
# Linux Containers and Dockers

Quando, vantaggi e svantaggi

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- The Solutions: Virtual Machines vs Vagrant vs Docker
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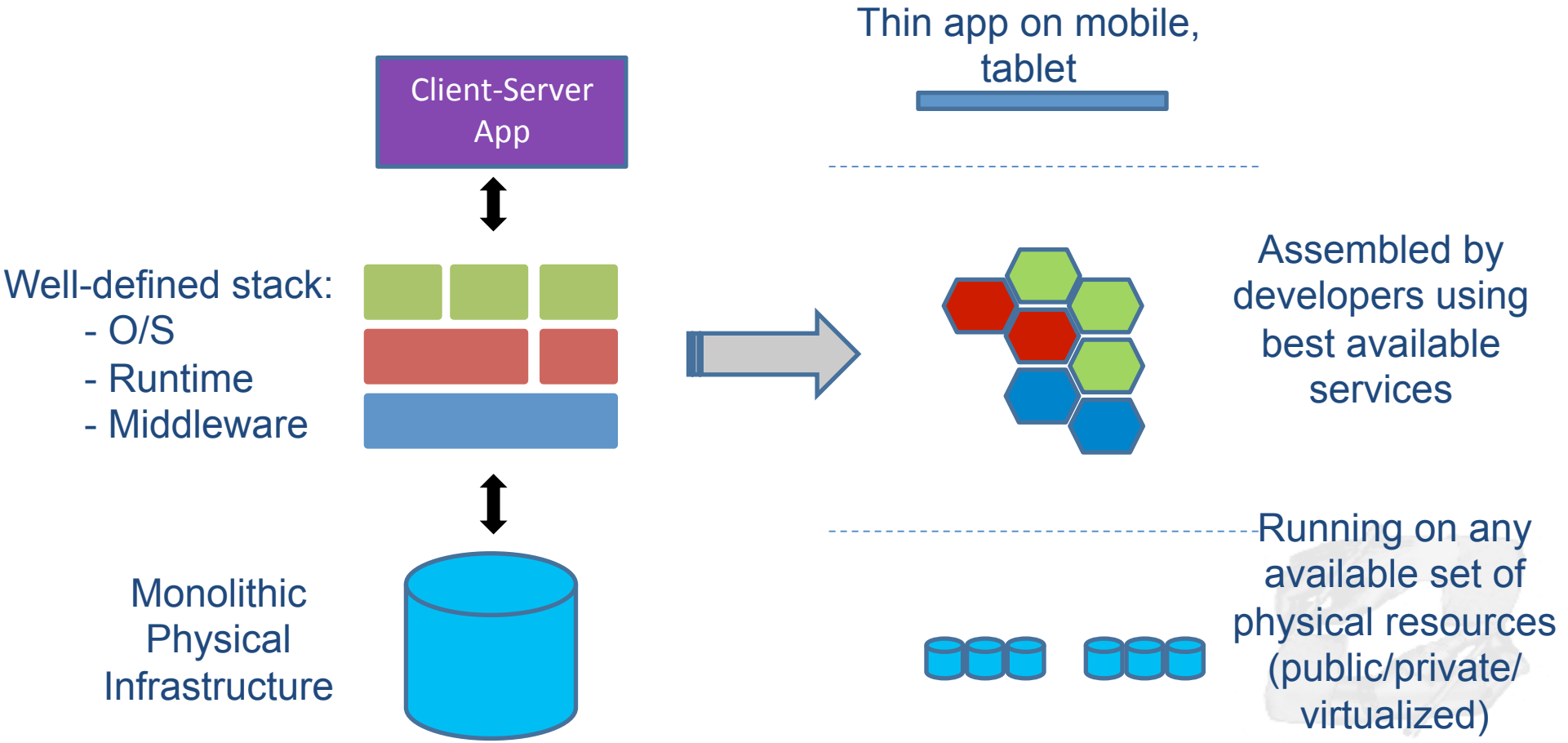
# From 1995 to 2015



# 2015 in Detail


User DB

postgresql + pgv8 + v8

Static website

nginx 1.5 + modsecurity + openssl + bootstrap 2

Queue

Redis + redis-sentinel

Analytics DB

hadoop + hive + thrift + OpenJDK

Background workers

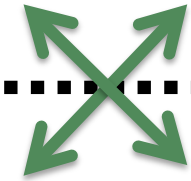
Python 3.0 + celery + pyredis + libcurl + ffmpeg + libopencv + nodejs + phantomjs

Web frontend

Ruby + Rails + sass + Unicorn

API endpoint

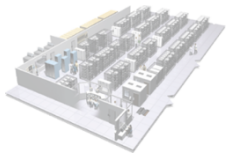
Python 2.7 + Flask + pyredis + celery + psycopg + postgresql-client



Public Cloud

Development VM

QA server



Production Cluster

Disaster recovery

Customer Data Center

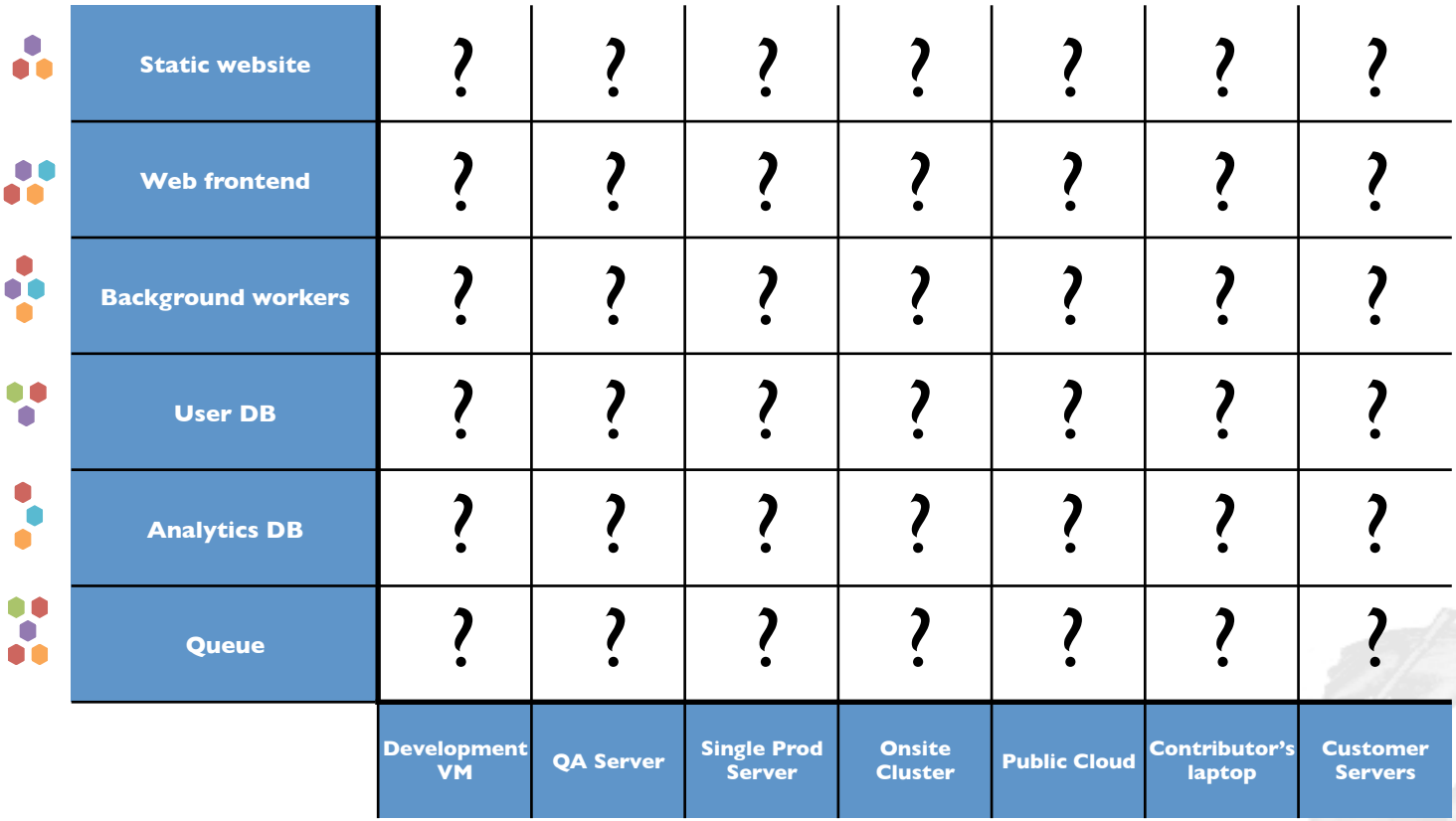
Production Servers

Contributor's laptop

# Challenges

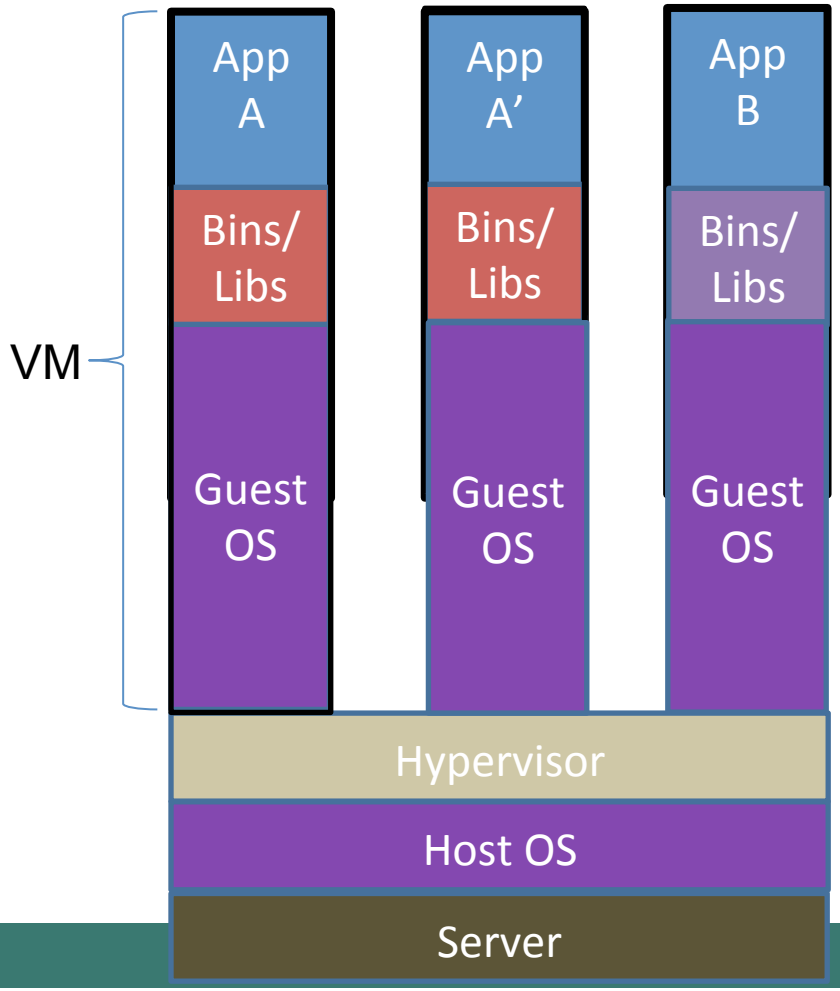

- How to ensure that services interact consistently?
- How to avoid to setup N different configurations and dependencies for each service?
- How to migrate and scale quickly ensuring compatibility?
- How to replicate my VM and services quickly?

# How to deal with different confs?



# 1. VIRTUAL MACHINES

# Virtual Machines




- Run on top of an Hypervisor

Pros

- fully virtualized OS
- Totally isolated

Cons

- Needs to take a snapshot of the entire VM to replicate
- Uses a lot of space
- Slow to move around

# Hypervisors Trend


2011

- XEN: Default choice given Rackspace and Amazon use
- KVM: Bleeding edge users

2012

- KVM: Emerges as the lead
- XEN: Loses momentum

# Hipervisors Trend


2013

- KVM: Maintains lead (around 90%+ for Mirantis)
- Vmware: Emerges as a surprising second choice
- Containers (LXC, Parallels, Docker): Web Hosting and SAS focused
- Xen and HyperV: Infrequent requests (XenServer.org)

2014 – 2015

- ???

# 2. VAGRANT

# Vagrant


- Open source VM manager released in 2010
- It allows you to script and package VMs config and the provisioning setup via a VagrantFile
- It is designed to run on top of almost any VM tool: VirtualBox, VMVare, AWS, OpenStack[1]
- It can be used together with provisioning tools such as shell scripts, Chef and Puppet.



1. https://github.com/cloudbau/vagrant-openstack-plugin

# Vagrant: idea


Use a VagrantFile to install

1. an operating system
2. Required libraries and software

and finally run programs and processes of your final application

```
box      = 'precise32'
url      = 'http://files.vagrantup.com/precise32.box'
hostname = 'myprecisebox'
domain   = 'example.com'
ip       = '192.168.0.42'
ram      = '256'

Vagrant::Config.run do |config|
  config.vm.box = box
  config.vm.box_url = url
  config.vm.host_name = hostname + '.' + domain
  config.vm.network :hostonly, ip

  config.vm.customize [
    'modifyvm', :id,
    '--name', hostname,
    '--memory', ram
  ]
end
```

# Vagrant: Feature

- Command-Line Interface
- Vagrant Share
- VagrantFile
- Boxes
- Provisioning
- Networking
- Synced Folders
- Multi-Machine
- Providers
- Plugins


https://www.vagrantup.com/downloads

# Vagrant: Demo


- It allows us to interact with Vagrant
- It offers the following commands: box, connect, destroy, halt, init, login, package a vm, rdp, …

https://docs.vagrantup.com/v2/cli/index.html

# Vagrant Example


1. Download and install VirtualBox and Vagrant

```
$ mkdir vagrant_first_vm && cd vagrant_first_vm
$ vagrant init
```

2. This will place a VagrantFile in the directory
3. Install a Box

```
$ vagrant box add ubuntu/trusty64
```

4. Using a Box -> https://vagrantcloud.com/

```
Vagrant.configure("2") do |config|
  config.vm.box = "ubuntu/trusty64"
end
```

# Vagran: Start


1. Start the box

```
$ vagrant up
```

2. Login into the vm

```
$ vagrant ssh
```

3. You can destroy the vm by

```
$ vagrant destroy
```

# Vagrant: Synced Folders


- By default, it shares your project directory to the /vagrant directory on the guest machine.

```
$ vagrant up
$ vagrant ssh
$ ls /vagrant
--Vagrantfile
```

- If you create a file on your gues os the file will be on the vagrant vm.

```
$ touch pippo.txt
$vagrant ssh
$ls /vagrant/
```

# Vagrant: Provisioning


- Let's install Apache via a boostrap.sh file

```
#!/usr/bin/env bash

apt-get update
apt-get install -y apache2
rm -rf /var/www
ln -fs /vagrant /var/www
```

- If you create a file on your gues os the file will be on the vagrant vm. (vagrant reload --provision)

```
Vagrant.configure("2") do |config|
  config.vm.box = "hashicorp/precise32"
  config.vm.provision :shell, path: "bootstrap.sh"
end
```

# Vagrant: Networking


- **Port Forwarding**: llows you to specify ports on the guest machine to share via a port on the host machine

```
Vagrant.configure("2") do |config|
  config.vm.box = "hashicorp/precise32"
  config.vm.provision :shell, path: "bootstrap.sh"
  config.vm.network :forwarded_port, host: 4567, guest: 80
end
```

- By running vagrant reload or vagrant up we can see on http://127.0.0.1:4567 our apache
- It supports also bridge configurations and other configurations (https://docs.vagrantup.com/v2/networking/)

# Vagrant: Share and Provider


- It is possible to share Vagrant box via vagrant cloud (but?)

## Providers

- By default Vagrant is configured with VirtualBox but you can change the provider

```
$ vagrant up --provider=vmware_fusion
$ vagrant up --provider=aws
```

- How?

```
$ vagrant plugin install vagrant-aws
```

# Vagrant: AWS Vagrantfile

```
Vagrant.configure("2") do |config|
# config.vm.box = "sean"

        config.vm.provider :aws do |aws, override|
        aws.access_key_id = "AAAAIIIIYYYY4444AAAA”
        aws.secret_access_key =
"c344441LooLLU322223526IabcdeQL12E34At3mm”
        aws.keypair_name = "iheavy"

        aws.ami = "ami-7747d01e"

        override.ssh.username = "ubuntu"
        override.ssh.private_key_path = "/var/root/iheavy_aws/pk-
XHHHHHMMMAABPEDEFGHOAOJH1QBH5324.pem"
        end
end
```

# 3. DOCKER

# Quick Survey


- How many people have heard of Docker before this Seminar?
- How many people have tried Docker ?
- How many people are using Docker in production ?

# What is Docker?


"Docker is an open-source engine to easily create lightweight, portable, self-sufficient containers from any application. The same container that a developer builds and test on a laptop can run at scale, in production, on VMs, OpenStack cluster, public clouds and more."

Docker.io

# Docker in simple words


- It is a technology that allow you running applications inside containers (not VM)
- This assures that libraries and package needed by the application you run are always the same.
- This means you can make a container for Memcache and another for Redis and they will work the same in any OS (also in Vagrant).

# How does docker work?


- LinuX Containers (LXC)
- Control Groups & Namespaces (CGroups)
- AUFS
- Client – Server with an HTTP API

# LXC- Linux Containers


- It  is a user-space interface for the Linux kernel containment features
- Through a powerful API and simple tools, it lets Linux users easily create and manage system or application containers.
- Currently LXC can apply the following kernel features to contain processes:
  - Kernel namespaces (ipc, uts, mount, pid, network and user)
  - Apparmor and SELinux profiles
  - Seccomp policies
  - Chroots (using pivot_root)
  - Kernel capabilities & Control groups (cgroups)

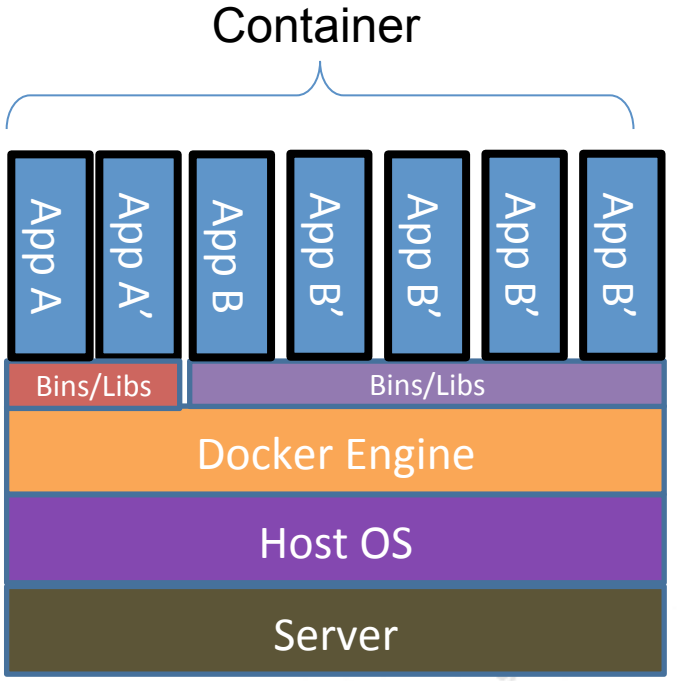
# cgroups


- Control groups is a Linux kernel feature to limit, account and isolate resource usage (CPU, memory, disk I/O, etc) of process groups.
- Features:
  - Resource limitation: limit CPU, memory…
  - Prioritization: assign more CPU etc to some groups.
  - Accounting: to measure the resource usage.
  - Control: freezing groups or check-pointing and restarting.

# LCX based Containers


- It allows us to 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.

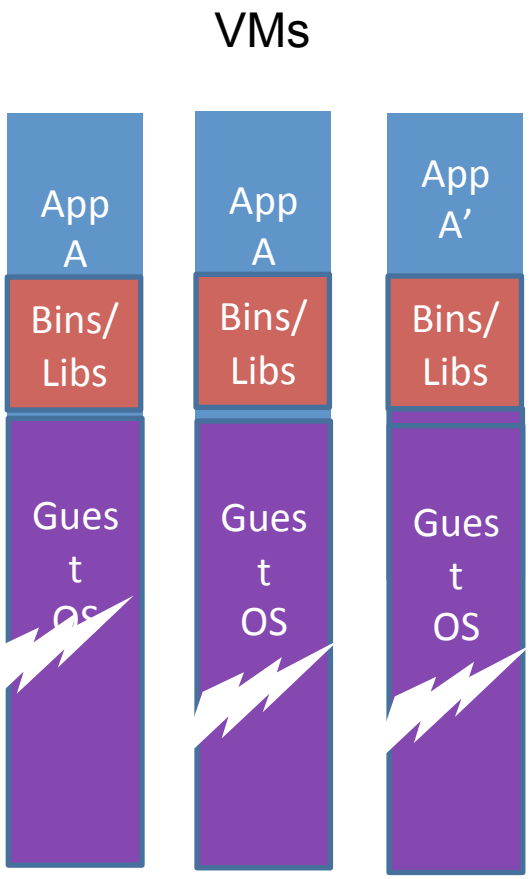
  - From the inside it looks like a VM
  - From the outside, it looks like normal processes

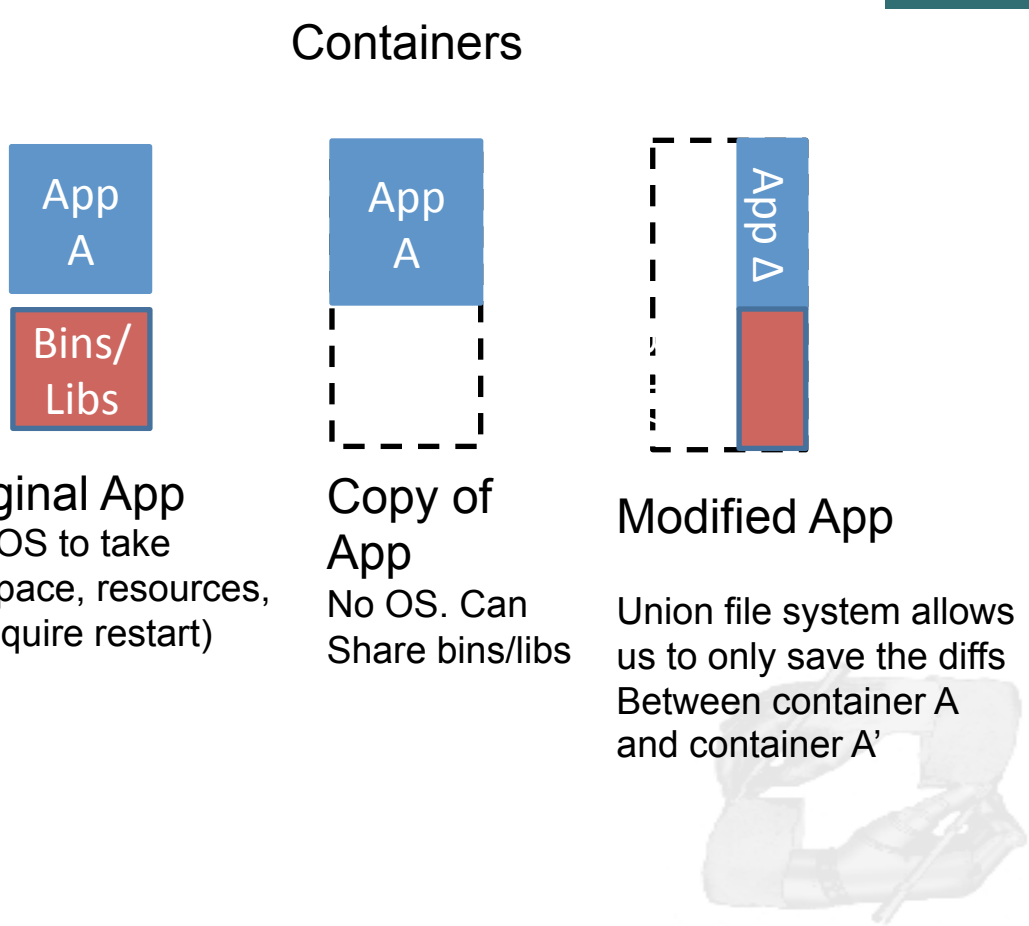


# Docker Features


- VE (Virtual Environments) based on LXC
- Portable deployment across machines
- Versioning: docker include git-like capabilities for tracking versions of a container
- Component reuse: it allows building or stacking already created packages. You can create ‘base images’ and then running more machine based on the image.
- Shared libraries: there is a public repository with several images (https://registry.hub.docker.com/)

# Why are Docker Containers lightweight?



# Docker Installation Ubuntu


- AUFS support

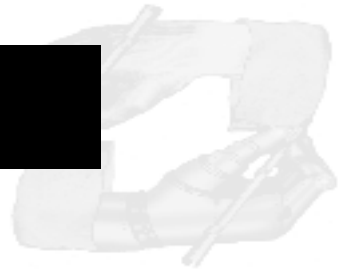
```
$ sudo apt-get update
$ sudo apt-get intall linux-image-extra-`uname –r`
```

- Add docker repo

```
$ sudo sh –c “curl https://get.docker.io/gpg | apt-key add -”
$ sudo sh –c “echo deb http://get.docker.io/ubuntu docker \
            main > /etc/apt/sources.list.d/docker.list”
```

- Install

```
$> sudo apt-get update
$> sudo apt-get install lxc-docker
```



# Docker Installation Vagrant


- Clone the docker repository

```
$ git clone https://github.com/dotcloud/docker.git
```

- Startup the vagrant image

```
$ vagrant up
```

- SSH into the image

```
$ vagrant ssh
```

- Docker client works normally

# BASE COMMANDS

# Docker: hello world


- Get one base image

```
$ docker pull ubuntu
```

- List images on your system

```
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)
```

- Print hello world

```
$ docker run ubuntu:12.10 echo “hello world”
```

# Detached mode


- Run in Docker using the detached flag (-d)

```
$ docker run –d ubuntu sh –c “while true; do echo hello
world; sleep 1; done”
$ docker ps
```

- Get the container’s id

| 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 <container id>
```

- Stop/Start/Restart the container

```
$ docker stop <container id>
```

# Public Index & Network


- Pull an apache image from the public repo

```
$ 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 |

- Expose public ports

```
$ docker run –d –p 8888:80 –p 4444:43 creack/apache2
$ docker ps
```

# Using Docker: the interactive way


```
$ docker run –i –t ubuntu bash
root@82fdsfs4885:/#
root@82fdsfs4885:/# apt-get update
root@82fdsfs4885:/# apt-get install memcached
root@82fdsfs4885:/# exit
```

- Commit the Image

```
$ docker commit `docker ps –q –l` user/memcached
```

- Start the image

```
$ docker crun –d –p 11211 –u daemon user/memcached memcached
```

# Docker: app using scripts


- Write a Dockerfile

```
# Memcached
FROM ubuntu
MAINTAINER Fabio Fumarola

RUN apt-get update
RUN apt-get install –y memcached

ENTRYPOINT [“memcached”]
USER daemon
EXPOSE 11211
```

- Build and Start the image

```
$ docker build –t=fabio/memcached
$ docker run –d fabio/memcached memcached
```

# Other Commands


- Docker cp: copy a file from container to host
- Docker diff: print container changes
- Docker top: display running processes in a container
- Docker rm /rmi: delete container/image
- Docker wait: wait until container stop and print exit code

More on: http://docs.docker.io/en/latest/commandline/cli

# Docker vs Vagrant?


- Less memory for Dockers  w.r.t VMs
- With a VM you get more isolation, but is much heavier. Indeed you can run 1000 of Dockers in a machine but not thousand of VMs with Xen.
- A VM requires minutes to start a Docker seconds

There are pros and cons for each type.

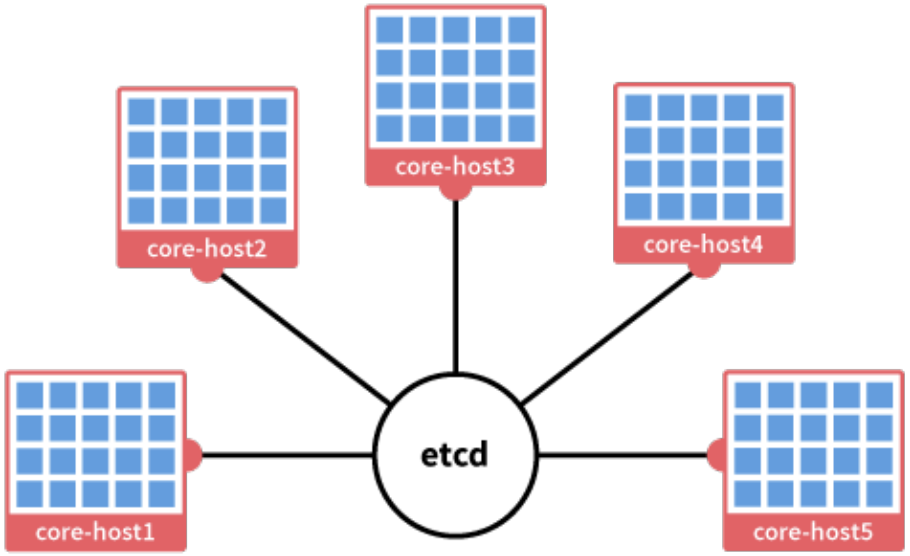
- If you want full isolation with guaranteed resources a full VM is the way to go.
- If you want hundred of isolate processes into a reasonably sized host then Docker might be the best solution

# CORE OS

# CoreOS


- A minimal operating system
- Painless updating: utilizes active/passive scheme to update the OS as single unit instead of package by package.
- Docker container
- Clustered by default
- Distributed System tools: etcd key-value store
- Service discovery: easily locate where service are running in the cluster
- High availability and automatic fail-over

# CoreOS




Clustered by default


High availability and a utomatic fail-over

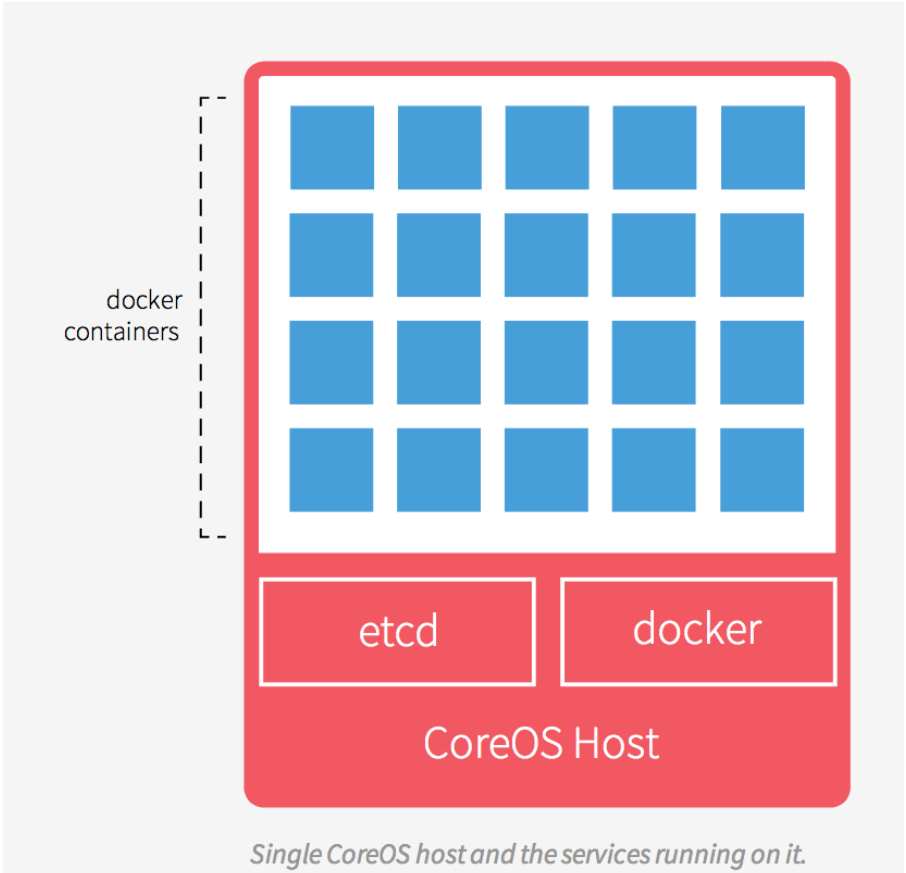
# Docker with CoreOS


**Features**

- Automatically runs on each CoreOS machine
- Updated with regular automatic OS updates
- Integrates with etcd
- Networking automatically configured

Example Akka cluster + Docker + CoreOS

https://github.com/dennybritz/akka-cluster-deploy




*Single CoreOS host and the services running on it.*

# References



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