# docker & HEP: containerization of applications for development, distribution and preservation

Sébastien Binet

LAL/IN2P3

2015-04-13

# Docker: what is it ?

- `http://www.docker.io/`
- an open source project to pack, ship and run any application as a lightweight container

## High level description

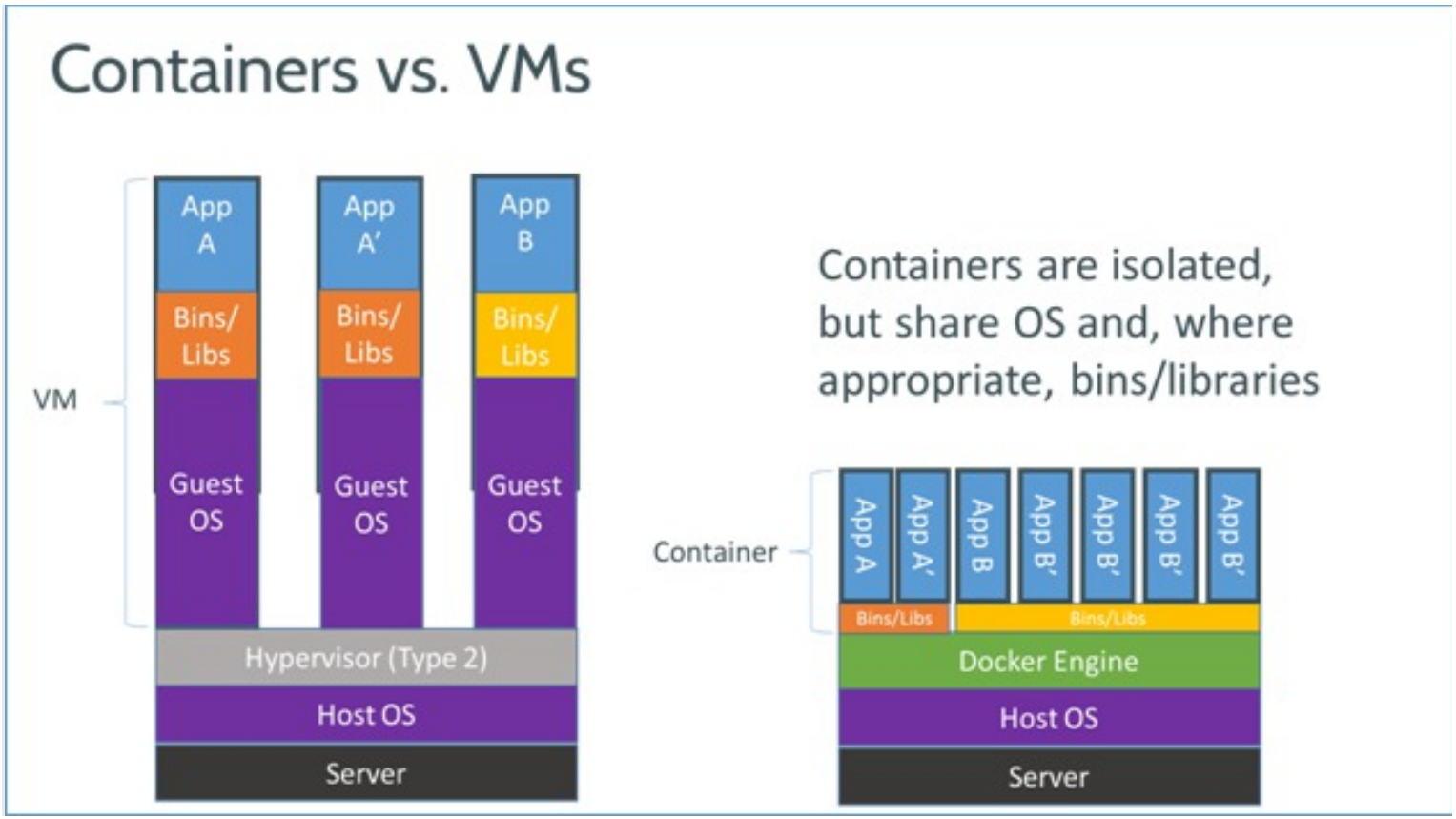
- kind of like a lightweight VM
- runs in its own process space
- has its own network interface
- can run stuff as `root`

## Low level description

- `chroot` on steroids
- container = isolated process(es)
- share kernel with host
- no device emulation

# Docker: why ?

- same use cases than for VMs
- speed: boots in (milli)seconds
- footprint: 100-1000 containers on a single machine/laptop. small disk requirements



# Docker: why ?

Efficiency: *almost* no overhead

- processes are isolated but run straight on the host
- `CPU` performance = native performance
- memory performance = a few % shaved off for (optional) accounting
- network performace = small overhead

Efficiency: storage friendly

- unioning filesystems
- snapshotting filesystems
- copy-on-write

- provisionning takes a few milliseconds
- . . . and a few kilobytes
- creating a new container/base-image takes a few seconds

# Docker: introduction

## Hello World

- get a base container (ubuntu, centos, . . . )

```
$ docker pull ubuntu
```

- list images already pulled in:

```
$ docker images
```

| | | | | |
|---|---|---|---|---|
| ubuntu | 12.04 | 8dbd9e392a96 | 5 months ago | 131.5 MB (virtual 131.5 MB) |
| ubuntu | latest | 8dbd9e392a96 | 5 months ago | 131.5 MB (virtual 131.5 MB) |
| ubuntu | precise | 8dbd9e392a96 | 5 months ago | 131.5 MB (virtual 131.5 MB) |
| ubuntu | 12.10 | b750fe79269d | 6 months ago | 24.65 kB (virtual 180.1 MB) |
| ubuntu | quantal | b750fe79269d | 6 months ago | 24.65 kB (virtual 180.1 MB) |

- run an executable inside a container

```
$ docker run ubuntu:12.10 echo ``hello world''
```

# Docker: introduction - II

## Detached mode

- run a container in detached mode:

```
$ docker run -d ubuntu sh -c \
  while true; do echo ''hello''; sleep 1; done;
```

- get the container id:

```
$ docker ps
```

| ID | IMAGE | COMMAND | CREATED | STATUS | PORTS |
|---|---|---|---|---|---|
| 78c88e279f26 | ubuntu:12.04 | /bin/sh -c while tru | 14 seconds ago | Up 11 seconds | |

- attach to the container

```
$ docker attach 78c88e279f26
```

- start/stop/restart a container

```
$ docker stop 78c88e279f26
```

# Docker: public index

## Public index

- pull an `apache` container from the index:

```
$ docker search apache
$ docker pull creack/apache2
```

- run the image and check the ports

```
$ docker run -d creack/apache2
$ docker ps
```

| ID | IMAGE | COMMAND | CREATED | STATUS | PORTS |
|---|---|---|---|---|---|
| 369602483ae9 | creack/apache2:latest | /usr/sbin/apache2ctl | 4 seconds ago | Up 1 seconds | 49153->80, 49154->443 |

Also available from the browser:
https://index.docker.io/

# Docker: creating a customized container

- run `docker` interactively:

```
$ docker run -i -t ubuntu bash
root@bf72b1a06e6c:/# apt-get update
Reading package lists... Done

root@bf72b1a06e6c:/# apt-get install memcached
[...]
root@bf72b1a06e6c:/# exit
```

- commit the resulting container

```
$ docker commit `docker ps -q -l ` binet/memcached
ab59e4b14266
```

- run the image

```
$ docker run -d -p 11211 -u daemon binet/memcached memcached
ab59e4b14266
```

# Docker: creating a customized container - Dockerfile

```
## install gaudi from RPMs
FROM hepsw/slc-base
MAINTAINER binet@cern.ch

ENV MYSITEROOT /opt/lhcb-sw
ENV CMTCONFIG x86_64-slc6-gcc48-opt

RUN mkdir -p $MYSITEROOT

## install some system dependencies
RUN yum install -y bzip2 freetype glibc-headers tar which

## retrieve install
RUN curl -O -L  http://cern.ch/lhcbproject/dist/rpm/lbpkr && \
    chmod +x ./lbpkr

## install (source+binaries)
RUN ./lbpkr install-project GAUDI v26r1
```

# Docker: Dockerfile - II

- build the container

```
$ docker build --tag=hepsw/lhcb-gaudi:v26r1 .
$ docker tag hepsw/lhcb-gaudi:v26r1 hepsw/lhcb-gaudi:latest
```

- run the container (and test the build)

```
$ docker run -i -t hepsw/lhcb-gaudi /bin/bash
[hepsw/lhcb-gaudi] $ cd /scratch
[hepsw/lhcb-gaudi] $ gaudirun.py \
   $GAUDIEXAMPLESROOT/options/TupleEx.py
```

- bind mounts

```
$ docker run -i -t hepsw/lhcb-gaudi \
  -v /host/build/results:/scratch
  /bin/bash
```

- copy files from container to host

```
$ docker cp hepsw/lhcb-gaudi:/scratch /host/build/results
```

# Benchmarks

- `kvm-and-docker-lxc-benchmarking`
  - executive summary: `docker` delivers very close to the bare-metal performances (consistantly better than `KVM` save for some `mysql` tests)
- tests `docker` containers creation, guest CPU/Mem/IO performances, . . .

# Benchmarks - II

Disk sizes of containers:

```
REPOSITORY                  TAG                 VIRTUAL SIZE
hepsw/lhcb-base             20150331            336.6 MB
hepsw/lhcb-gaudi            v26r1               3.911 GB
hepsw/lhcb-davinci          v36r5               7.790 GB

lhcb-base     (slimmed)     latest              322.3 MB
lhcb-gaudi    (slimmed)     latest              3.893 GB
lhcb-davinci  (slimmed)     latest              7.771 GB

hepsw/cvmfs-base            20150331            629.4 MB
hepsw/cvmfs-lhcb            20150331            629.4 MB
```

Disk sizes of `$MYSITEROOT`:

```
hepsw/lhcb-base:     /opt/lhcb-sw     67M
hepsw/lhcb-gaudi:    /opt/lhcb-sw  3.600G
hepsw/lhcb-davinci:  /opt/lhcb-sw  7.300G
```

*slimmed:* use `docker export+import` to shrink image size.

# Benchmarks - III

Running `gaudirun.py GaudiExamples/TupleEx.py`

- `AFS`

```
56.87s user 14.26s system 66% cpu 1:46.50 total # kick AFS
57.62s user 13.07s system 99% cpu 1:11.17 total
57.69s user 13.46s system 99% cpu 1:11.58 total
57.93s user 13.26s system 99% cpu 1:11.66 total
```

- `Docker-RPMs`

```
55.93s user 12.34s system 98% cpu 1:09.54 total
55.43s user 12.88s system 98% cpu 1:09.12 total
55.54s user 12.16s system 98% cpu 1:08.83 total
55.39s user 11.60s system 98% cpu 1:07.81 total
```

- `Docker-CVMFs` (a `docker` container where `CVMFs` is configured and running)

```
55.53s user 14.01s system 88% cpu 1:18.75 total # kick CVMFs
54.95s user 12.83s system 97% cpu 1:09.36 total
55.42s user 12.86s system 98% cpu 1:09.35 total
55.42s user 13.01s system 98% cpu 1:09.63 total
```

# Docker: on non-Linux ?

- no container backend for MacOSX (yet?)
- it is foreseen that at some point a `jail`-based backend will appear
- in the meantime: `boot2docker`
  - launches a very thin Linux-VM where the `docker` daemon is installed
  - installs the `docker` client on the host
  - talks via HTTP/REST to the daemon

- `boot2docker` works also for `Windows (TM)`

# Conclusions & Prospects

- easily distribute dev-environments
- easily provision build and dev-environments
- easily relocate binaries (remember: `chroot` on steroids!)
- provision efficient performance-wise environments (production)


- run a `HEP`-dedicated `docker` images repository ?
  - *ACLs*
  - $O(GB)$ images . . .
- put a `Frontier` server in front ?

# Docker: HEP examples

```
hepsw/docks (github)
hepsw/containers (docker public registry)
```