפקודה)
   - test-vol1 ו- test-vol2
   קשר את my_shared ל /app לכל אחד מה containers
4. ב test-vol1
   - כנס לתיקיית app באמצעות הפקודה: cd app
   - הרץ את הפקודה: Echo hello > test.txt
5. בדוק שנוצר קובץ באמצעות הפקודה ls
6. עבור ל test-vol2
   - כנס לתיקיית app באמצעות הפקודה: cd app
   - בדוק שהקובץ קיים גם /app באמצעות הפקודה: ls
7. הרץ container חדש מסוג alpine עם CLI, מפה כונן c:\temp ל /app
8. ייצר קובץ בתיקיית ה WINDOWS ובדוק שהקובץ קיים ב container.