A gentle Introduction to docker and gitlab-CI

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Verimag Technical Seminar

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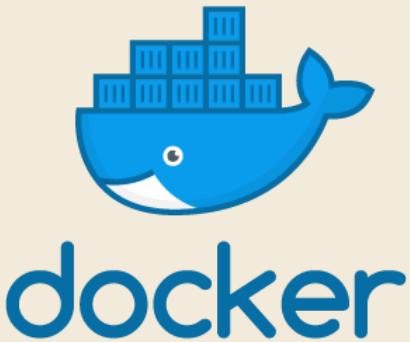
Outline

Plan

1. **Docker**
   - What?
   - How?
   - When?
2. **Gitlab CI/CD**
   - What?
   - How?
   - When?

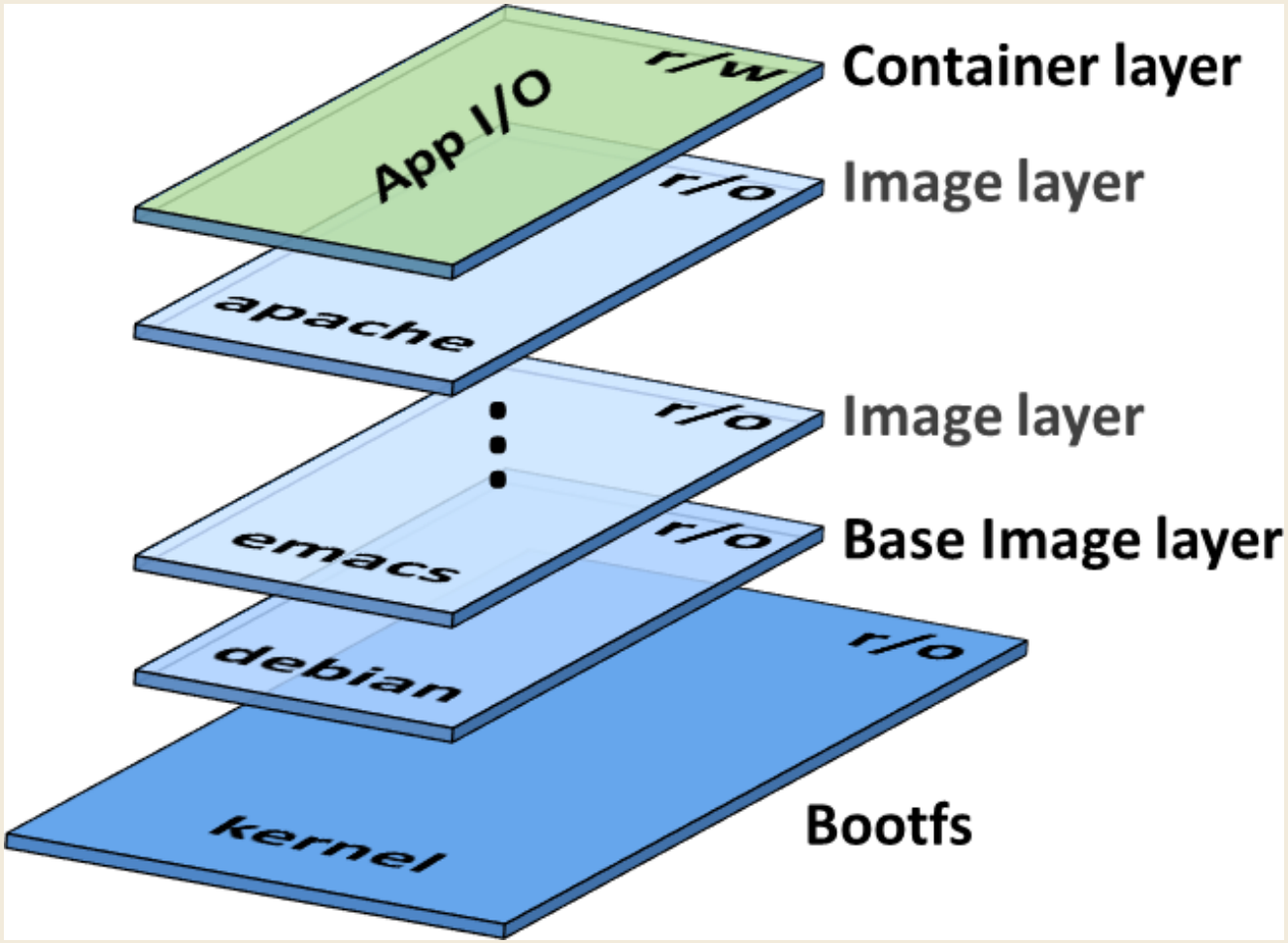
Docker: what?

- A platform to develop, deploy, and run applications with containers
- A container is a lightweight Virtual machine (VM), that shares the kernel/OS of the host machine
  - fast launching
  - fast executables
  - low memory consumption
  - smaller images
  - but are less versatile



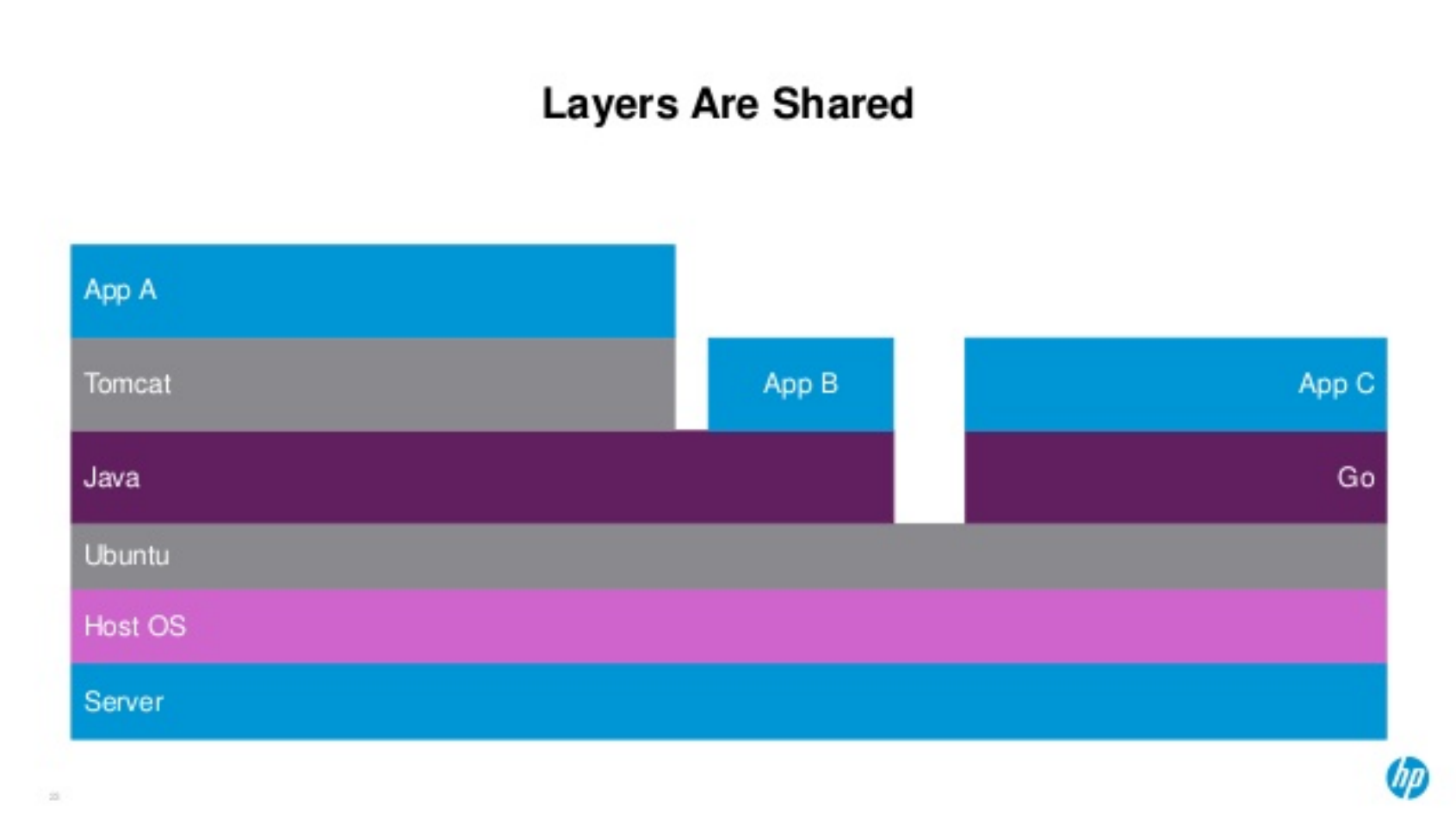

```
docker run -it java
    javac -version
    cat /etc/os-release
    uname -a
docker run java javac -version
```

Docker Layers



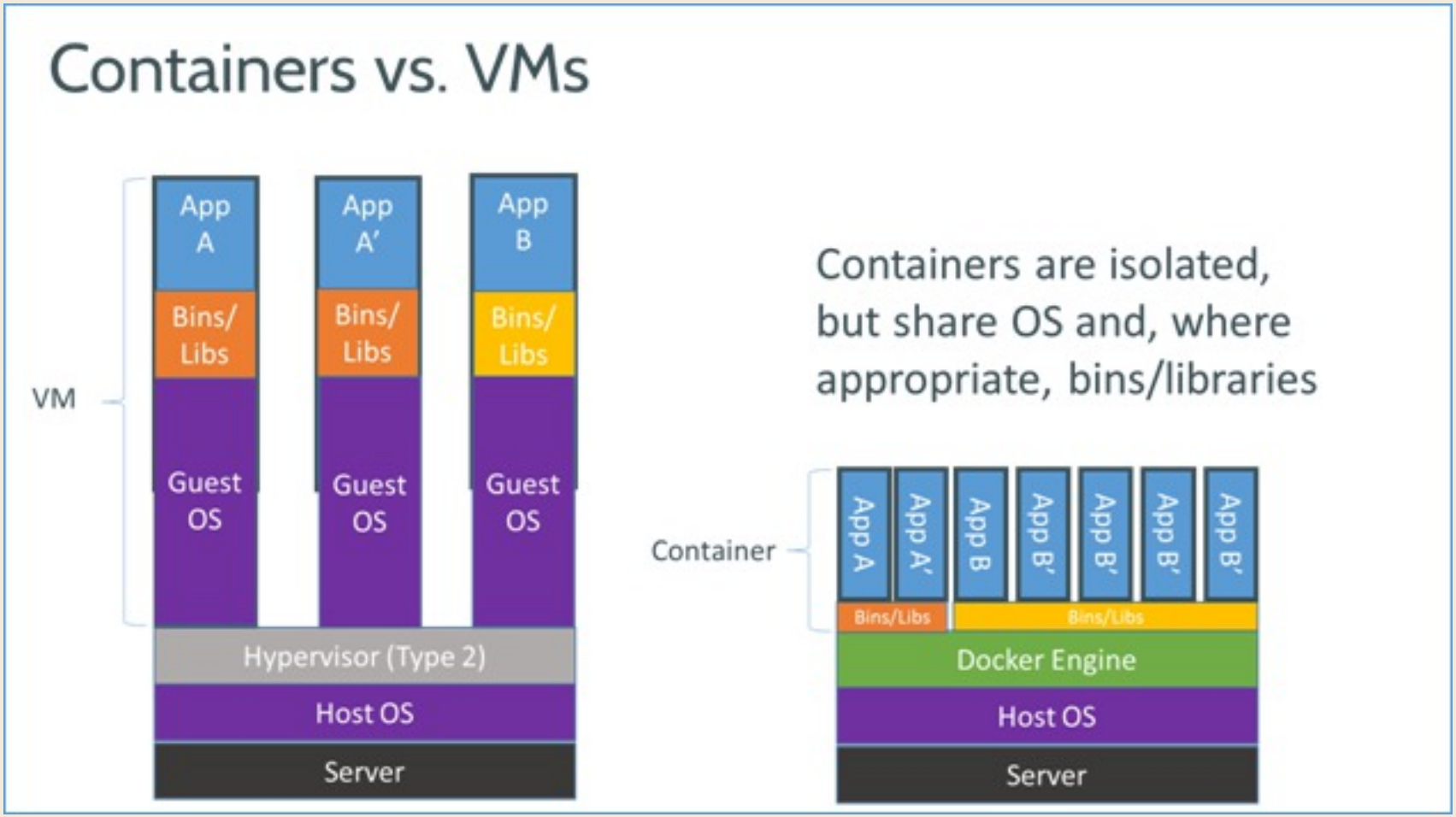
source: http://neokobo.blogspot.com/2017/03/docker-container.html

Docker Layers



source: https://www.slideshare.net/mattfarina/a-dive-into-containers-and-docker

Docker versus VM



source : https://www.fotozik.fr/docker

CLI versus GUI

- docker is CLI, while VMs are GUIs
- If you want to manage VMs via CLI
  - docker-machine
  - Vagrant: a CLI to uniformly manage Virtual machines such as:
    - Docker
    - Virtual box
    - vmware
    - and others

Docker Versatility

- Linux docker images can run under
  - Linux boxes
  - Windows 10 (via Virtual Box)
  - Mac (via Virtual Box or HyperKit)
- What about mac-os docker images ?
  - ok under mac
  - possible also under pc/linux, but forbidden!

cf https://docs.docker.com/install/

docker: how?

- find an image

```
docker search gabu
```

- use an image

```
docker run -it gabuzomeu
docker run \
    -v "$PWD":/current_dir -w /current_dir \
    -e DISPLAY=$DISPLAY -v /tmp/.X11-unix:/tmp/.X11-unix \
    -it gabuzomeu
```

Docker: how?

How to make your own image?

`Dockerfile`:

```
FROM ocaml/opam:ubuntu-16.04_ocaml-4.06.0
MAINTAINER Erwan Jahier erwan.jahier@univ-grenoble-alpes.fr

#### install coq and coqide
RUN sudo apt-get install -qq -yy libexpat1-dev libgtk2.0-dev libgtksourceview2.0-dev m4 pkg-config
RUN opam update && opam install -y coqide && opam user-setup install

# set a nicer prompt
RUN echo "export PS1=[some nifty prompt] " >> ~/.bashrc

RUN sudo mkdir /usr/local/lib/jvm/java5 && \
 wget http://download.oracle.com/otn/java/jdk/1.5.0_22/java5.tar.gz
 sudo tar xf java5.tar.gz -C /usr/local/lib/jvm/java5 && \
 sudo update-alternatives --install "/usr/local/bin/java" "java" "/usr/local/lib/jvm/java5/jdk1.5.0/bin/java" 1 && \
 sudo update-alternatives --install "/usr/local/bin/javac" "javac" "/usr/local/lib/jvm/java5/jdk1.5.0/bin/javac" 1 && \
 sudo update-alternatives --install "/usr/local/bin/javaws" "javaws" "/usr/local/lib/jvm/java5/jdk1.5.0/bin/javaws" 1
&& \
 sudo chmod a+x /usr/local/bin/java && \
 sudo chmod a+x /usr/local/bin/javac && \
 sudo chmod a+x /usr/local/bin/javaws && \
 sudo chown -R root:root /usr/local/lib/jvm/java5/jdk1.5.0

ENV PATH=$PATH:/usr/local/bin
```

Docker images: Build, Distribute, Use

- build and use you own image

```
docker build -t my-image-with-little-onions - < Dockerfile
docker run -it my-image-with-little-onions
```

- Upload an image on the cloud

```
docker tag my-image-with-little-onions myrepo/my-image-with-little-onions
docker push myrepo/my-image-with-little-onions
```

- Use your image anywhere

```
docker run -it myrepo/my-image-with-little-onions
```

Docker Trusted Registry (a.k.a. DTR)

If you do not trust the cloud, you can set-up your own registry

- a registry is a collection of repository
- a repository is a collection of images
- the docker CLI uses Docker's public registry by default

```
docker pull myregistry.local:5000/myrepo/my-image-with-little-onions
```

And much more

```
config container image network node plugin secret service stack swarm
system trust volume attach build commit cp create diff events exec export
history images import info inspect kill load login logout logs pause port
ps pull push rename restart rm rmi run save search start stats
stop tag top unpause update version wait
```

Security

```
sudo docker run -it some_repo/some_image_from_an_unkown_source
docker run -v "$HOME:/some_dir -w /some_dir
docker run -v "$PWD:/some_dir -w /some_dir
```

Docker: when?

Some Use Cases

- Install/try new software without polluting its `.bashrc`
- Reproduce an experiment (reproducible research)
- Provide a working/uniform tool environment to students
- Distribute software
- Test (on various architectures)
- CI/CD

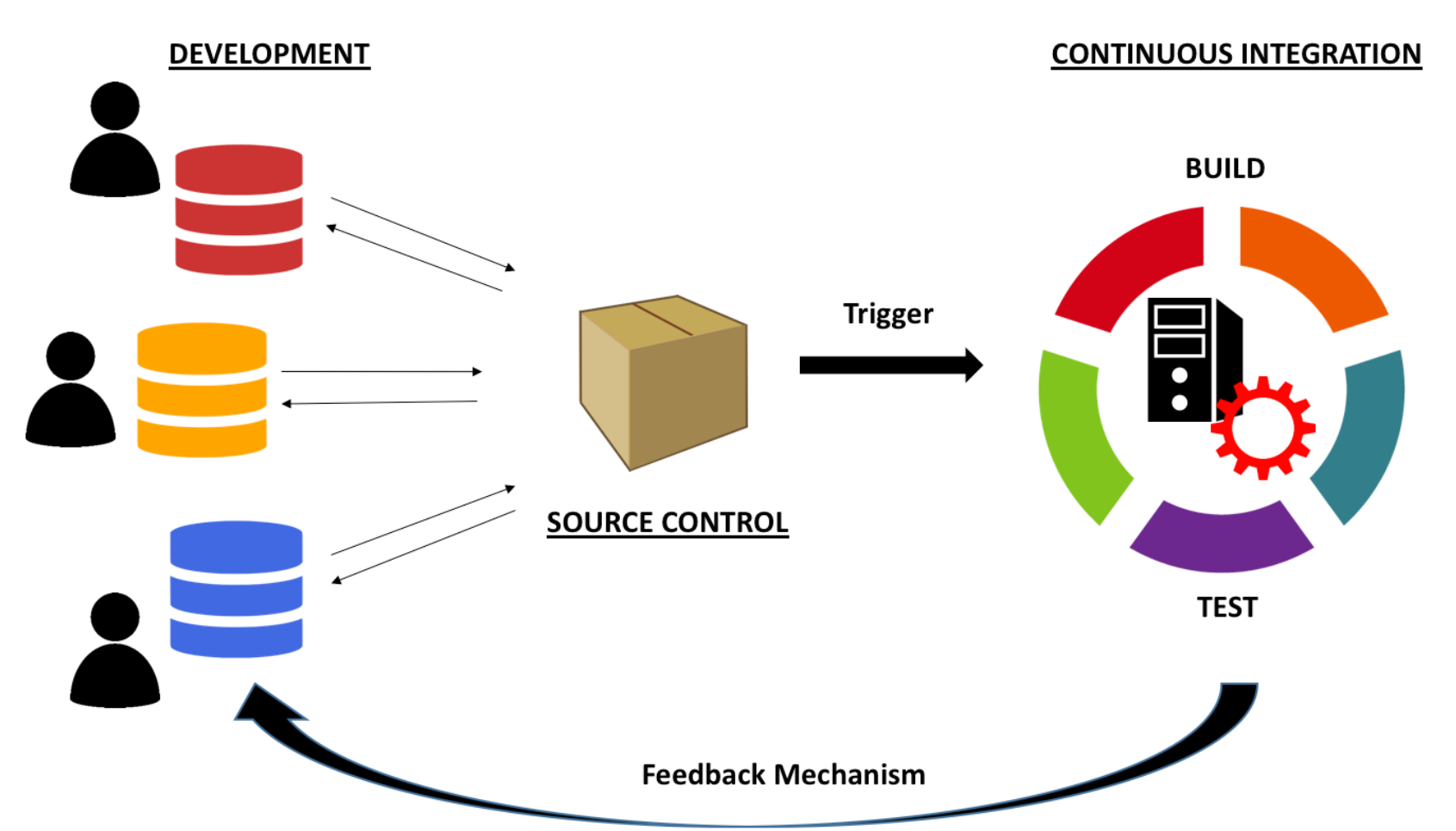
Some Alternatives

- Linux Containerization
  - `runc`
  - `rkt`
  - `LXC`, `LXD`
  - `Linux-VServer`
  - `OpenVZ`
- `nanobox` (a wrapper around docker)
- `Vagrant`
- `nix` (declarative package manager)
  - aims at installing packages in isolation
  - uses less disk space

Plan

1. Docker
   - What?
   - How?
   - When?
2. **Gitlab CI/CD**
   - What?
   - How?
   - When?

Continuous Integration (CI)



[1]

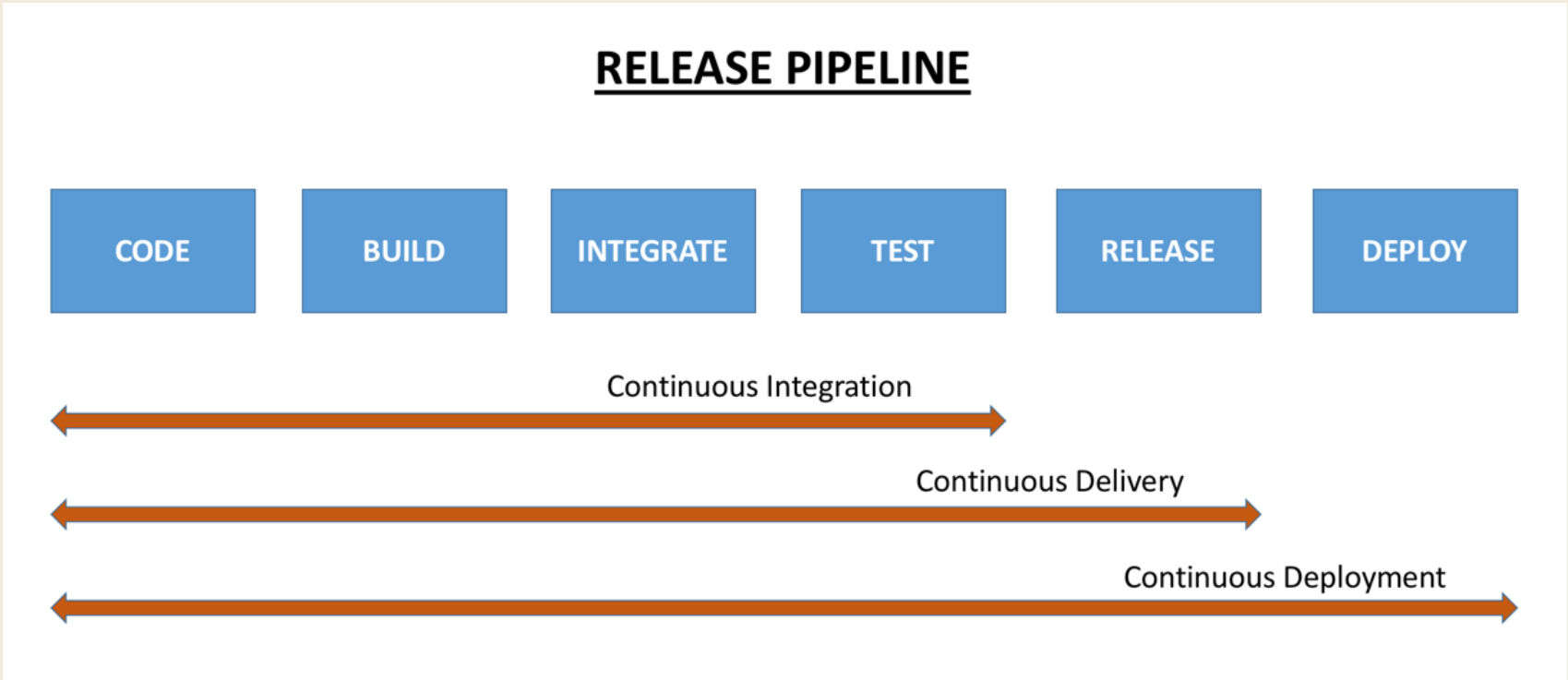
[1] source de l'image: https://dotnetvibes.com/2018/04/10/continuous-delivery-is-not-continuous-deployment/

Continuous Integration (CI)

CI is the practice of merging all developer working copies to a shared mainline several times a day

- Requires
  - a version manager
  - automated builds
  - automated testing scripts
- Comes from the Extreme Programming community

CI/CD = Continuous Integration/De???



1

Gitlab CI/CD: how?

Gitlab CI scripts are written in YAML

- Yet Another Markup Language (`xml`)
- Yaml Ain't a Markup Language
- Yaml Goals :
  1. serialize/deserialize structured data
  2. Independently of any programming language
  3. Standard
  4. human-eye (and human-finger) friendly (more than `xml` or even `json`)

YAML

Allow to write in a natural way:

- Association Tables (:)
- Lists (-)
- Scalars
  - Integers
  - Floats
  - String
  - Boolean
  - Date
  - etc.

Indentation => expressions scope

YAML: examples

- ex1: a table associating a string to a list of floats

```
x1 :
  - 1.0
  - 2.0
  - 3.0
x2 :
  - 5.0
  - 6.0
```

- ex2: a table of tables; spaces define scope!

```
table1 :
  1 :
    - 2012-08-06
    - 2013-02-05
  2 :
    - 1973-19-06
table2 :
  1 :
    - 2018-28-02
```

YAML: Anchors and References

- Anchors (`&ident`) and references (`*ident`) can avoid code duplication

```
foo: &anchor
 K1: "One"
 K2: "Two"
bar: *anchor
  K3: "Three"
```

- `<<: *ident` let one extend an association table

```
foo: &anchor
  K1: "One"
  K2: "Two"
bar:
  <<: *anchor
  K2: "I Changed"
  K3: "Three"
```

During the merge, the last one wins; K2 is therefore associated to “I Changed”

YAML serialization / deserialization

An example in java

- Sérialisation

```
Yaml.dump(object, new File("dump.yml"));
```

- Désérialisation

exemple.yaml:

```
- A char string
- 2
- { three: 3.0, four: true }
```

```
System.out.println(Yaml.load(new File("exemple.yaml")));
```

```
[A char string, 2, {tree=3.0, four=true}]
```

Gitlab CI: how?

- The CI work is controlled by a YAML file named `.gitlab-ci.yml` located at the project root
- `.gitlab-ci.yml`
  - define « jobs »
  - jobs can be executed in sequence (pipeline) or in parallel
  - jobs are executed by « `runners` »
- « `Runners` » can execute jobs via
  - a local shell
  - ssh
  - a virtual machine
  - `docker`
- `Runners` requires some set-up/configuration work
  - A shared `docker` runner is provided by gitlab/gricad
  - ∃ `veri-gitlabrun` @ Verimag (10 Xeon @2.00GHz; 8M RAM)

Gitlab CI jobs in parallel

Here is a `.gitlab-ci.yml` defining 2 jobs in parallel on a docker image running the latest `ubuntu`:

```
image: ubuntu:latest
job1:
   - echo "you can run any command available on the latest ubuntu" > cmd.sh
   - . cmd.sh

job2:
   - ls
   - pwd
   - apt-get update
   - apt-get install
   - make
```

- each of this job is executed by a (possibly different) « Runner »
- the `git clone` has been done implicitly

Gitlab CI jobs in sequence (Pipeline)

In order to run jobs in sequence, one need to define “stages”

```
stages:
  - test
  - build
  - deploy

job1:
  stage: build
  script:
    - mvn build

job2:
  stage: test
  script:
    - mvn test

job3:
  stage: deploy
  script:
    - mvn deploy
```

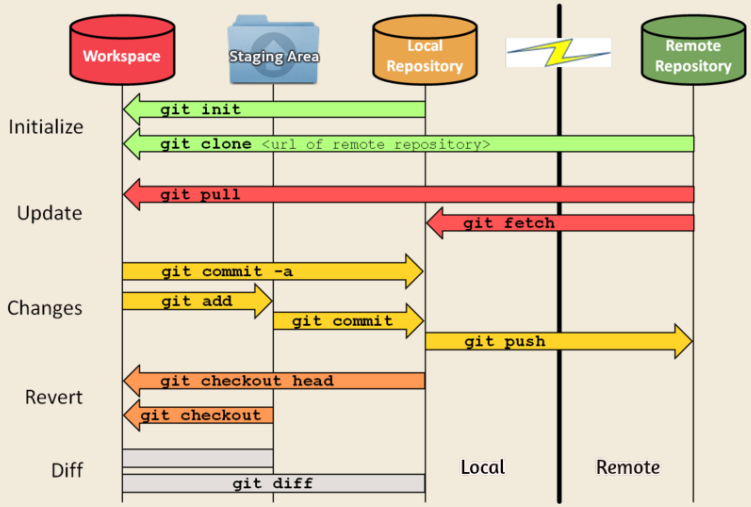
nb: by default a job is scheduled during the test stage

how to avoid Code duplication

1. One can use YAML anchors and references
2. One can extend its own image
3. The keywords `before_script` allows to factorize a sequence of commands

```
image: ubuntu:latest
before_script:
  - apt-get update
  - apt-get install maven openjdk-8-jre
tp1 tests:
  script:
    - cd tp1/
    - mvn test
tp2 tests:
  script:
    - cd tp2/
    - mvn test
```

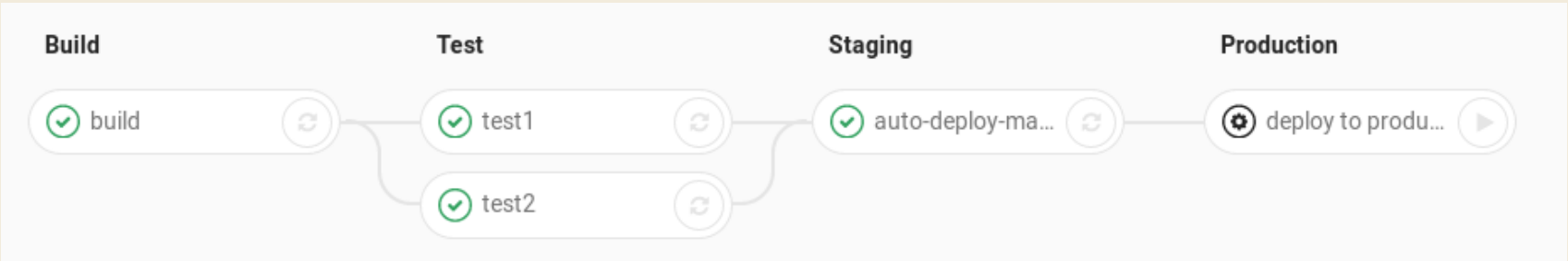
CI/CD jobs triggering



- By default, CI pipelines are triggered by `git push`
- CI jobs can be run on some specific branches only
- external trigger (POST), useful for multi-project CI
- scheduled trigger
- nb: jobs can be executed locally before doing a « `git push` » (using `docker` and `gitlab-runner`)

TL;DR

- At every « `git push` », a script (.gitlab-ci.yml) is executed
- which launch jobs in sequence and/or in parallel (pipelines)
  - Build
  - Test
  - Deploy (pdf, binaries, web pages)



- Jobs are executed by « Runners » that requires some set-up work
- ∃ a shared runner @ Gricad + `veri-gitlabrun` @ Verimag

Gitlab CI: when?

When should we write CI scripts?

- Well, of course, it depends on the kind of projects
  - For software development: always! (at least build and basic tests)
  - What about other version-controlled files such as article?

Gitlab CI for research articles

Even on papers it makes sense!

```
image: aergus/latex

paper:
  script:
    - cd papers; make; make bib; make; make
  artifacts:
    paths:
      - papers/main.pdf

slides:
  script:
    - cd slides; make; make
  artifacts:
    paths:
      - slides/main.pdf
```

Give a public access to your CI artifacts

```yaml
pages:
  stage: deploy
  script:
    - cp papers/main.pdf public/paper.pdf
    - cp slides/main.pdf public/slides.pdf
    - cd public; tree -H > index.html
  artifacts:
    paths:
    - public
```

The resulting public link is available via `Settings > Pages`
nb: does not work for projects in sub-groups

Reproducible Research

- A neglected topic in computer science community
- script the experimentation and the generation of Figures that are included in the article
- cf the Gitlab group verimag/reproducible-research
  - anyone can see the source and the output of the CI jobs
  - anyone can should be able to reproduce the experimentation locally (if it is based on docker runners)
- `org-mode` is a great tool (used in conjunction of gitlab/docker) to:
  - write articles
  - write slides
  - write web site
  - do literate programming

Conclusion

- We now have a much nicer software forge
- Running basic tests automatically is easy
- Your test are run on a `docker` runner
- `docker` is worth having a look at (independently of gitlab-CI)