Containers

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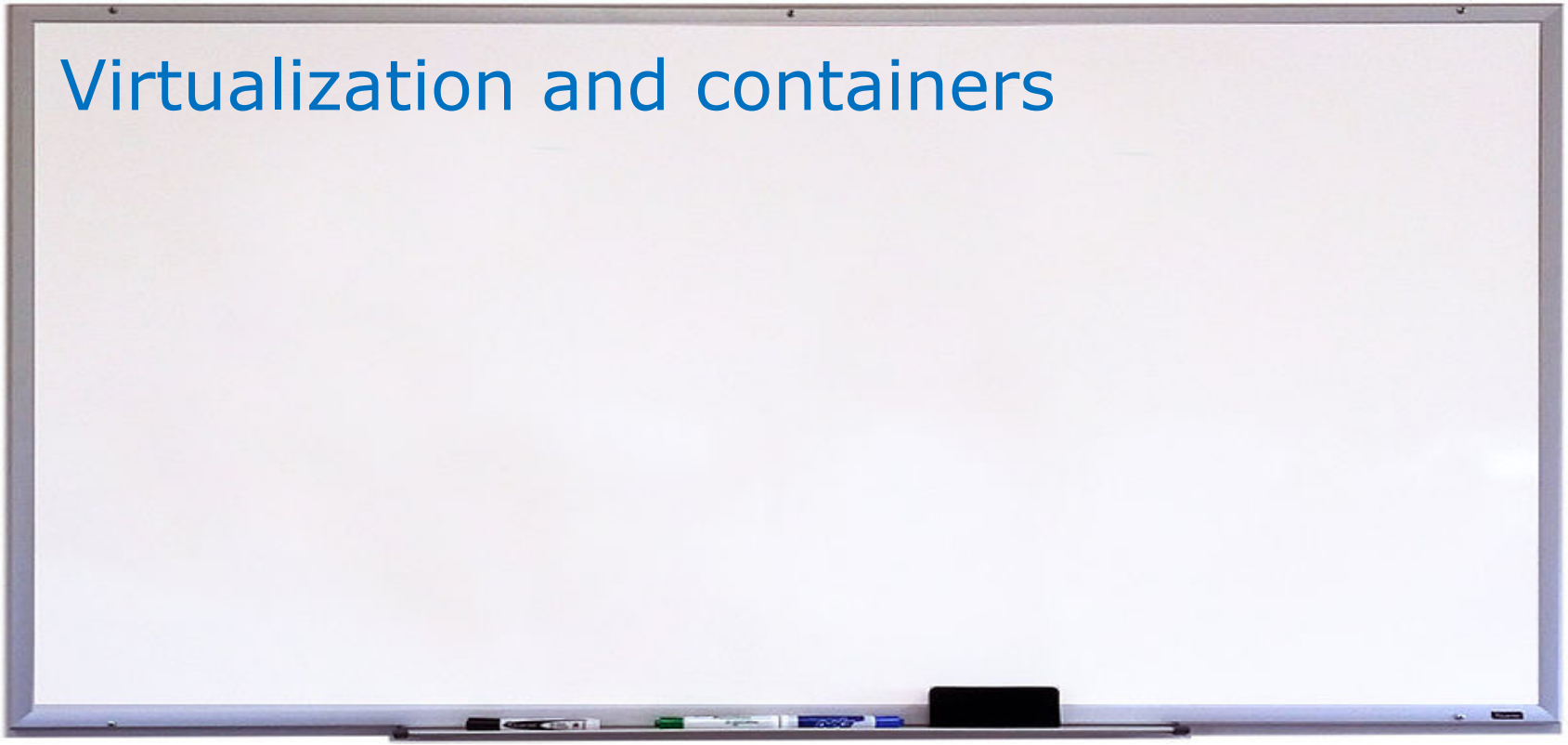
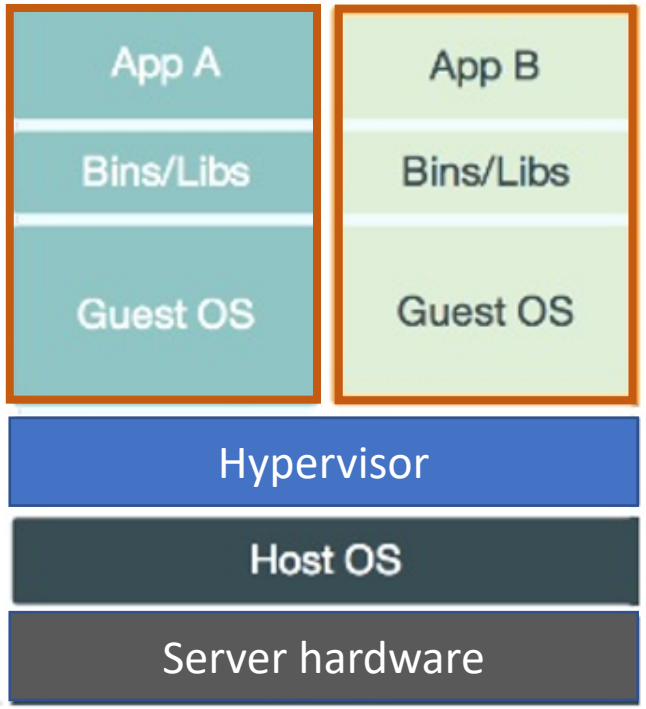
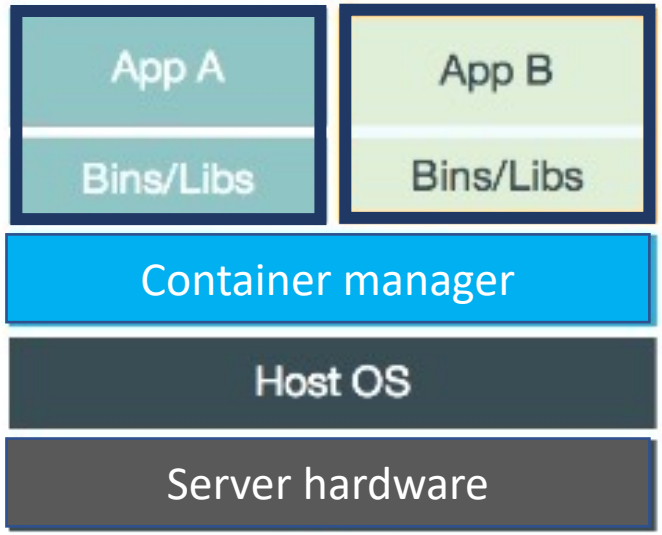
Virtualization and containers



From VMs to containers





- Server virtualization
- Many virtual machines (each with its OS) running on same physical server
- ("Type 1" hypervisor loaded directly on HW)

Key idea of containers: Exploit OS kernel's capability of allowing multiple isolated user-space instances

+ lighter (require less resources, from Gb to Mb)

+ faster to start (from mins to secs)

- share same OS

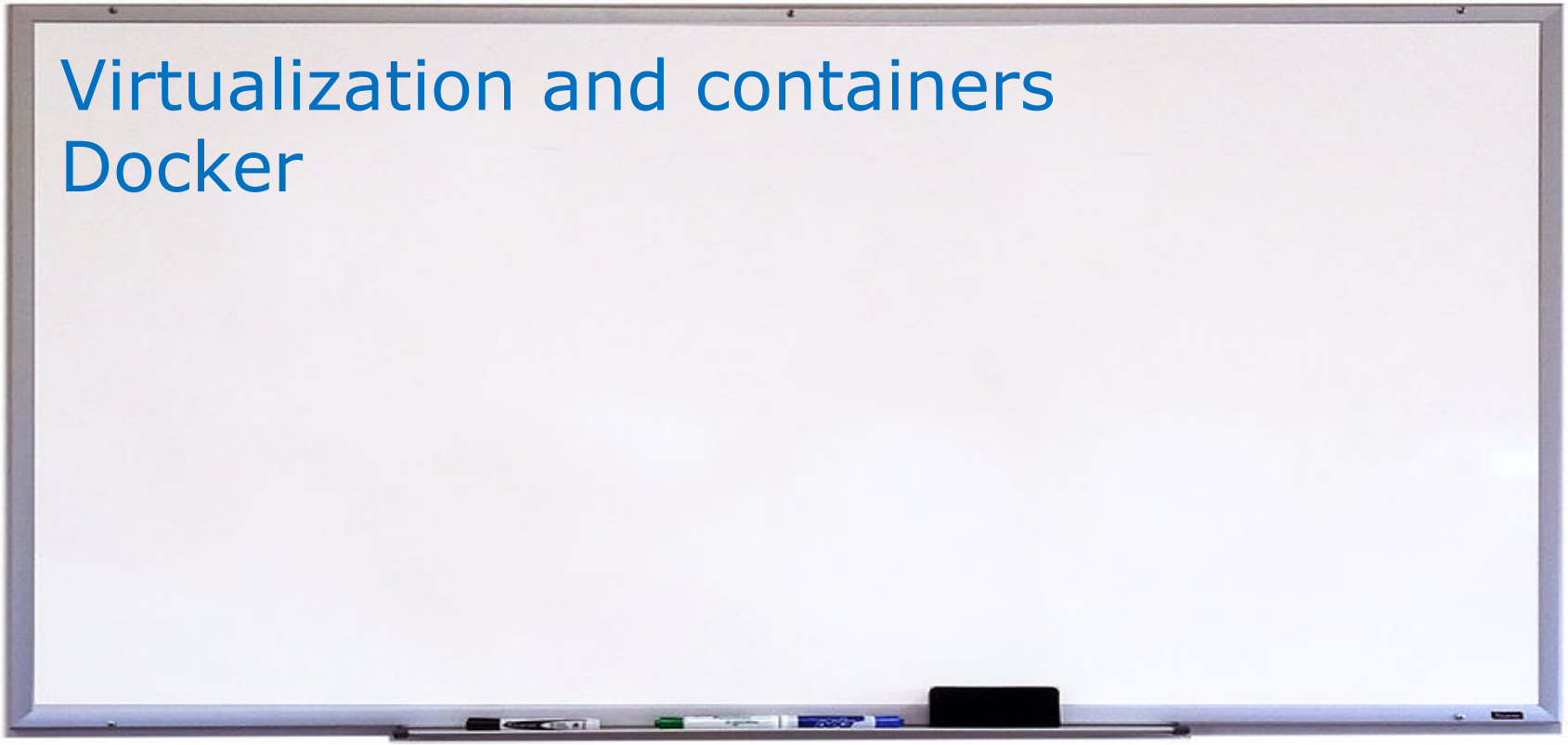
How old are containers?

- For decades, UNIX *chroot* command provided a simple form of filesystem isolation
- 1998 – FreeBSD *jail* utility extended *chroot* sandboxing to processes
- 2005 – Google started developing *CGroups* for Linux kernel and began moving its infrastructure to containers
- 2008 – Linux Containers (LXC) provided a complete containerization solution

2013 - Docker added the missing pieces - *portable images* and *friendly UI* – to the containerization puzzle, and containers entered the mainstream

The Docker platform consisted of:

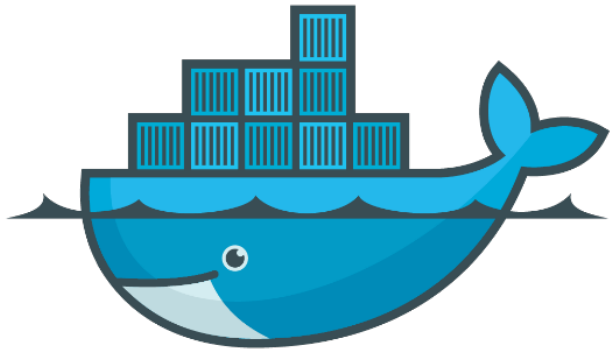
- **Docker Engine** (for creating and running containers)
- **Docker Hub** (for distributing containers)


Virtualization and containers
Docker

What is Docker?

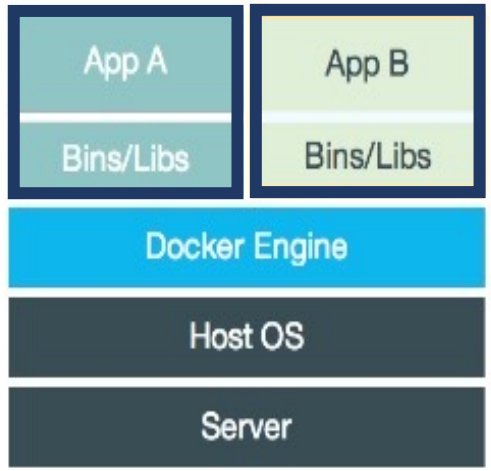
Docker is a platform that allows us
to run applications in an isolated environment

Docker allows us to develop and run portable applications
by exploiting *containers*



Docker

- Docker exploits container-based virtualization to run multiple isolated guest instances on the (same) OS



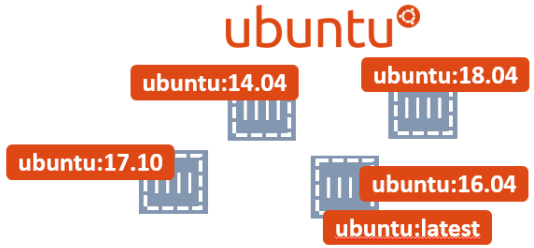
- Software components are packaged into ***images***, which are exploited as read-only templates to create and run ***containers***

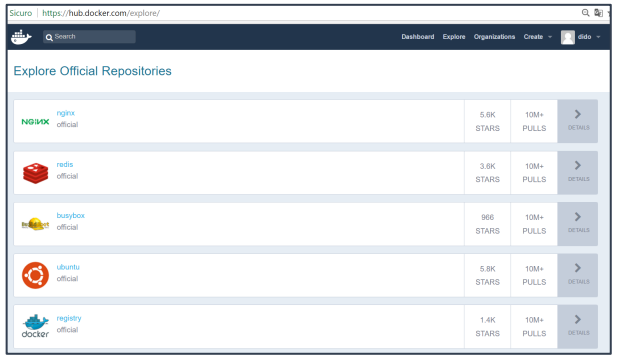
- External ***volumes*** can be mounted to ensure data persistence

"Build, ship, and run any app, anywhere"

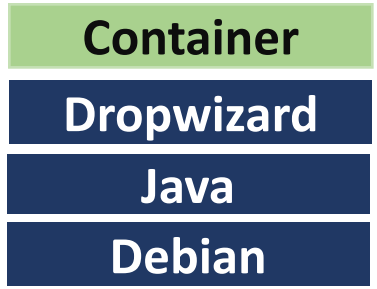
Docker images

- (read-only) templates used to create containers
- stored in a (private or public) Docker **registry**
  - registry structured in repositories
  - each repository contains a set of immages, for different versions of a software
  - images identified by pairs **repository:tag**
  - **Docker Hub**

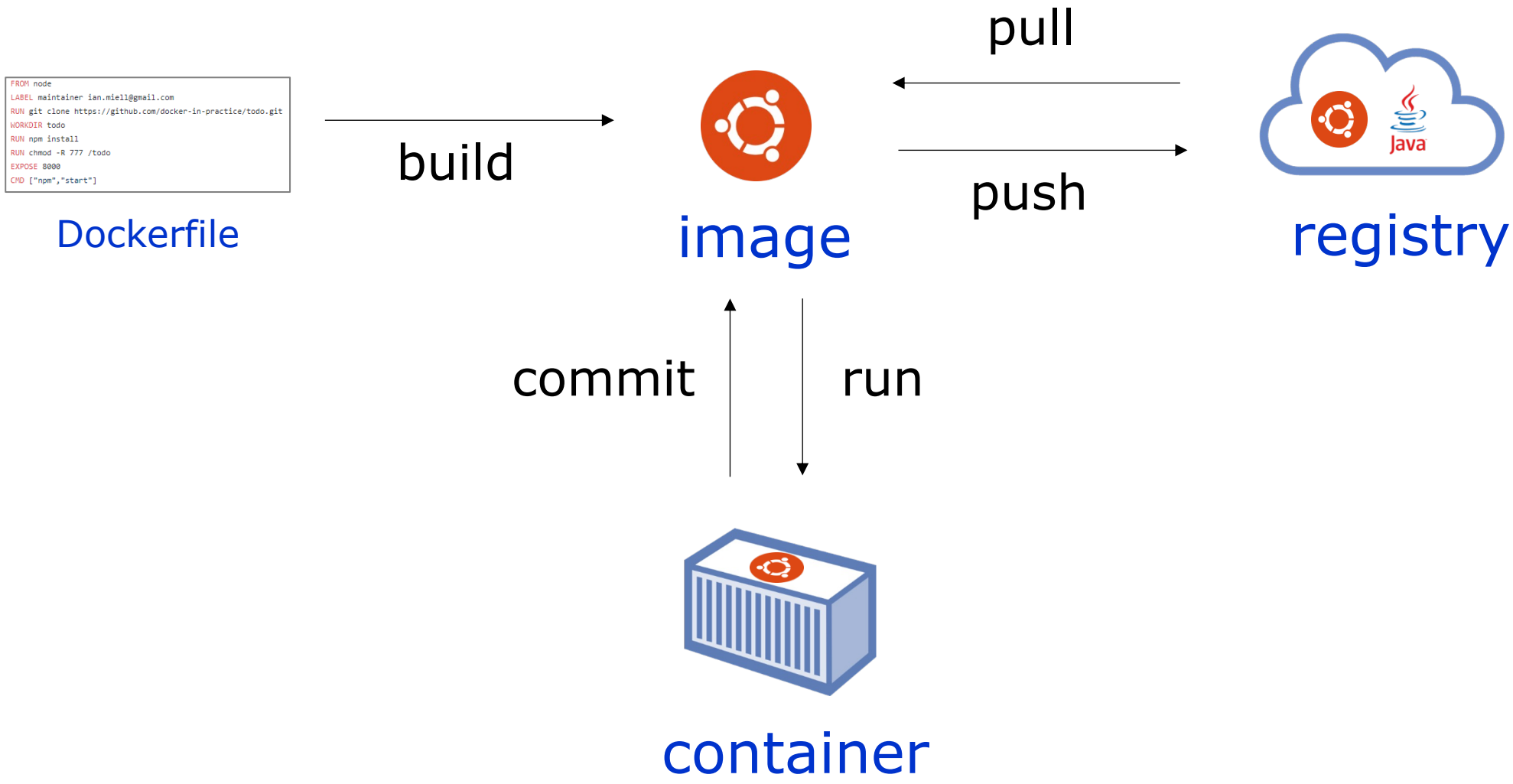




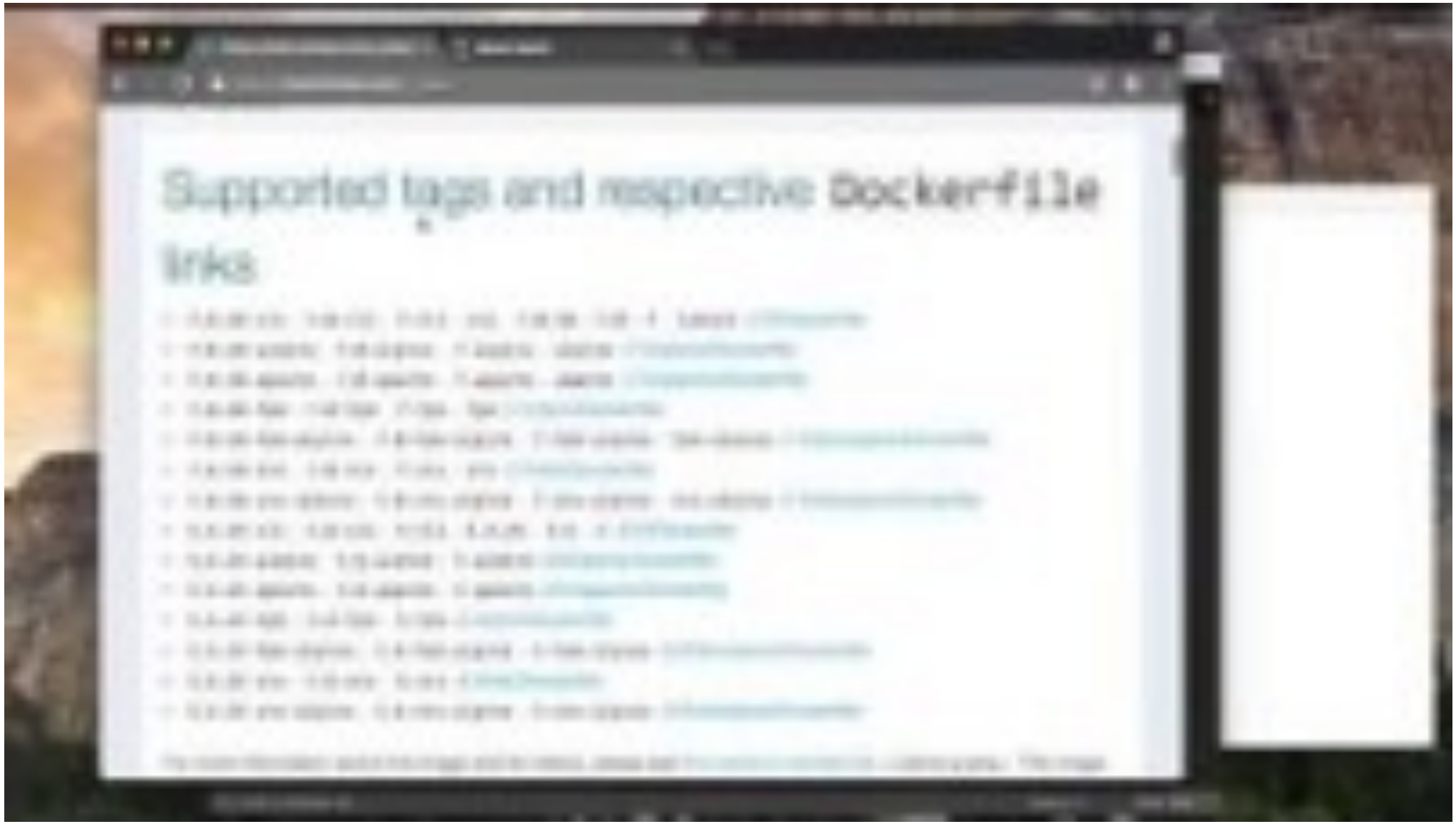
- images structured into (read-only) layers
- each layer is in turn an image, lowest layer called base image
- running container can write in new top layer, changes can be committed into new image



Docker commands



Learn Docker in 12 min



https://www.youtube.com/watch?v=YFl2mCHdv24

Advantages of Docker

- same environment
- sandbox projects
- it just works

Containers

- lighter and faster to start than VMs
- share OS
- images defined via Dockerfile
- build and run

Demo

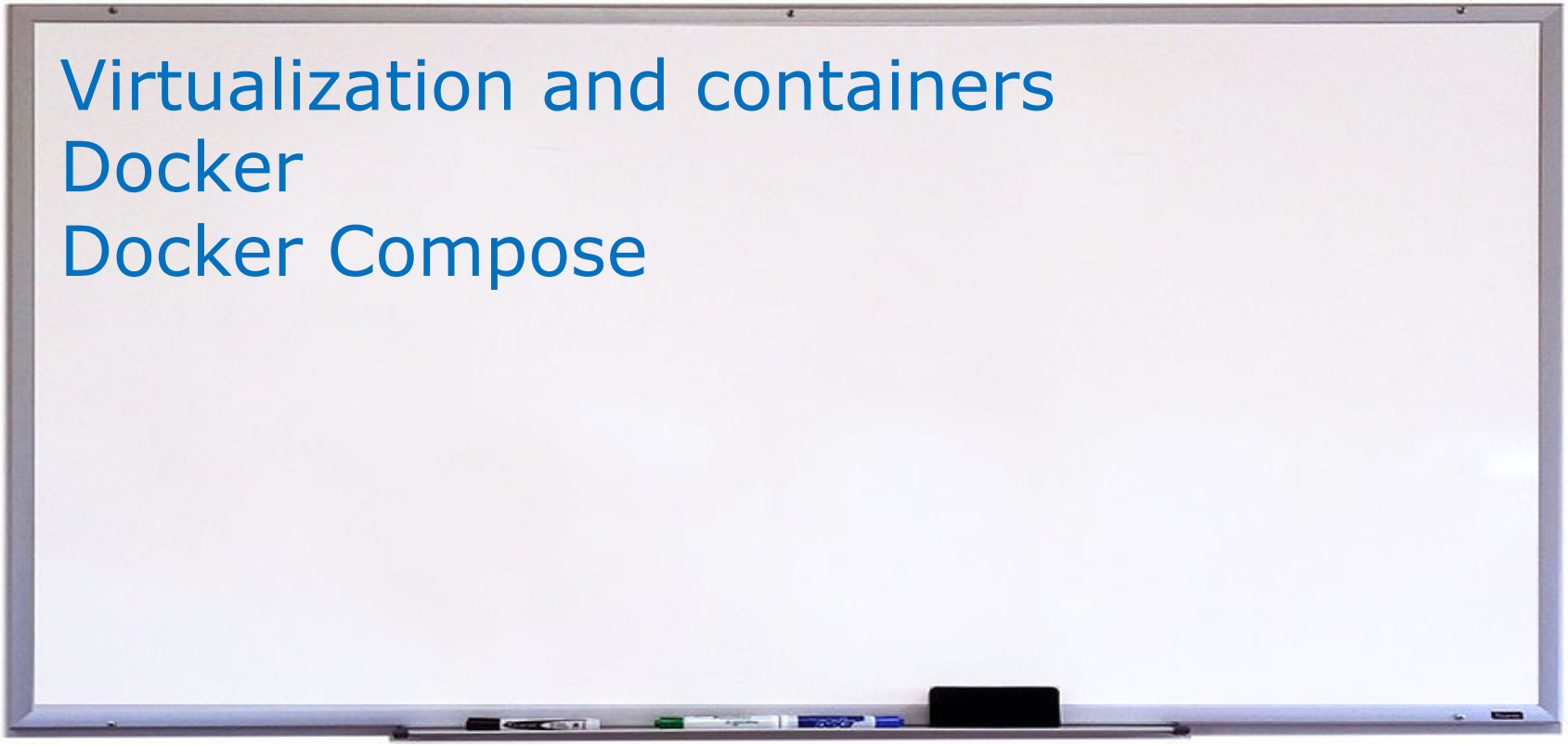
- install Docker
- simple php “hello world” app
  - index.php

```
1 <?php
2
3 echo "Hello, World"
```

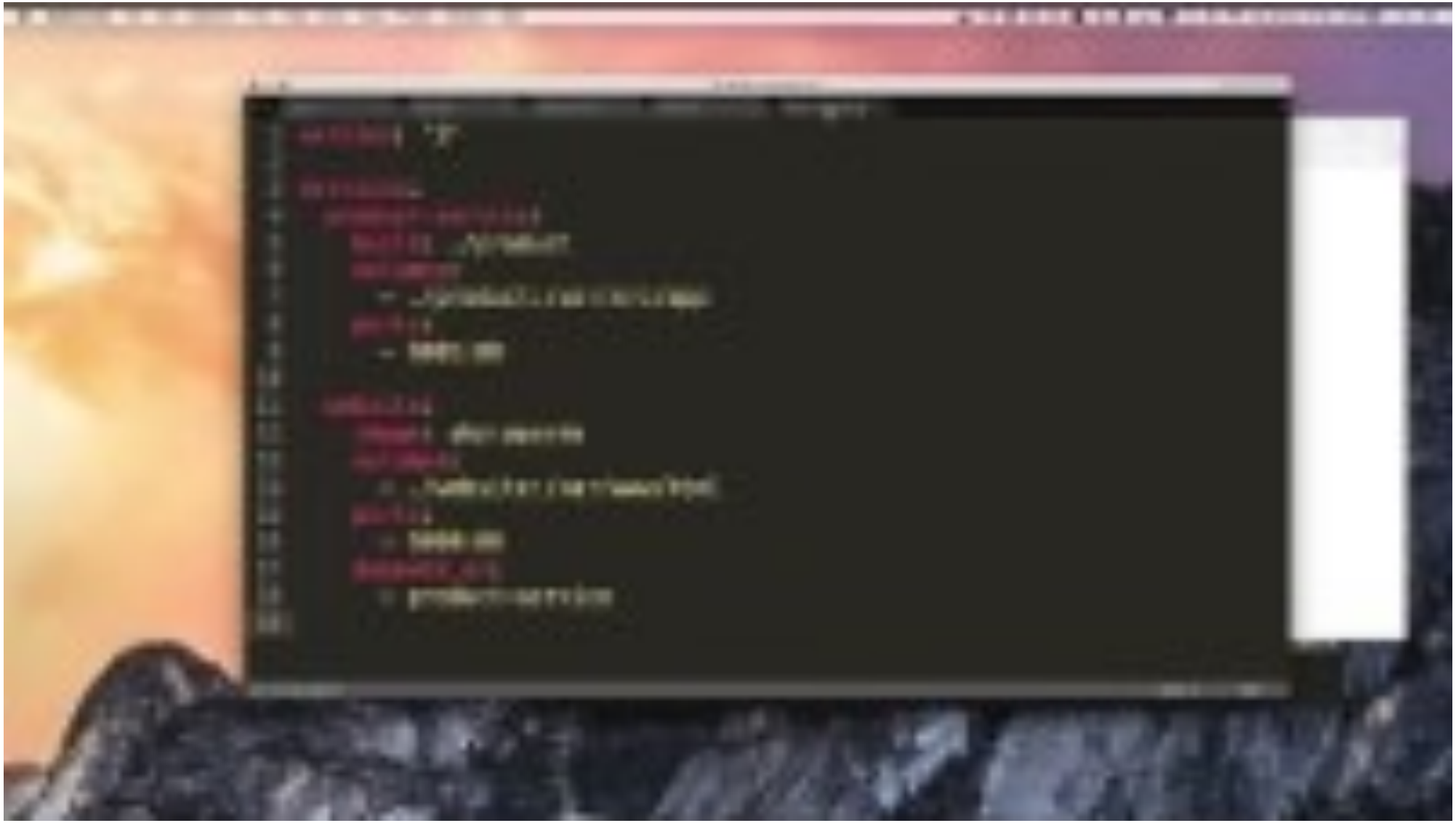
  - Dockerfile
    - find php image from Docker Hub

```
1 FROM php:7.0-apache
2 COPY src/ /var/www/html
3 EXPOSE 80
```

  - >docker build –t hello-world .
  - >docker run –p 80:80 hello-world
  - using a volume to share folder between host and container
  - one process per container


Virtualization and containers
Docker
Docker Compose

Docker Compose in 12 min



https://www.youtube.com/watch?v=Qw9zlE3t8Ko

//product service

api.py

```python
from flask import Flask
from flask_restful import Resource, Api

app = Flask(__name__)
api = Api(app)

class Product(Resource):
    def get(self):
        return {
            'products': ['Ice cream',
                         'Chocolate',
                         'Fruit',
                         'Eggs']
        }

api.add_resource(Product, '/')

if __name__ == '__main__':
    app.run(host='0.0.0.0', port=80, debug=True)
```

requirements.txt

```
Flask==0.12
flask-restful==0.3.5
```

Dockerfile

```
FROM python:3-onbuild
COPY . /usr/src/app
CMD ["python", "api.py"]
```

docker-compose.yml

```yaml
version: '3'

services:
  product-service:
    build: ./product
    volumes:
      - ./product:/usr/src/app
    ports:
      - 5001:80

  website:
    image: php:apache
    volumes:
      - ./website:/var/www/html
    ports:
      - 5000:80
    depends_on:
      - product-service
```

>docker-compose up
>docker ps
>docker-compose stop

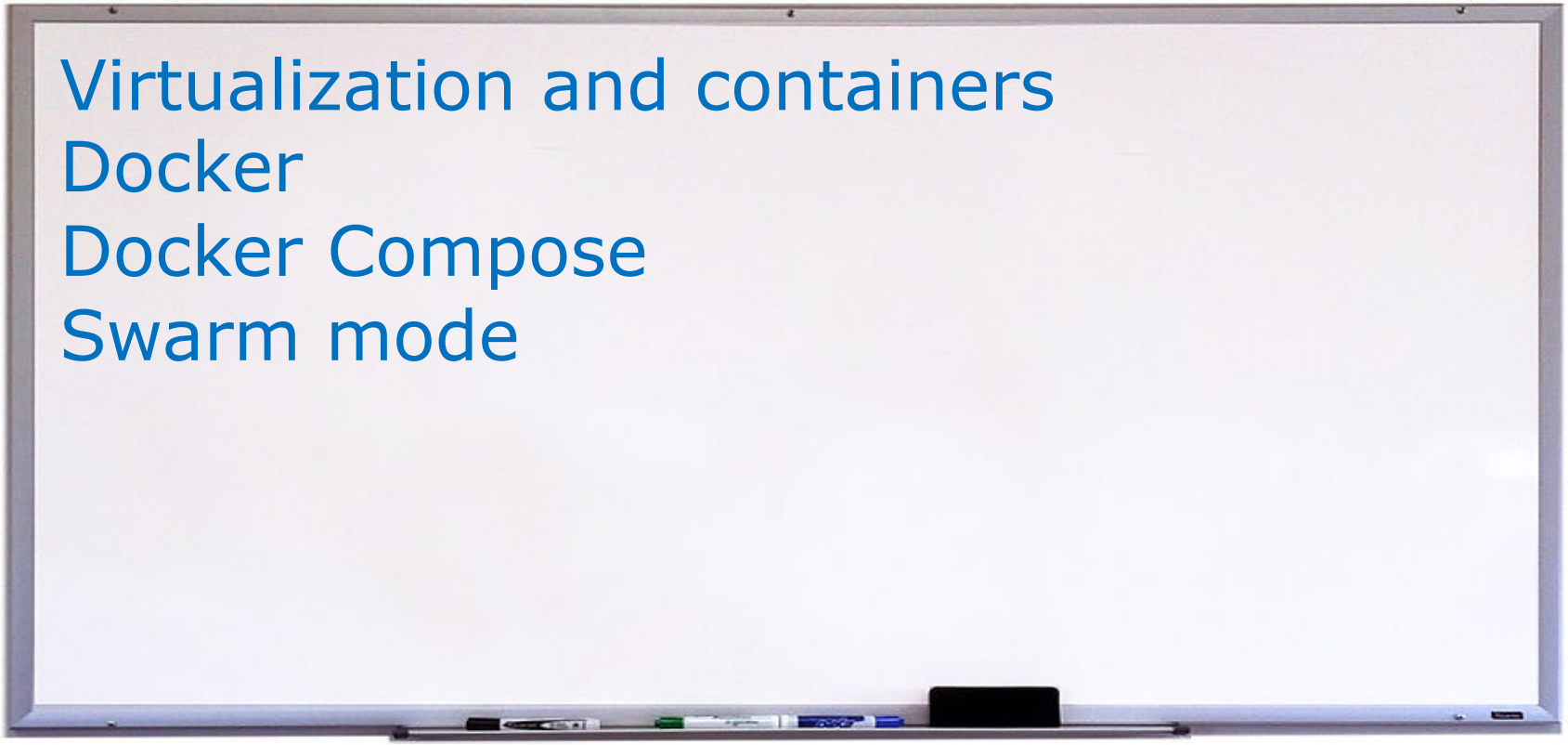
//website

index.php

```php
<html>
    <head>
        <title>My Shop</title>
    </head>

    <body>
        <h1>Welcome to my shop</h1>
        <ul>
            <?php
                $json = file_get_contents('http://product-service');
                $obj = json_decode($json);

                $products = $obj->products;
                foreach ($products as $product) {
                    echo "<li>$product</li>";
                }
            ?>
        </ul>
    </body>
</html>
```


Virtualization and containers
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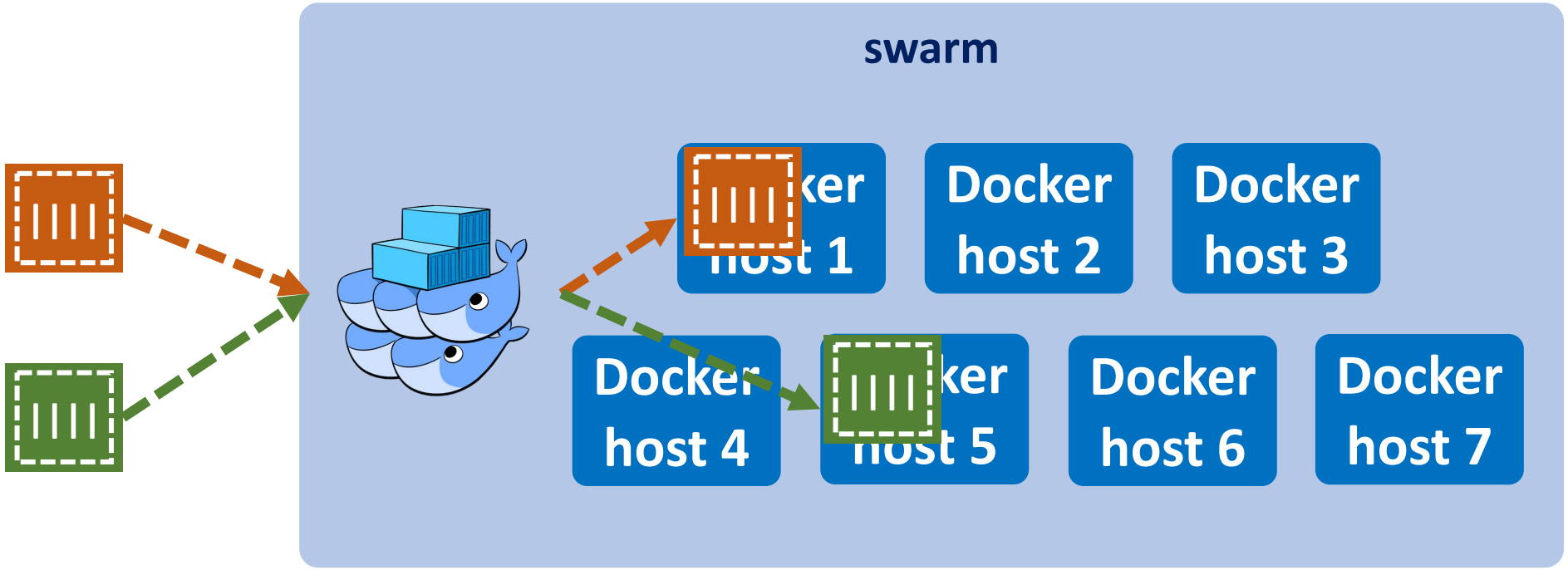
Docker Compose
Swarm mode

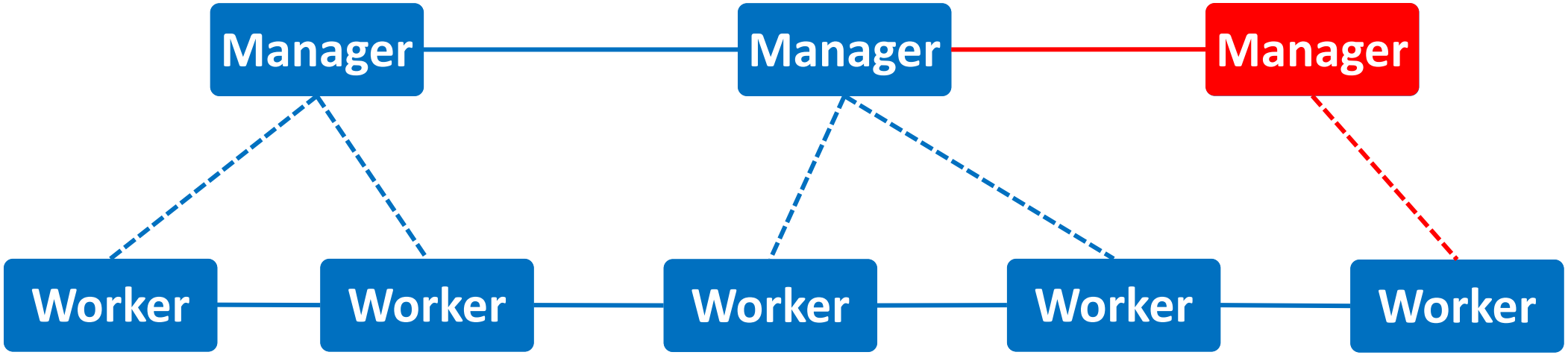
Swarm mode

Docker includes ***swarm mode*** for managing a cluster of Docker hosts called a *swarm*

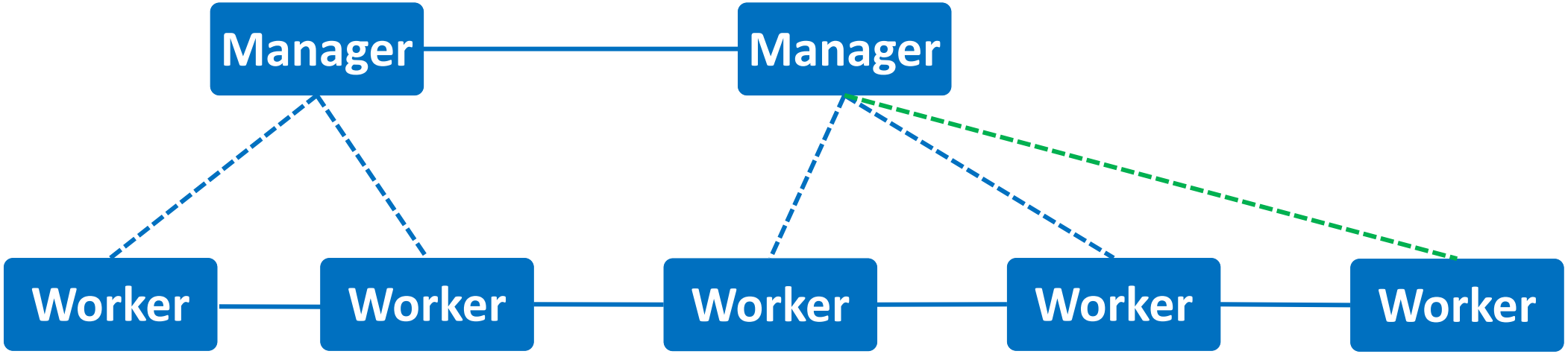


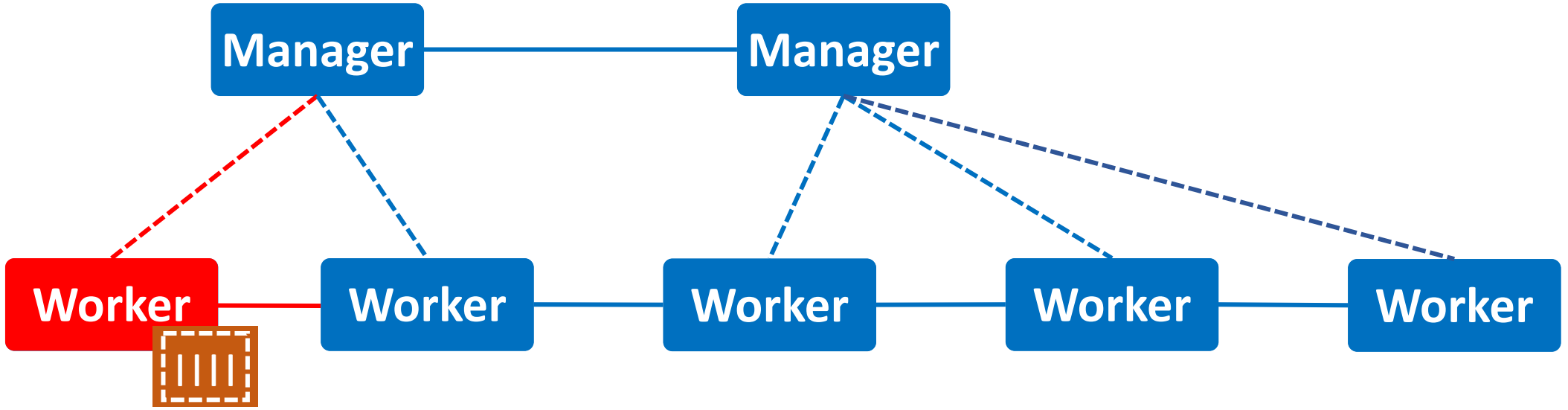
Swarm mode

- Swarm nodes can act as managers (delegating tasks workers) and workers (executing the tasks assigned to them)
- You can define the desired state of the various services in your application stack, including the number of tasks to run in each service
- Swarm manager nodes assign each service in the swarm a unique DNS name and load balances running containers
- Swarm manager nodes constantly monitor the cluster state and reconcile any differences between the actual state and your expressed desired state
  - For example, if you set up a service to run 10 replicas of a container, and a worker machine hosting two of those replicas crashes, two new replicas are created and assigned to workers that are running and available



Manager fails → manager's workers are assigned to another manager





Worker fails → worker's containers are assigned to another worker