docker containers for HEP
-
first steps

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Outline

- What ?
- Why ?
- How ?
- (When ?)

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

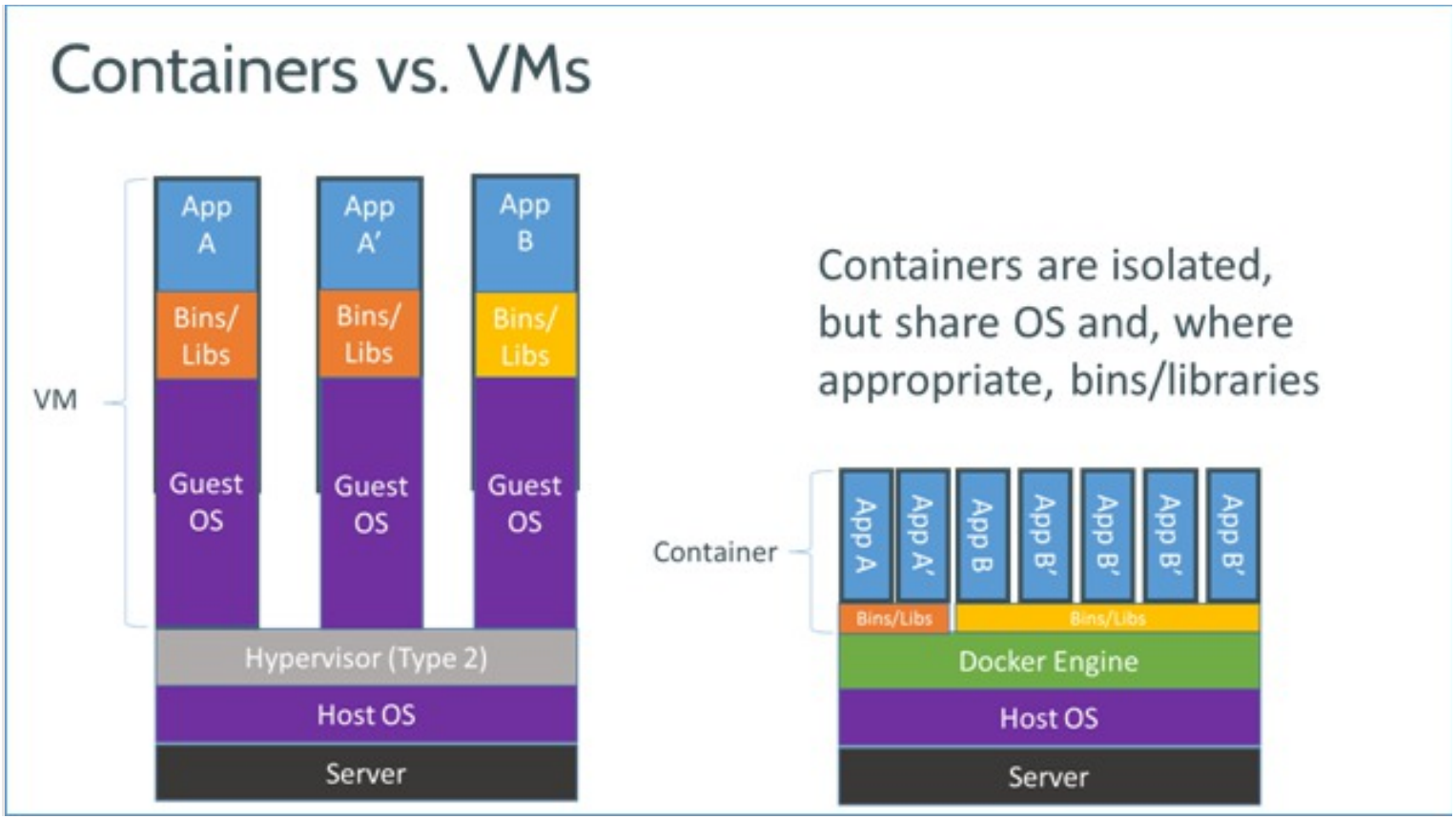
- kind of like a lightweight VM
- runs in its own process space
- has its own network interface
- can run stuff as `root`

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 perfomace = 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: how ?

- LinuX Containers (LXC)
- Control Groups and Namepsaces
- AUFS (overlaying filesystem), or BTRFS, or DeviceMapper
- Client-Server with an `http/REST` API

LXC

- Let's your run a Linux system within another Linux system
- A container is a group of processes on a Linux box, put together is an isolated environment
- From the inside, it looks like a VM. From the outside, it looks like normal processes
- *"chroot on steroids"*

Control Group & Namespaces

Linux kernel feature to limit, account and isolate resource usage:

- CPU
- Memory
- disk I/O

Docker: how ? (AUFS example)

AUFS

- File system that implements union mount

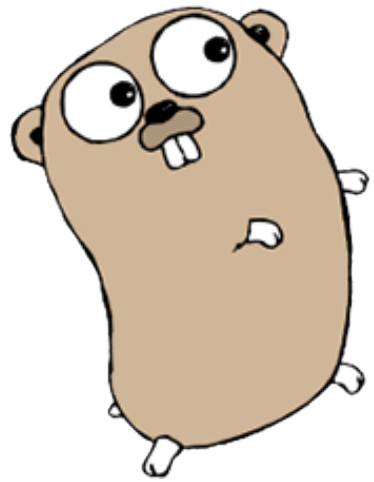
```
$ mount -t aufs -o br=/files1:/files2 none /files
```

- Supports copy-on-write (COW)

```
$ mount -t aufs -o br=/tmp=rw:/bin=ro none /files
```

Go

`Docker` is actually a `Go` binary scripting `LXC` and `AUFS`



Docker: installation

Requirements

- Linux Kernel 3.8 or above
- AUFS || BTRFS || DeviceMapper
- LXC
- 64-bit

More on: http://docs.docker.io/en/latest/installation

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

```
## build gaudi
FROM binet/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 tar which

## retrieve install
RUN curl -O -L http://cern.ch/binet/sw/dist/pkr && \
    chmod +x ./pkr

## install (source+binaries)
RUN ./pkr install GAUDI_v25r1_x86_64_slc6_gcc48_opt
```

Docker: Dockerfile - II

- build the container

```
$ docker build --tag=binet/gaudi:v25r1 .
$ docker tag binet/gaudi:v25r1 binet/gaudi:latest
```

- run the container (and test the build)

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

- bind mounts

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

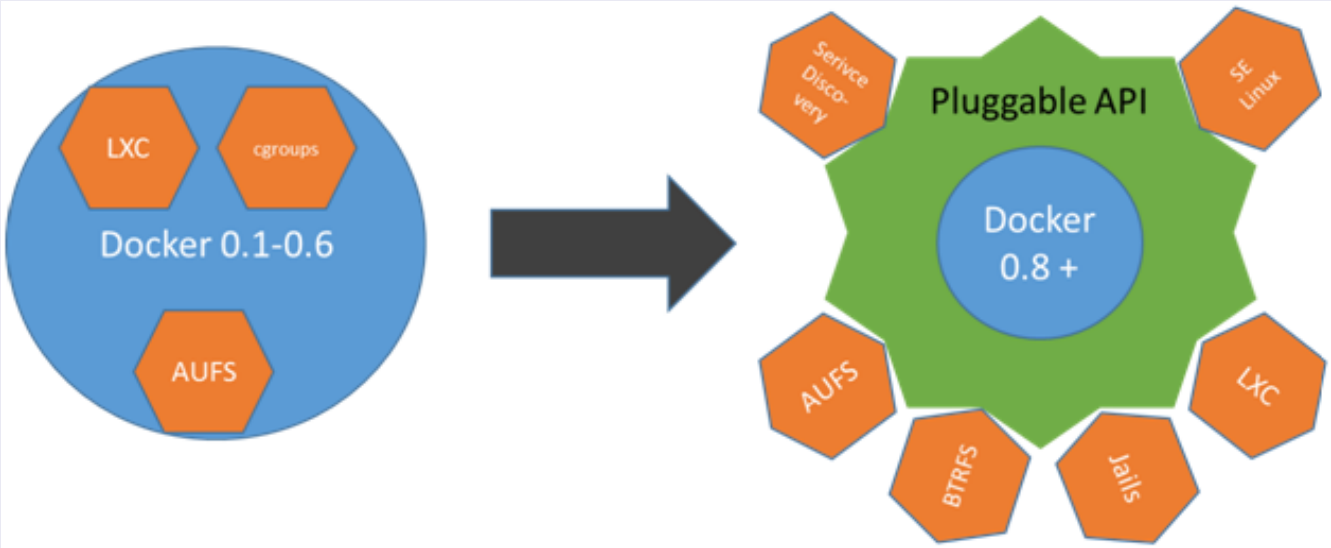
- copy files from container to host

```
$ docker cp binet/gaudi:/scratch /host/build/results
```

Docker: when ? where ?

- `OpenStack-Havana` has support for running `docker` containers
- so since beginning 2014: technically possible to run those on `openstack.cern.ch` (some configuration required though [`RQF0335022`])

- since version `docker-0.7` no `AUFS` hard-requirement. multiple backends:
  - BTRFS
  - DeviceMapper
- packaged for `Fedora-20`
- available on `RHEL/SLC-6.5` (`apt-get install docker-io`)



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, . . .

- Next time: Gaudi-based benchmarks
  - no access to a physical SLC6 machine with `docker` installed
  - on the way at LAL
  - happy to test it somewhere else too

Docker: on MacOSX ?

- 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)`

Docker: pie-in-the-sky

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

Docker: HEP examples

```
sbinet/docker-containers (github)
sbinet/containers (docker public registry)
```