



Introduction to Docker & 12 Factor App Implementation Using Docker



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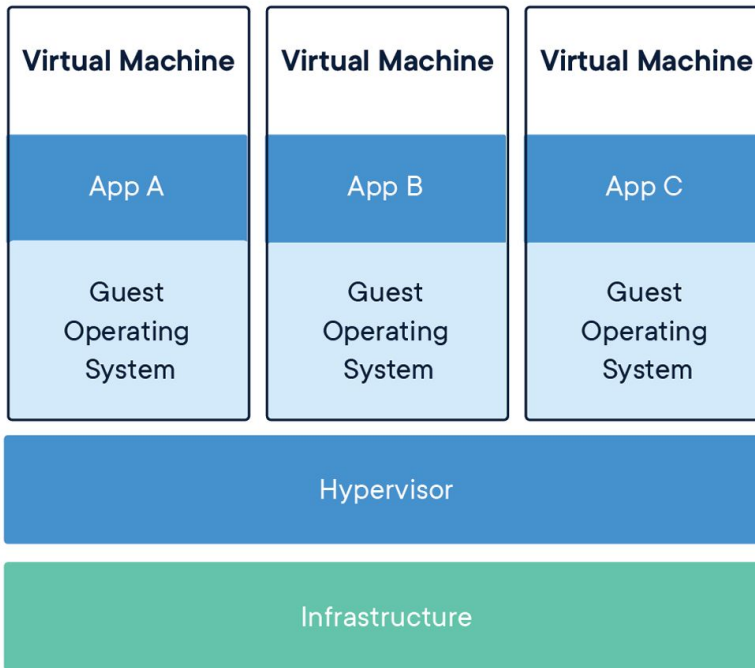
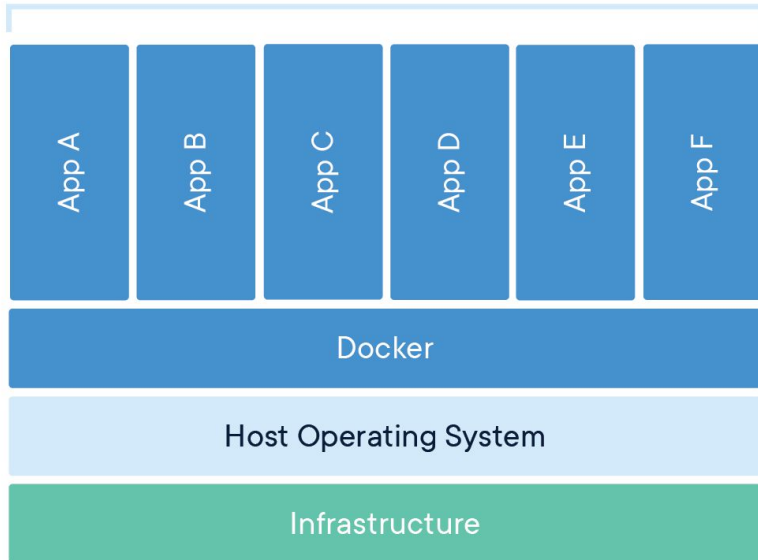


What is a container ?

- Standard unit of software that includes
 - The application code
 - All its dependencies needed to run that application
 - Isolated from other processes
 - own users
 - process IDs
 - memory / cpu limits

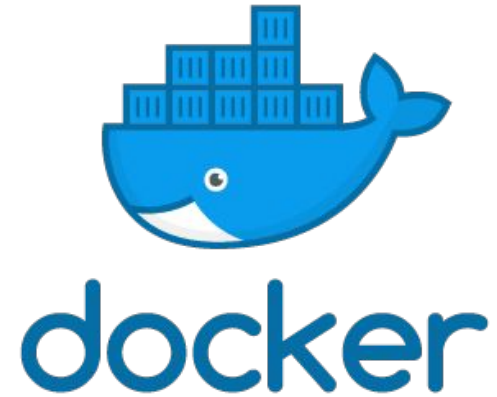
Containers vs Virtual Machines

Containerized Applications



What is Docker ?

- An open platform
- A tool designed to make it easier to create, deploy, and run applications by using containers.





Docker Container Example

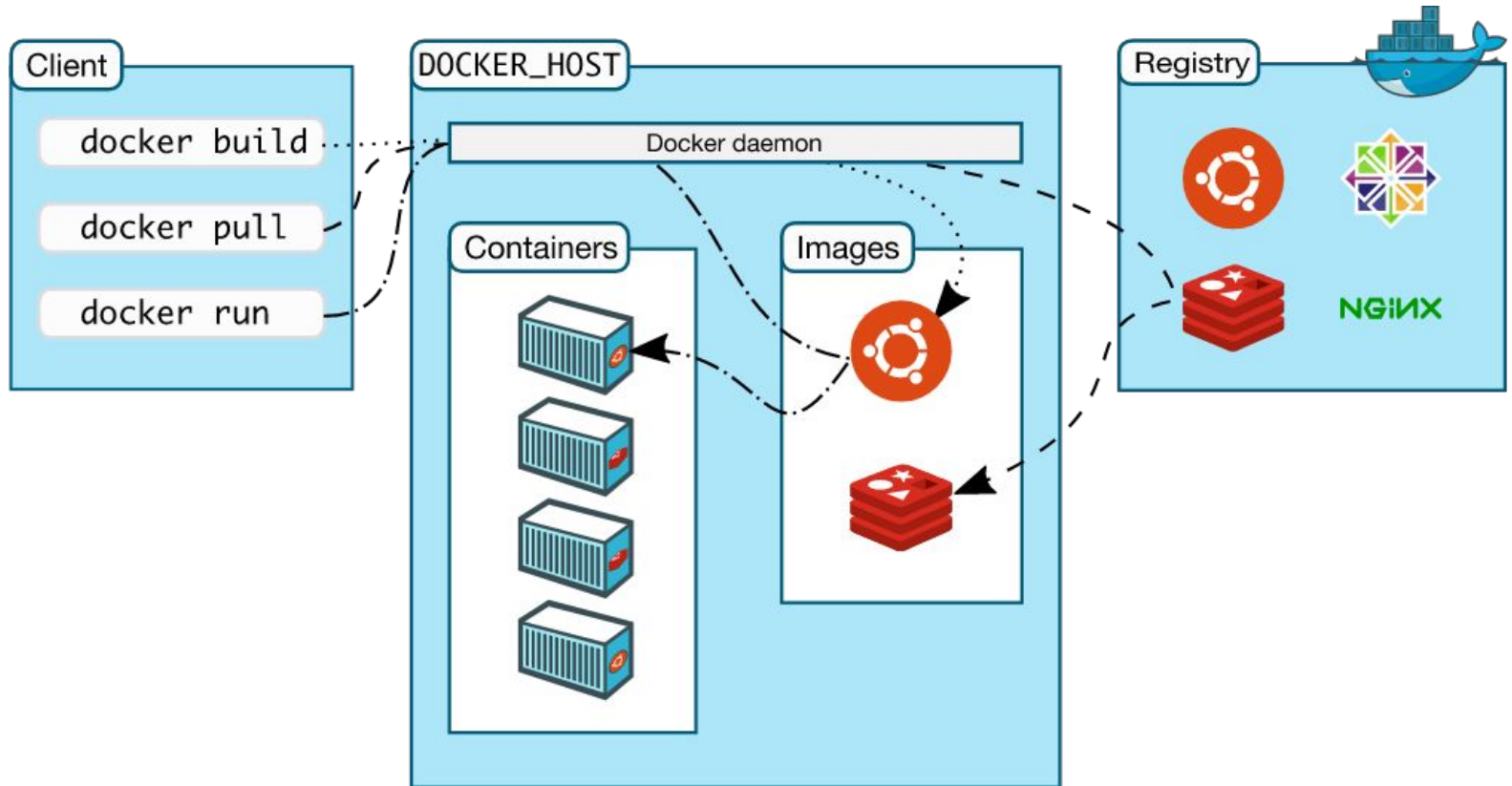
```
→ ~ docker run --name greeting ubuntu:18.04 echo "Hello class of CS443, I'm a container"
Unable to find image 'ubuntu:18.04' locally
18.04: Pulling from library/ubuntu
5c939e3a4d10: Already exists
c63719cdbe7a: Already exists
19a861ea6baf: Already exists
651c9d2d6c4f: Already exists
Digest: sha256:8d31dad0c58f552e890d68bbfb735588b6b820a46e459672d96e585871acc110
Status: Downloaded newer image for ubuntu:18.04
Hello class of CS443, I'm a container
→ ~ █
```



Docker Run Command

- `--name` flag - specify a name for your container
- `ubuntu:18.04` - Docker image
- `echo` - process name to execute
- greeting message - parameter(s)

Docker Client - Host Communication



Docker Image Creation (Docker commit)

```
→ ~ docker run -it --name greeting ubuntu:18.04 bash
root@76ba099af323:/# echo hello > hello.txt
root@76ba099af323:/# cat hello.txt
hello
root@76ba099af323:/# exit
exit
→ ~ docker commit greeting ubuntu:18.04-greeting
sha256:492cc01917eb38c2832084cafc8a0eb07a996c175a49d1e1a70b2b50aab89ad3
→ ~ docker run -it --name greeting-new ubuntu:18.04-greeting bash
root@70b58835b46b:/# cat hello.txt
hello
root@70b58835b46b:/#
```

Docker Image Creation (Declarative Approach - Dockerfile)



Dockerfile x

```
1 FROM ubuntu:18.04
2
3 RUN echo hello > hello.txt
4
5
```

```
→ backend git:(master) x docker build -t ubuntu:18.04-greeting-declarative .
Sending build context to Docker daemon 106kB
Step 1/2 : FROM ubuntu:18.04
---> ccc6e87d482b
Step 2/2 : RUN echo hello > hello.txt
---> Running in 603f82cc6874
Removing intermediate container 603f82cc6874
---> 21ff26d14177
Successfully built 21ff26d14177
Successfully tagged ubuntu:18.04-greeting-declarative
→ backend git:(master) x docker run -it --name greeting-declarative ubuntu:18.04-greeting-declarative bash
root@87cae5072156:/# echo hello.txt
hello.txt
root@87cae5072156:/# cat hello.txt
hello
root@87cae5072156:/#
```

Dockerfile Example of a Java Program

backend >  Dockerfile

```
1 FROM maven:3.6.1-jdk-11-slim as maven
2
3 WORKDIR /app
4 COPY ./pom.xml ./pom.xml
5
6 # build all dependencies
7 RUN mvn dependency:go-offline -B
8
9 COPY ./src ./src
10
11 RUN mvn clean package
12
13 # specify base image runtime
14 FROM openjdk:11.0-jre-slim
15
16 WORKDIR /app
17 VOLUME /tmp
18
19 # copy over the built artifact from the maven image
20 COPY --from=maven /app/target/*.jar /app/target/
21
22 # set the startup command to run binary
23 CMD java ${JAVA_OPTS} -jar /app/target/*.jar
24
```



Docker Benefits

- Build once, run anywhere (Platform independent)
- Isolated and Disposable Applications
- Rapid Deployment of the applications
- Scale up & down fast



Docker Use Cases

- Deployment of multiple microservices
- Running different versions of the same application at the same time
- Easily switch between different versions of a deployment



Container Management Solutions

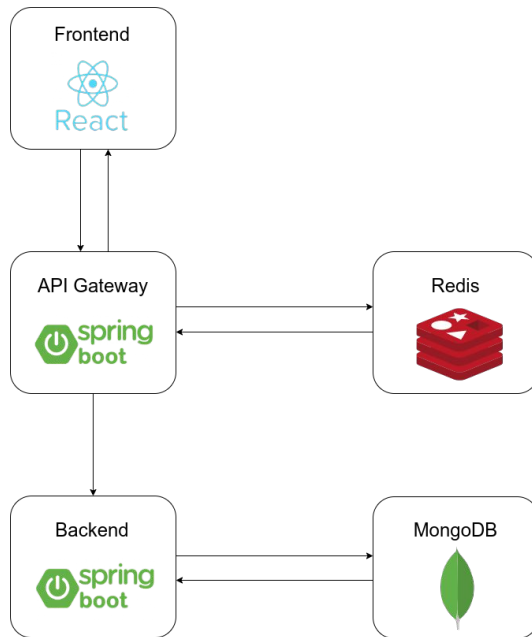
- Docker Compose
- Docker Swarm
- Kubernetes
- Amazon Container Service
- Google Container Engine
- Azure App Services



Some of the Keywords

- **Image:** A package that contains the application along with the dependencies that required to run this application.
- **Container:** Running instance of the image
- **Tag:** Convey useful information about a specific image version/variant
- **Registry:** Storage and distribution system for named images

Sample CRUD App and 12-factor App

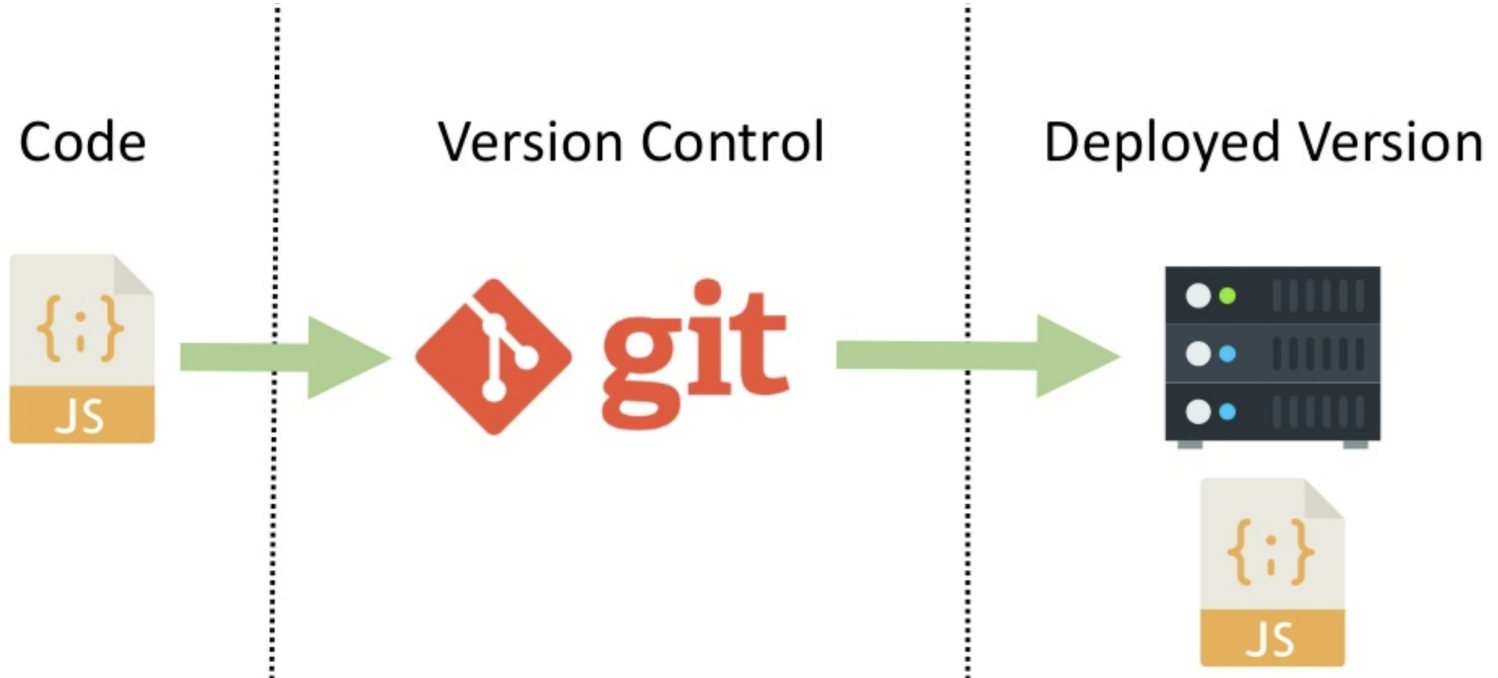


\$ git clone <https://github.com/cemalunal/sample-crud-app.git>

\$ git clone <https://github.com/cemalunal/cloud-native-application-development-workshop.git>

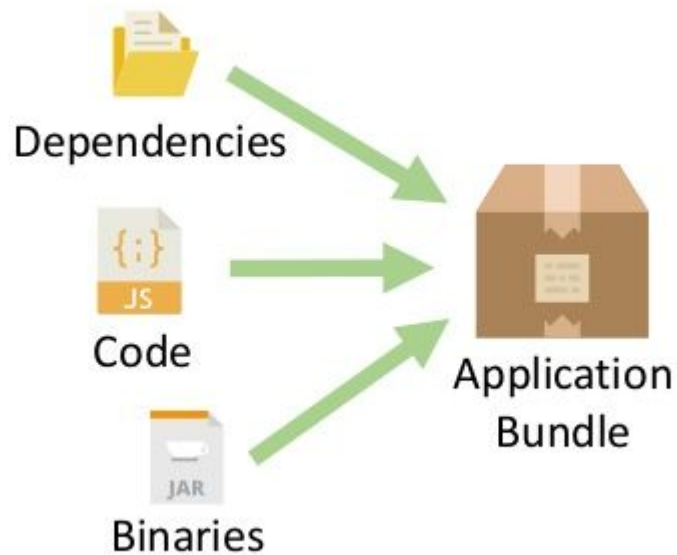
1- Codebase

One codebase tracked in revision control, many deploys



2- Dependencies

Explicitly declare and isolate dependencies



Dependency Declaration - Node.js

package.json

```
{
  "name": "simple-frontend",
  "version": "0.1.0",
  "private": true,
  "dependencies": {
    "@material-ui/core": "^3.0.0",
    "isomorphic-fetch": "^2.2.1",
    "react": "^16.4.2",
    "react-dom": "^16.4.2",
    "react-router-dom": "^4.3.1",
    "react-scripts": "1.1.5",
    "serve": "^10.1.2"
  },
}
```

\$ npm install



Dependency Declaration - Java w/ Maven

pom.xml

```
<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-jetty</artifactId>
  <version>2.2.4.RELEASE</version>
</dependency>

<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-data-mongodb</artifactId>
  <version>2.2.4.RELEASE</version>
</dependency>

<dependency>
  <groupId>io.springfox</groupId>
  <artifactId>springfox-swagger2</artifactId>
  <version>2.7.0</version>
</dependency>
```

\$ mvn install




3- Config

Store config in the environment

- Frontend
 - URL of the backend service is stored in environment variables and accessed via **window.env**
 - `fetch(`${window.env.REACT_APP_BACKEND_URI}/customers`)`
- Backend
 - MongoDB connection URI is stored in environment variables and accessed via application-deployment.properties file
 - `spring.data.mongodb.uri=${MONGODB_URI}`

Backend container gets config from the environment

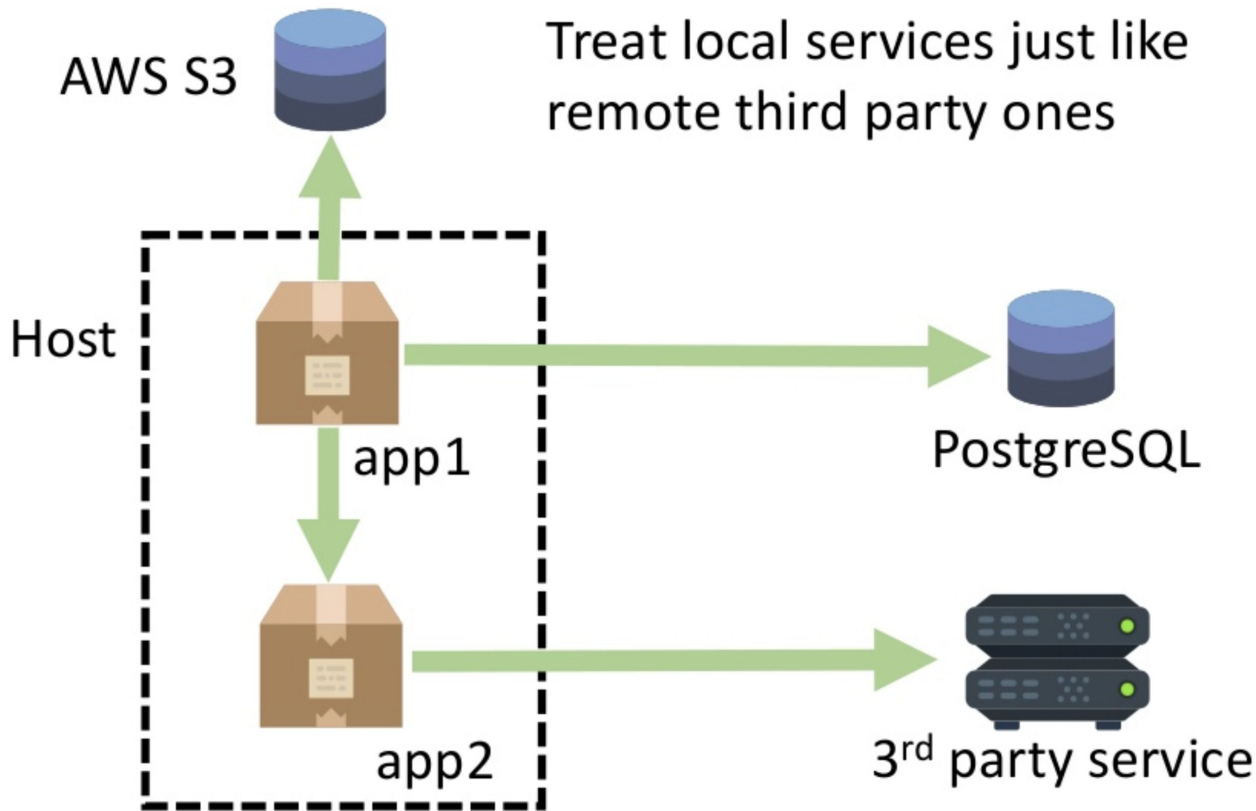


```
application-deployment.properties ✕  
1  server.port=${SERVER_PORT}  
2  spring.data.mongodb.uri=${MONGODB_URI}
```

```
docker run -d --network=crud-app \  
    --name backend \  
    -e MONGODB_URI="mongodb://mongodb:27017/sample-app" \  
    -e JAVA_OPTS="-Dspring.profiles.active=deployment -Dserver.port=80 -Xms125m -Xmx250m" \  
    --restart=on-failure \  
    cunal/demo-backend:v0.0.1
```

4- Backing Services

Treat backing services as attached resources



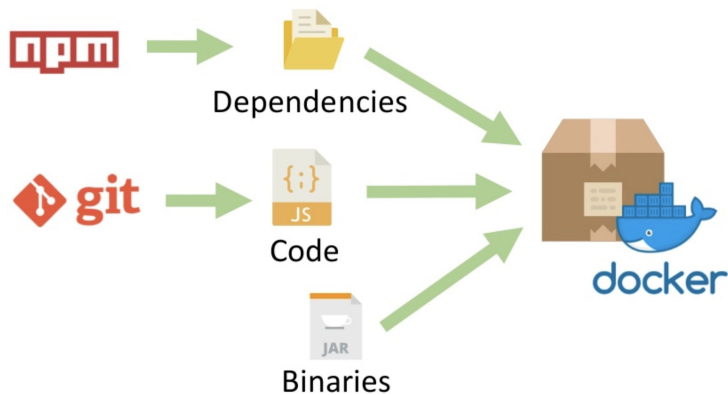


MongoDB connection for Backend

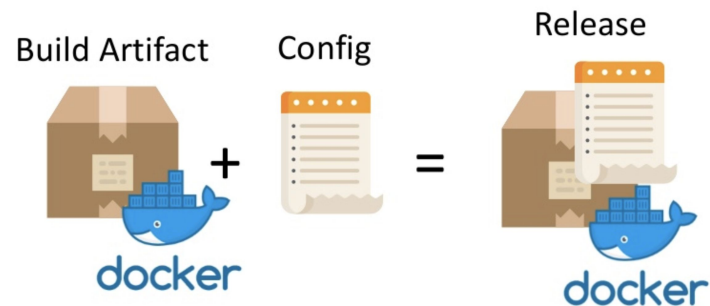
- Think about MongoDB - Connection URI is stored in **MONGODB_URI** environment variable.
- We can easily switch between local and production MongoDB databases. Or we can even use Azure Cosmos DB by just changing the connection string. Examples:
 - `mongodb://localhost:27017/sample-app`
 - `mongodb://mongodb:27017/sample-app`
 - `mongodb://user:pass@test.documents.azure.com:10255/dbname?ssl=true`

5- Build, release, run *Strictly separate build and run stages*

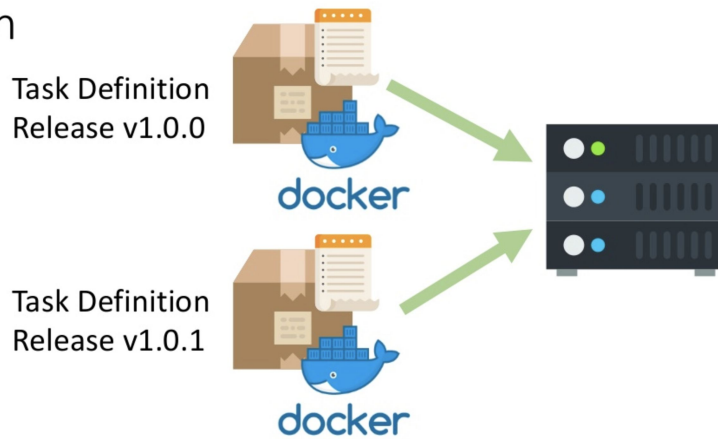
Build



Release



Run



Build - Release



Minor tweaks

master



faa7f33



Docker

on: push

✓ push

Docker / push

succeeded 1 hour ago in 3m 5s

- ▶ ✓ Set up job
- ▶ ✓ Run actions/checkout@v2
- ▶ ✓ Build backend image
- ▶ ✓ Build frontend image
- ▶ ✓ Build gateway image
- ▶ ✓ Log into registry
- ▶ ✓ Push image
- ▶ ✓ Post actions/checkout@v2
- ▶ ✓ Complete job

Search packages...

backend

latest

CemalUnal/sample-crud-app

docker

frontend

latest

CemalUnal/sample-crud-app

docker

gateway

latest

CemalUnal/sample-crud-app

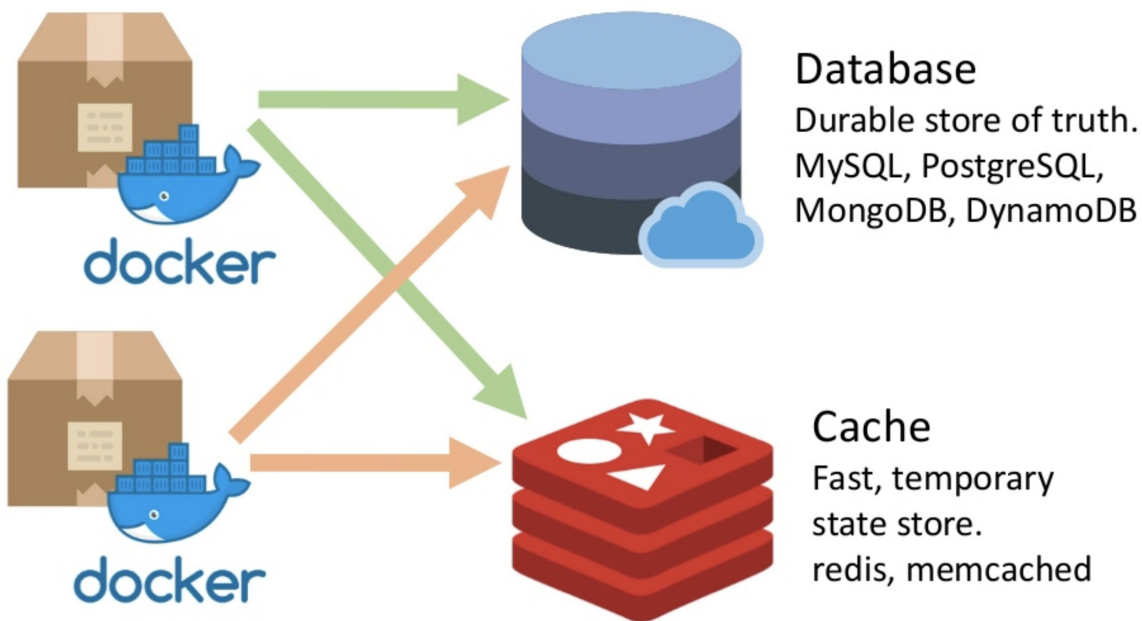
docker



Run:

6- Processes

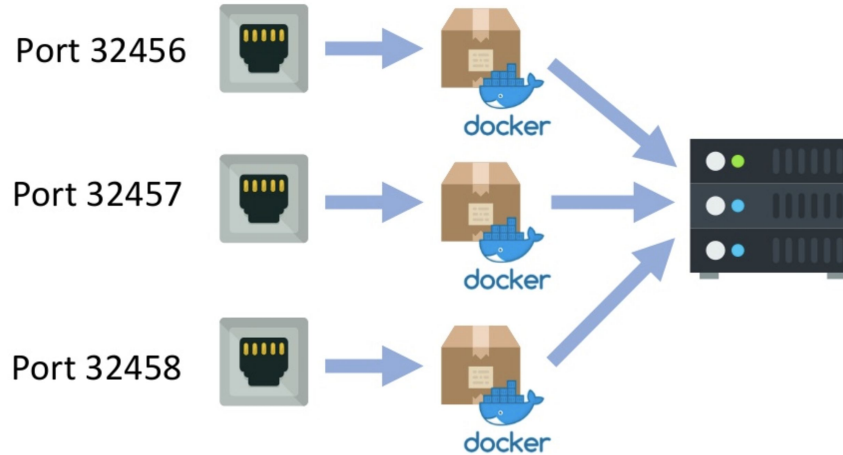
Execute the app as one or more stateless processes



- The application delegates stateful persistence to MongoDB.
- It is easily scalable since it is stateless.

7- Port binding

Export services via port binding



- Backend and Gateway
 - Spring Boot is used along with embedded Jetty server.
 - `server.port=${SERVER_PORT}` in `application-deployment.properties`
- Frontend
 - `serve` npm package is used to serve the static frontend
 - `serve -l $SERVER_PORT -s build` in `startup.sh`

8- Concurrency

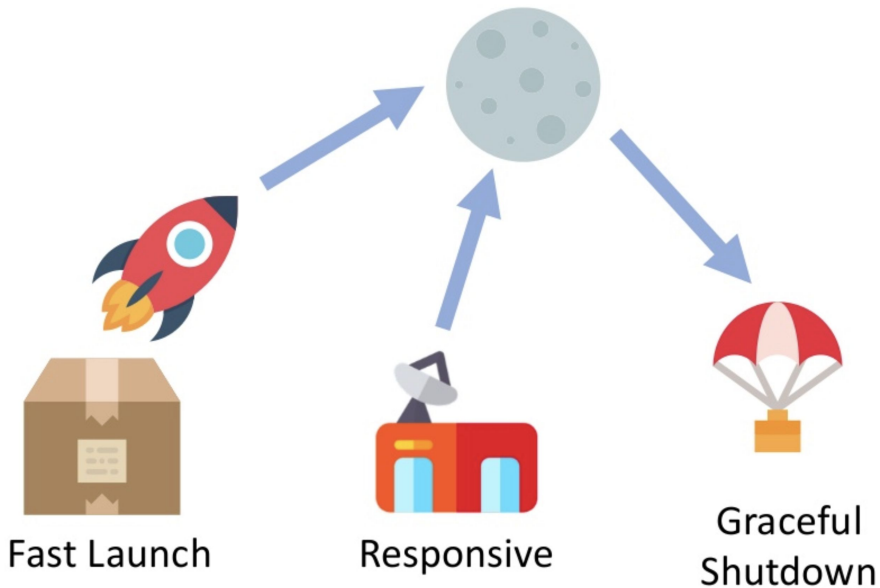
Scale out via the process model



- All components of the application is dockerized
- Launching multiple instances is simple.

9- Disposability

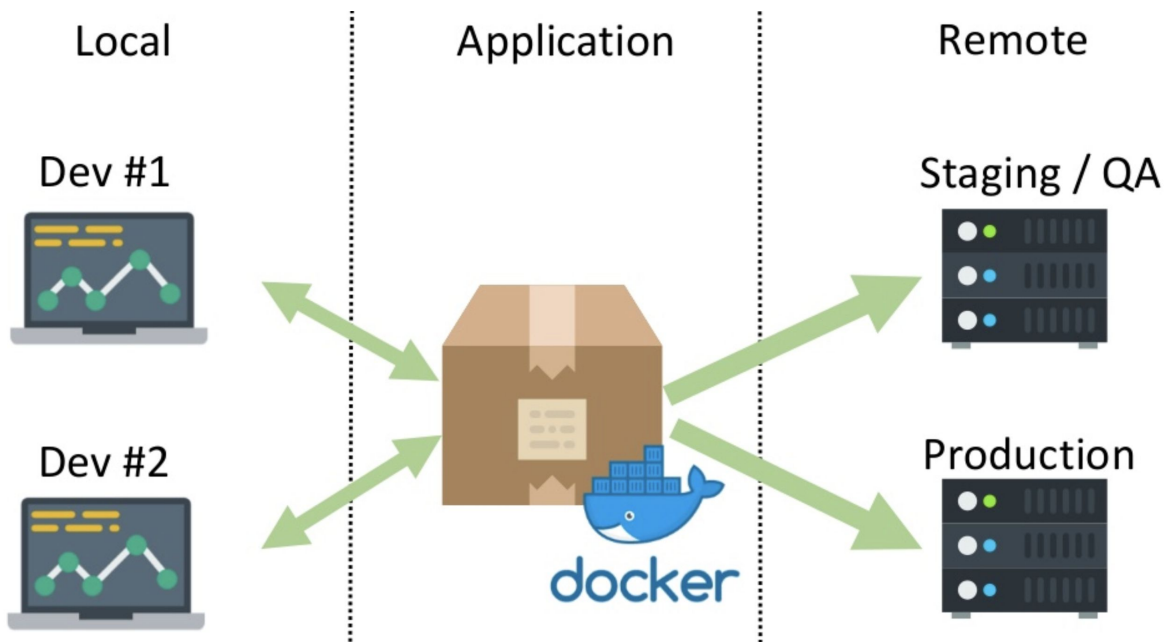
Maximize robustness with fast startup and graceful shutdown



- All components of the sample application are disposable and can be started and stopped quickly
- They shut down gracefully when they receive SIGTERM

10- Dev / prod parity

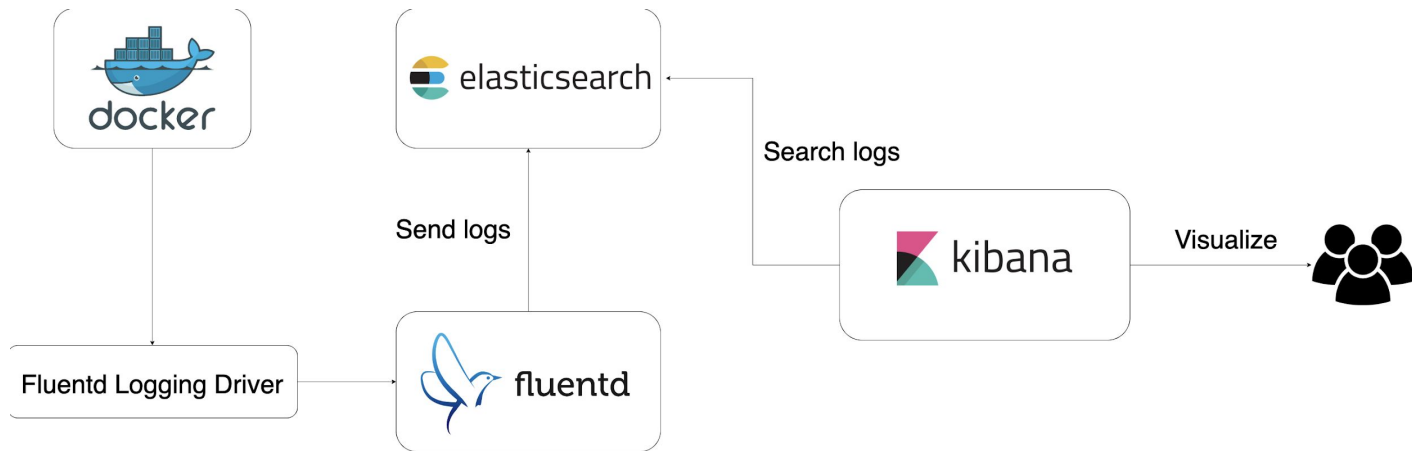
Keep development, staging, and production as similar as possible



- **Docker** is used to run app components and the third party services.
- **Docker** and **Docker Compose** allow developers to run local environments which closely approximate production environments.

11- Logs

Treat logs as event streams



```
docker run -p 27017:27017 -d --network=demo-network \
  --name mongodb \
  -v mongodb_data:/data/db \
  --restart=on-failure \
  --log-driver=fluentd --log-opt fluentd-address=localhost:24224 \
  mongo:4.0.2
```



12- Admin processes

Run admin/management tasks as one-off processes



THANKS!