1. what difference between virtual machine & docker container?

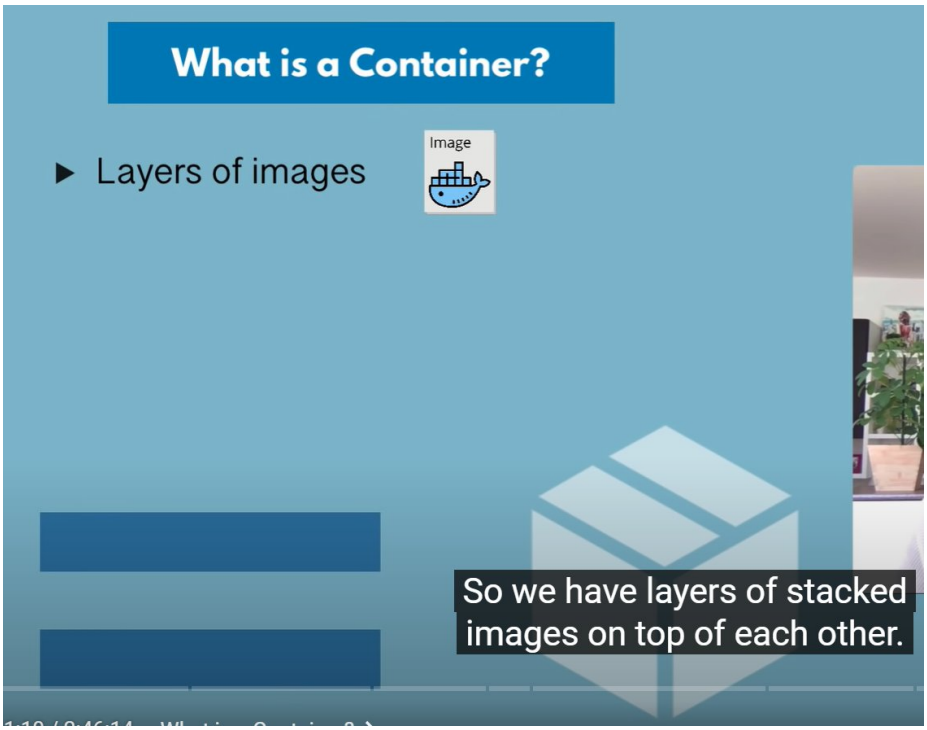
=> VM run on full guest OS including Own kernel executable, library.
Docker shared host OS kernel and only include application,minimum OS-like components lib, executable from base image.
2. what difference between docker image & docker container?
Image is **read-only template t**hat contains everything needed to run an application, including the application code, dependencies, libraries, and minimal OS components.
image is **immutable** means once created cannot modified unless you create new version.
Example: docker build -t my-app . creates an image named my-app. OR Built using a Dockerfile.

build is command

docker container is running instance of image.
writable envionment where application run with own isolated file system.

Summary Table

Feature	Docker Image	Docker Container
Nature	Static, read-only template	Dynamic, running instance
Contains	App, dependencies, config	Image + writable layer for runtime
Creation	Built with *docker build*	Created with *docker run*
Storage	Stored in registry or locally	Exists locally, tied to runtime
Purpose	Blueprint for containers	Executes the application
Lifecycle	Persistent until deleted	Ephemeral, can be stopped/deleted



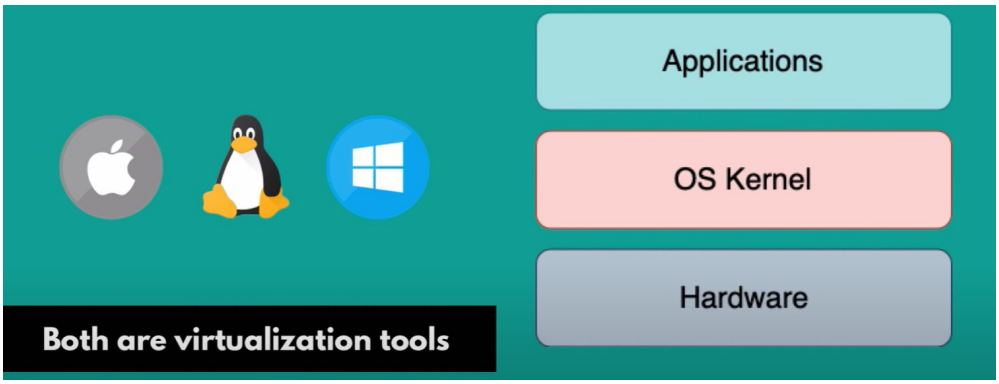
Docker is multi layer image file.

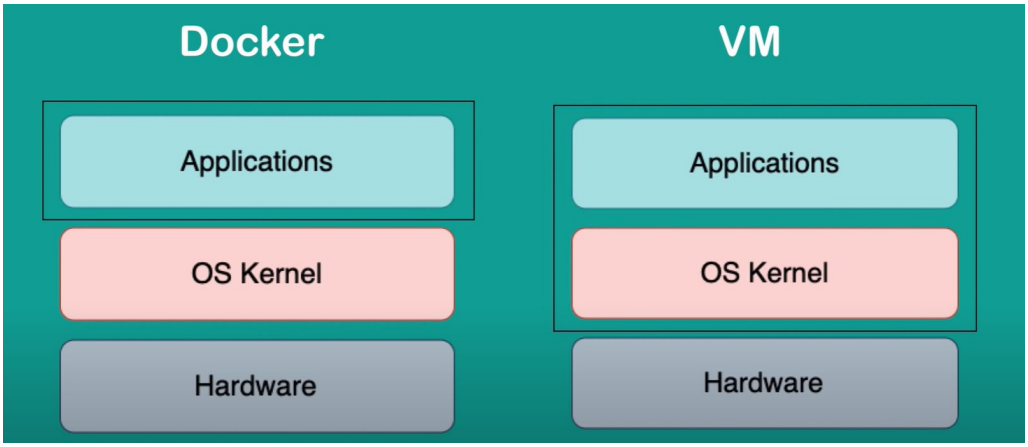
When you want upgrade version of software at that time it NOT download whole docker , it just download only upgraded layer , base layer kept as it.

```
Last login: Sat Sep 28 10:57:20 on ttys001
Nanas-MBP:~ nanabiz$ docker ps
CONTAINER ID        IMAGE               COMMAND                  CREATED             STATUS              PORTS
S
fad0f8456ca7        postgres:9.6        "docker-entrypoint..."   45 seconds ago      Up 47 seconds       5432/tcp
eless_haibt
Nanas-MBP:~ nanabiz$
```

```
Nanas-MBP:~ nanabiz$ docker run postgres:10.10
Unable to find image 'postgres:10.10' locally
10.10: Pulling from library/postgres
8f91359f1fff: Already exists
c6115f5efcde: Already exists
28a9c19d8188: Already exists
2da4beb7be31: Already exists
fb9ca792da89: Already exists
cedc20991511: Already exists
b866c2f2559e: Already exists
5d459cf6645c: Already exists
6de9d066d892: Downloading [==================================>
401fcd8e29c4: Download complete
9b130e26214a: Download complete
1c048e77610c: Download complete
431b5e6c27b3: Download complete
```

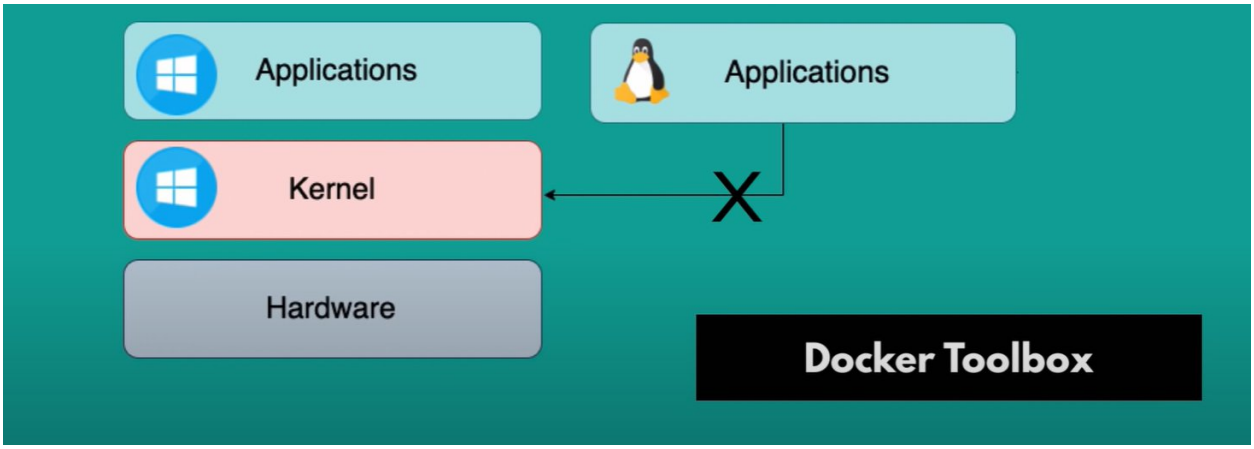
some layers already exist ✅



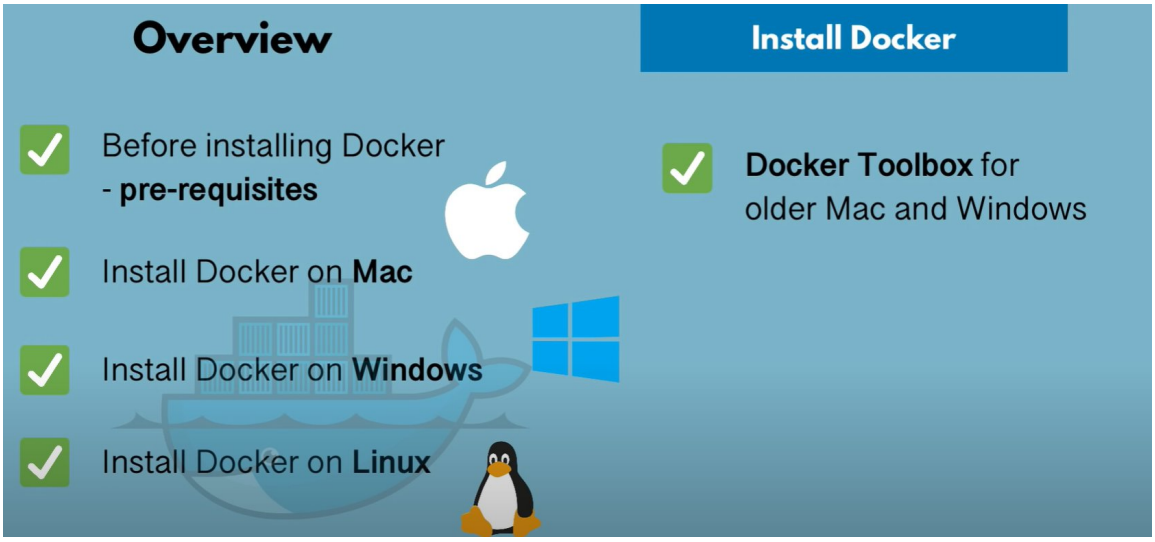


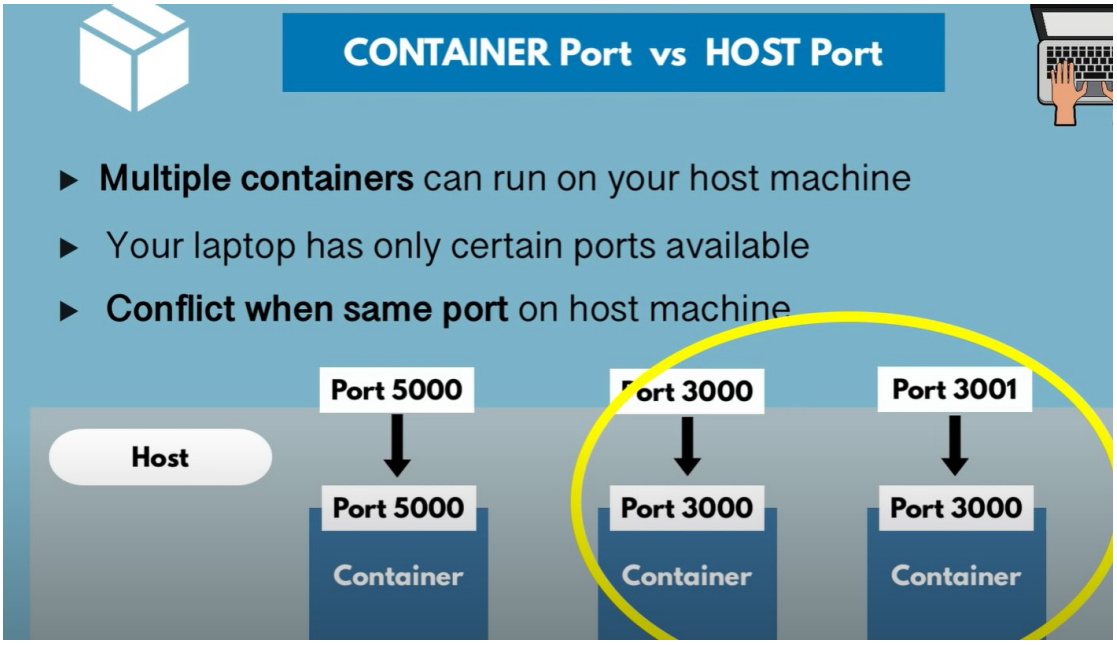
Docker virtualize at application layered where VM Virtualize at OS layered .
SIZE:- That why Docker is small in SIZE than VM
SPEED:- Docker is much faster then VM
OS Kernel Depedency (Compatibility) :- Docker run on any linux but if it window it extra Docker tool ,
When VM doen't required , VM can run any host .

FOR Windows



Workaround for Windows & Mac





Port Mapping

What is port binding ?

=> connecting a port on the host machine to a port inside the container.

A process of linking a **port on your host machine** (your computer or server) to a **port inside a Docker container**.Service inside container can access out of container is port mapping.

I remember that when you run a container, services inside it **aren't** accessible from outside unless you map the ports. For example, if a container is running a web server on port 80, you need to map the host's port 8080 to the container's port 80 to access it via localhost:8080.

Why port mapping is necessary?

=> Containers have their **own isolated network**, so without mapping, the ports aren't exposed to the host or the outside world.

If a service (e.g., a web server) runs on port 80 inside a container, it's **not accessible from outside the container** unless you explicitly map the container's port to a host port.

Port Mapping Ex. Docker run command syntax. It's usually -p host_port:container_port.

What's the difference between -p and -P?

=>-P flag publishes all exposed ports to random ports on the host. That's useful when you don't want to specify each port manually.

How It Works

- **Host Port:** Port on your machine (e.g., 8080).
- **Container Port:** Port the service uses inside the container (e.g., 80).

When you map 8080:80, traffic sent to http://localhost:8080 on the host is forwarded to port 80 in the container.

ex. docker run -p <HOST_PORT>:<CONTAINER_PORT> <IMAGE Name>

1. docker run -p 8080:80 nginx
2. docker run -p 192.168.1.100:8080:80 nginx
3. # Docker picks a random host port (e.g., 32768) and maps it to container port 80

```
docker run -p 80 n nginx

# Check assigned port with `docker ps
```

What is docker-compose, how port mapping is handled

=> It define the configuration of all your application's services (e.g., databases, web servers, etc.) in a single YAML file**.** It used link containers, share volumes, or set environment variables.

Also used :

- Use a single command (docker-compose up) to start multiple services at once.
- Easily scale services, manage networking, and configure volume mounts.

Key Concepts of Docker Compose:

1. **Services**: These are the containers defined in the `docker-compose.yml` file. Each service can represent a different container (e.g., a web app container, a database container).
2. **Networks**: Docker Compose automatically creates a network for your services to communicate with each other.
3. **Volumes**: Shared storage that can be used by containers.

Example of docker compose file:

```
version: '3.8'  # Specify the version of Docker Compose


services:
  web:
    image: nginx:latest  # Use the official Nginx image
    ports:
      - "8080:80"  # Map port 8080 on host to port 80 on the container
  db:
    image: mysql:5.7  # Use the official MySQL image
    environment:
      MYSQL_ROOT_PASSWORD: example_password  # Set environment variables
    volumes:
      - db_data:/var/lib/mysql  # Use a named volume for database data


volumes:
  db_data:  # Define the named volume
```

Port Mapping Format in docker compose file :

`yaml`

```
ports:    - "host_port:container_port"
```

Example of Port Mapping:

```
version: '3'
services:
  app:
    image: your_app_image
    ports:
      - "5000:80"  # HTTP port
      - "8443:443" # HTTPS port
```

Starting Docker Compose:

```
docker-compose up
```

Stopping Docker Compose:

```
docker-compose down
```

docker run command

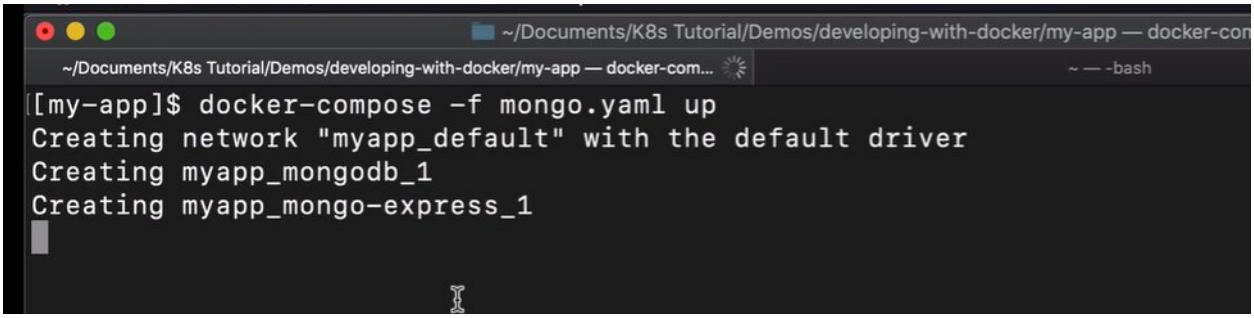
```
docker run -d \
--name mongo-express \
-p 8080:8080 \

-e ME_CONFIG_MONGODB_
   ADMINUSERNAME=admin \
-e ME_CONFIG_MONGODB_
   ADMINPASSWORD=password \
-e ME_CONFIG_MONGODB_
   SERVER=mongodb \

--net mongo-network \
mongo-express
```

mongo-docker-compose.yaml

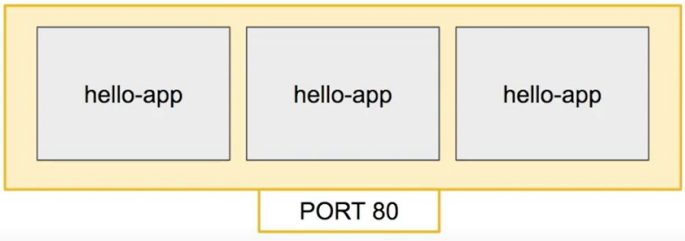
```
version: '3'
services:
    mongodb:
        image: mongo
        ...
    mongo-express:
        image: mongo-express
        ports:
          - 8080:8080
        environment:
          - ME_CONFIG_MONGODB_A....
```

it's going to be easier for you to edit the file

To Run docker compose file



With a Service



(My simple) definition:

Service = n containers all running with the same parameters, available at the same port