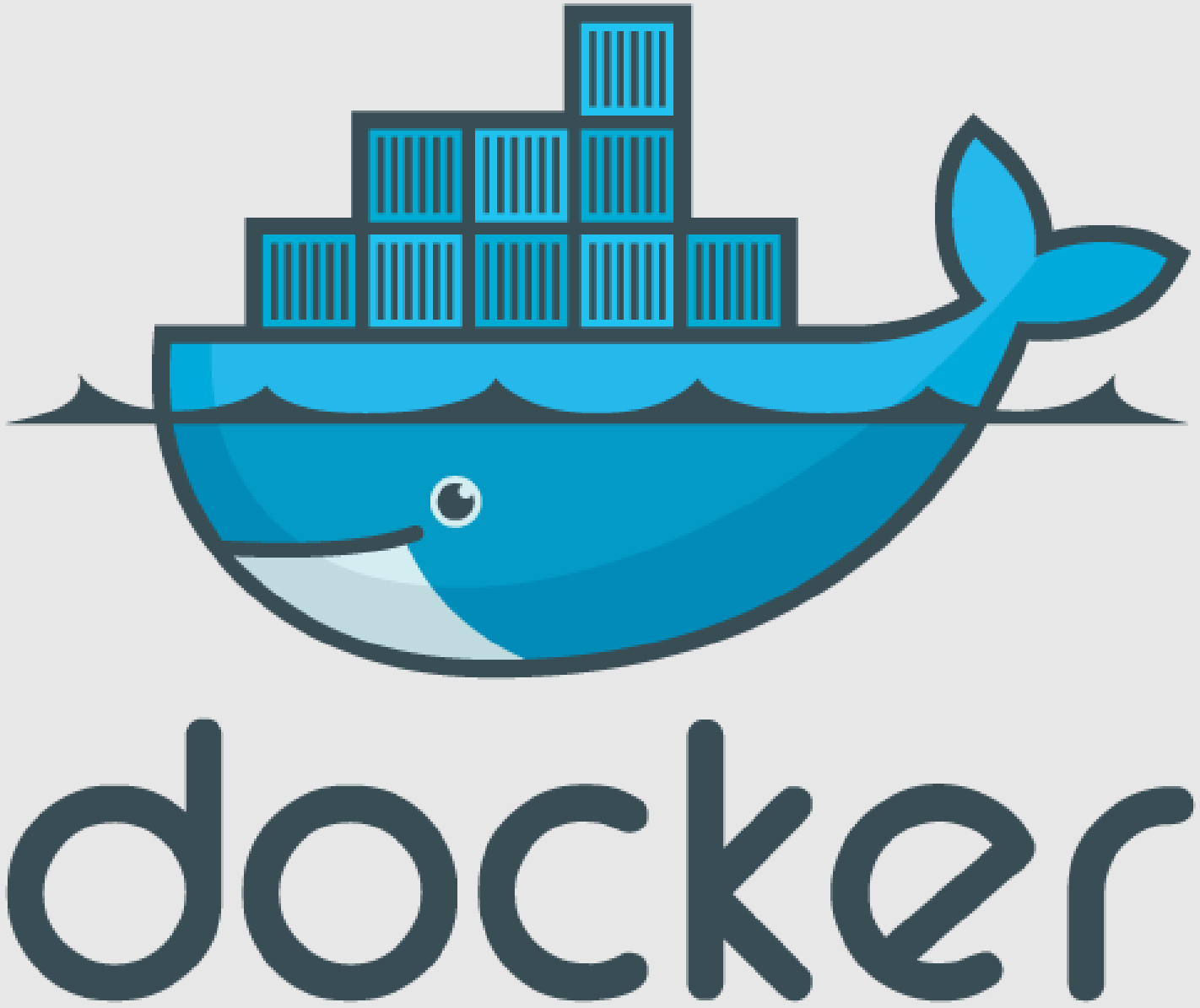

docker

Best practices in development and deployment, with Docker and Containers

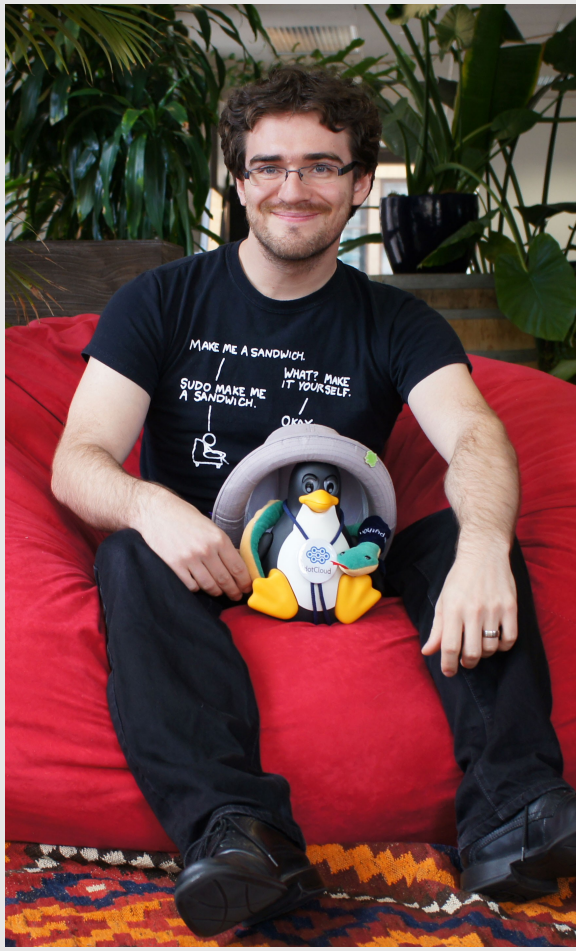
SCALE 12x

February 2014—Docker 0.8.1

docker

@jpetazzo

- Wrote dotCloud PAAS deployment tools
  - EC2, LXC, Puppet, Python, Shell, ØMQ...
- Docker contributor
  - Docker-in-Docker, VPN-in-Docker, router-in-Docker... CONTAINERIZE ALL THE THINGS!
- Runs Docker in production
  - You shouldn't do it, but here's how anyway!



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docker

Outline

- Why should I care?
- The container metaphor
- Very quick demo
- Working with Docker
- Building images
- Docker future

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Outline

- **Why should I care?**
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Deploy everything

- webapps
- backends
- SQL, NoSQL
- big data
- message queues
- … and more

Deploy almost everywhere

Deploy almost everywhere

YUP

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Deploy almost everywhere

YUP

SOON

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Deploy almost everywhere

YUP

SOON

SOON

Deploy almost everywhere

YUP

SOON

SOON

Deploy almost everywhere

YUP

SOON

SOON

CLI

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Deploy almost everywhere

YUP SOON SOON CLI

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docker

Deploy almost everywhere

YUP

SOON

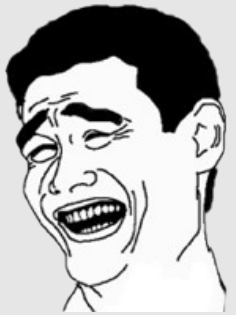
SOON

CLI

Yeah,
right...

Deploy almost everywhere

YUP SOON SOON CLI



Deploy almost everywhere

- Linux servers
- VMs or bare metal
- Any distro
- Kernel 3.8 (or RHEL 2.6.32)

Deploy reliably & consistently


WORKED FINE IN DEV
OPS PROBLEM NOW

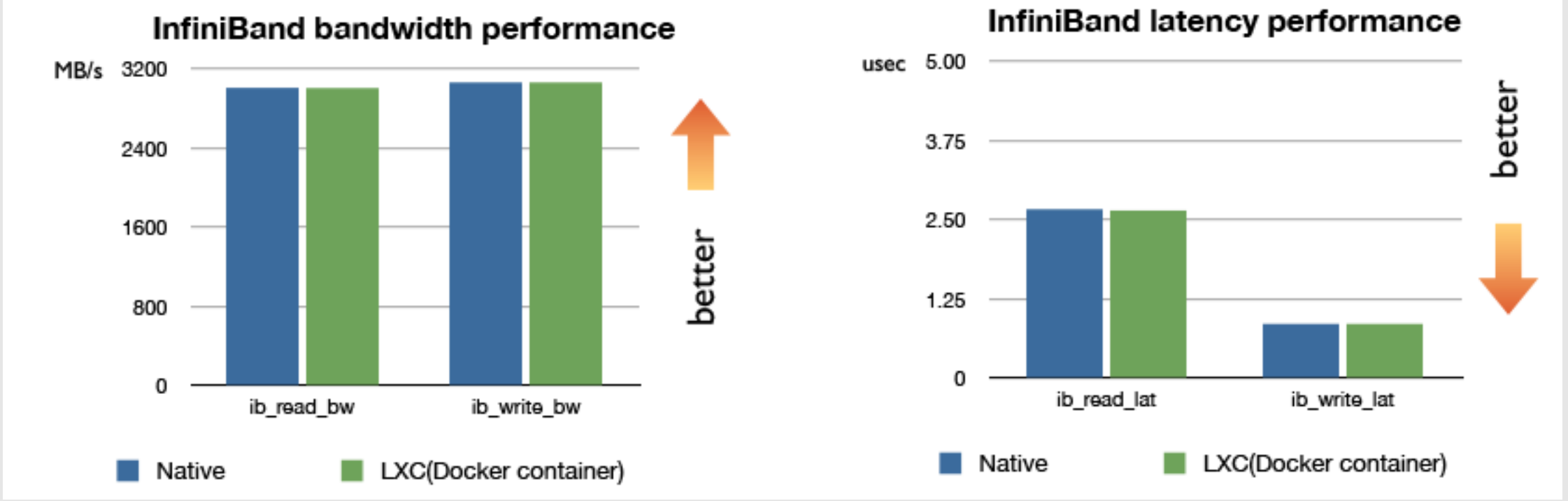
Deploy reliably & consistently

- If it works locally, it will work on the server
- *With exactly the same behavior*
- Regardless of versions
- Regardless of distros
- Regardless of dependencies

Deploy efficiently

- Containers are lightweight
  - Typical laptop runs 10-100 containers easily
  - Typical server can run 100-1000 containers
- Containers can run at native speeds
  - Lies, damn lies, and other benchmarks:
    http://qiita.com/syoyo/items/bea48de8d7c6d8c73435

The performance!
It's over 9000!



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… Container ?

High level approach: it's a lightweight VM

- own process space
- own network interface
- can run stuff as root
- can have its own /sbin/init (different from the host)

« Machine Container »

Low level approach: it's chroot on steroids

- can also *not* have its own /sbin/init
- container = isolated process(es)
- share kernel with host
- no device emulation (neither HVM nor PV)

« Application Container »

How does it work?
Isolation with namespaces

- pid
- mnt
- net
- uts
- ipc
- user

pid namespace

```
jpetazzo@tarrasque:~$ ps aux | wc -l
212

jpetazzo@tarrasque:~$ sudo docker run -t -i ubuntu bash
root@ea319b8ac416:/# ps aux
USER    PID %CPU %MEM    VSZ   RSS TTY   STAT START  TIME COMMAND
root      1  0.0  0.0  18044  1956 ?     S    02:54  0:00 bash
root     16  0.0  0.0  15276  1136 ?     R+   02:55  0:00 ps aux
```

(That's 2 processes)

mnt namespace

```
jpetazzo@tarrasque:~$ wc -l /proc/mounts
32 /proc/mounts
```

```
root@ea319b8ac416:/# wc -l /proc/mounts
10 /proc/mounts
```

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net namespace

```
root@ea319b8ac416:/# ip addr

1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever

22: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc
pfifo_fast state UP qlen 1000
    link/ether 2a:d1:4b:7e:bf:b5 brd ff:ff:ff:ff:ff:ff
    inet 10.1.1.3/24 brd 10.1.1.255 scope global eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::28d1:4bff:fe7e:bfb5/64 scope link
       valid_lft forever preferred_lft forever
```

uts namespace

```
jpetazzo@tarrasque:~$ hostname
tarrasque
```

```
root@ea319b8ac416:/# hostname
ea319b8ac416
```

ipc namespace

```
jpetazzo@tarrasque:~$ ipcs
------ Shared Memory Segments --------
key        shmid      owner      perms      bytes      nattch     status
0x00000000 3178496    jpetazzo   600        393216     2          dest
0x00000000 557057     jpetazzo   777        2778672    0
0x00000000 3211266    jpetazzo   600        393216     2          dest


root@ea319b8ac416:/# ipcs
------ Shared Memory Segments --------
key        shmid      owner      perms      bytes      nattch     status
------ Semaphore Arrays --------
key        semid      owner      perms      nsems
------ Message Queues --------
key        msqid      owner      perms      used-bytes   messages
```

user namespace

- No demo, but see LXC 1.0 (just released)
- UID 0→1999 in container C1 is mapped to UID 10000→11999 in host;
  UID 0→1999 in container C2 is mapped to UID 12000→13999 in host; etc.
- what will happen with copy-on-write?
  - double translation at VFS?
  - single root UID on read-only FS?

How does it work? Isolation with cgroups

- memory
- cpu
- blkio
- devices

memory cgroup

- keeps track pages used by each group:
  - file (read/write/mmap from block devices; swap)
  - anonymous (stack, heap, anonymous mmap)
  - active (recently accessed)
  - inactive (candidate for eviction)
- each page is « charged » to a group
- pages can be shared (e.g. if you use any COW FS)
- Individual (per-cgroup) limits and out-of-memory killer

cpu and cpuset cgroups

- keep track of user/system CPU time
- set relative weight per group
- pin groups to specific CPU(s)
  - Can be used to « reserve » CPUs for some apps
  - This is also relevant for big NUMA systems

blkio cgroups

- keep track IOs for each block device
  - read vs write; sync vs async
- set relative weights
- set throttle (limits) for each block device
  - read vs write; bytes/sec vs operations/sec

Note: earlier versions (<3.8) didn't account async correctly. 3.8 is better, but use 3.10 for best results.

`devices` cgroups

- controls read/write/mknod permissions
- typically:
  - allow: /dev/{tty,zero,random,null}...
  - deny: everything else
  - maybe: /dev/net/tun, /dev/fuse, /dev/kvm, /dev/dri...
- fine-grained control for GPU, virtualization, etc.

How does it work?
Copy-on-write storage

- Create a new machine instantly
  (Instead of copying its whole filesystem)
- Storage keeps track of what has changed
- Since 0.7, Docker has a storage plugin system

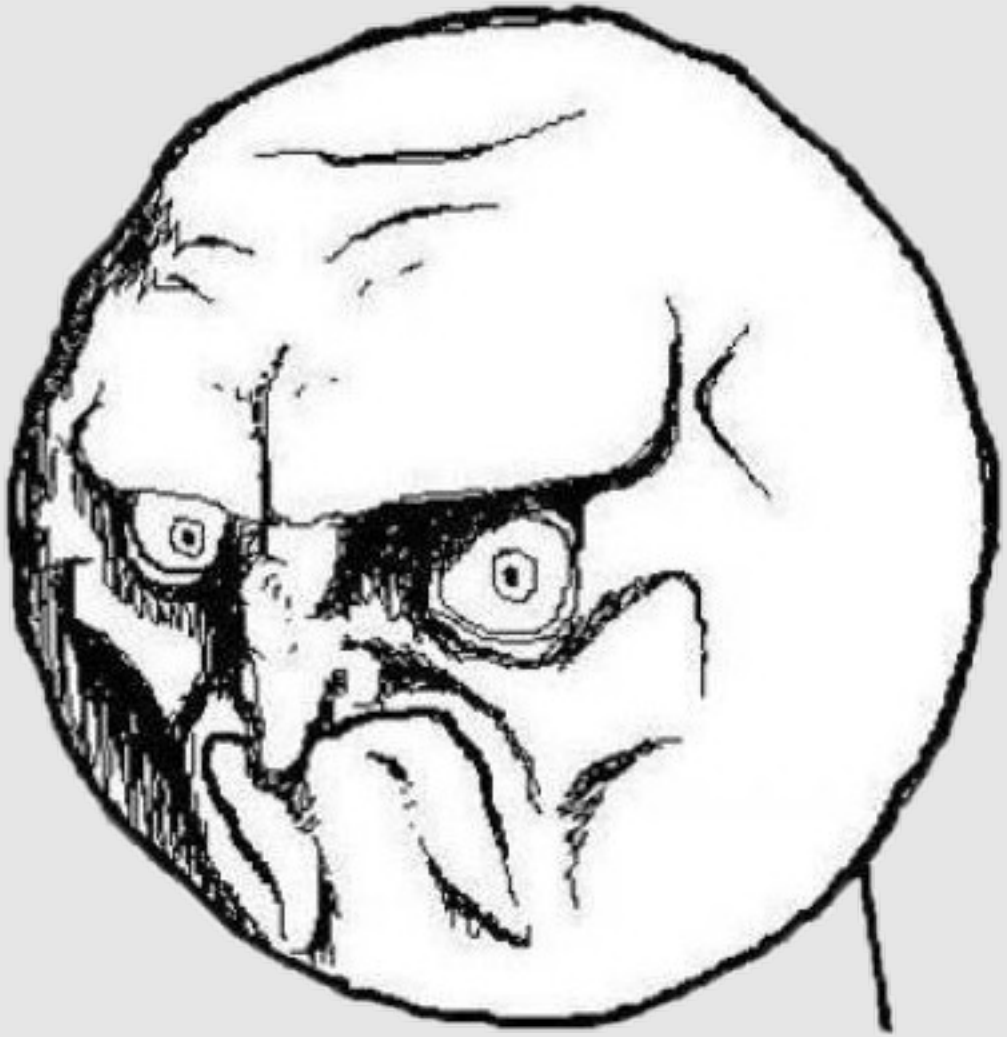
Storage: many options!

	Union Filesystems	Snapshotting Filesystems	Copy-on-write block devices
Provisioning	Superfast Supercheap	Fast Cheap	Fast Cheap
Changing small files	Superfast Supercheap	Fast Cheap	Fast Costly
Changing large files	Slow (first time) Inefficient (copy-up!)	Fast Cheap	Fast Cheap
Diffing	Superfast	Superfast	Slow
Memory usage	Efficient	Efficient	Inefficient (at high densities)
Drawbacks	Random quirks AUFS not mainline !AUFS more quirks	ZFS not mainline BTRFS not as nice	Higher disk usage Great performance (except diffing)
Bottom line	**Ideal for PAAS and high density things**	**This is the Future (probably)**	**Dodge Ram 3500**

Compute 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 performance
  = small overhead; can be reduced to zero

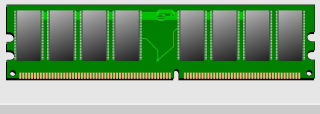
Alright, I get this.
Containers = nimble VMs.



NO.

The container metaphor

Problem: shipping goods

	?	?	?	?	?	?
	?	?	?	?	?	?
	?	?	?	?	?	?
	?	?	?	?	?	?
	?	?	?	?	?	?
	?	?	?	?	?	?
						

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Solution:
the *intermodal shipping container*

Solved!

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Problem: shipping code

	?	?	?	?	?	?
	?	?	?	?	?	?
	?	?	?	?	?	?
	?	?	?	?	?	?
	?	?	?	?	?	?
	?	?	?	?	?	?
						

Solution: the *Linux* container

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Solved!

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Separation of concerns: Dave the Developer

- inside my container:
  - my code
  - my libraries
  - my package manager
  - my app
  - my data

Separation of concerns: Oscar the Ops guy

- outside the container:
  - logging
  - remote access
  - network configuration
  - monitoring

Separation of concerns: what it *doesn't* mean

« I don't have to care »

≠

« I don't care »


DEV
VS
OPS
cars.com

Outline

- Why should I care?
- The container metaphor
- **Very quick demo**
- Working with Docker
- Building images
- Docker future

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docker

```
root@dockerhost:~#
```

Yes, but...

- « I don't need Docker;
  I can do all that stuff with LXC tools, rsync,
  and some scripts! »
- correct on all accounts;
  but it's also true for apt, dpkg, rpm, yum, etc.
- the whole point is to **commoditize**,
  i.e. make it ridiculously easy to use

What this really means…

- instead of writing « very small shell scripts » to manage containers, write them to do the rest:
  - continuous deployment/integration/testing
  - orchestration
- = use Docker as a building block
- re-use other people images (yay ecosystem!)

Docker-what?
The Big Picture

- Open Source engine to commoditize LXC
- using copy-on-write for quick provisioning
- allowing to **create and share** *images*
- **standard format** for containers
  (stack of layers; 1 layer = tarball+metadata)
- standard, *reproducible* way to *easily* build
  trusted images (Dockerfile, Stackbrew...)

Docker-what?
History

- rewrite of dotCloud internal container engine
  - original version: Python, tied to dotCloud PaaS
  - released version: Go, legacy-free
- remember SCALE11X talk about LXC?
  - Docker was announced one month later!

Docker-what?
Under the hood

- the Docker daemon runs in the background
  - manages containers, images, and builds
  - HTTP API (over UNIX or TCP socket)
  - embedded CLI talking to the API

Docker-what?
Take me to your dealer

- Open Source
  - GitHub public repository + issue tracking
    https://github.com/dotcloud/docker
- Nothing up the sleeve
  - public mailing lists (docker-user, docker-dev)
  - IRC channels (Freenode: #docker #docker-dev)
  - public decision process

Docker-what?
The ecosystem

- Docker Inc. (formerly dotCloud Inc.)
  - ~30 employees, VC-backed
  - SAAS and support offering around Docker
- Docker, the community
  - more than 300 contributors, 1500 forks on GitHub
  - dozens of projects around/on top of Docker
  - x100k trained developers

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One-time setup

- On your servers (Linux)
  - Packages (Ubuntu, Debian, Fedora, Gentoo, Arch...)
  - Single binary install (Golang FTW!)
  - Easy provisioning on Rackspace, Digital Ocean, EC2, GCE...
- On your dev env (Linux, OS X, Windows)
  - Vagrantfile
  - boot2docker (25 MB VM image)
  - Natively (if you run Linux)

The Docker workflow 1/2

- Work in dev environment
  (local machine or container)
- Other services (databases etc.) in containers
  (and behave just like the real thing!)
- Whenever you want to test « for real »:
  - Build in *seconds*
  - Run *instantly*

The Docker workflow 2/2

Satisfied with your local build?

- Push it to a *registry* (public or private)
- Run it (automatically!) in CI/CD
- Run it in production
- Happiness!

Something goes wrong? Rollback painlessly!

Outline

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Authoring images with run/commit

1) docker run ubuntu bash
2) apt-get install this and that
3) docker commit <containerid> <imagename>
4) docker run <imagename> bash
5) git clone git://.../mycode
6) pip install -r requirements.txt
7) docker commit <containerid> <imagename>
8) repeat steps 4-7 as necessary
9) docker tag <imagename> <user/image>
10) docker push <user/image>

Authoring images with run/commit

- Pros
  - Convenient, nothing to learn
  - Can roll back/forward if needed
- Cons
  - Manual process
  - Iterative changes stack up
  - Full rebuilds are boring, error-prone

Authoring images with a Dockerfile

```
FROM ubuntu

RUN apt-get -y update
RUN apt-get install -y g++
RUN apt-get install -y erlang-dev erlang-manpages erlang-base-hipe ...
RUN apt-get install -y libmozjs185-dev libicu-dev libtool ...
RUN apt-get install -y make wget

RUN wget http://.../apache-couchdb-1.3.1.tar.gz | tar -C /tmp -zxf-
RUN cd /tmp/apache-couchdb-* && ./configure && make install

RUN printf "[httpd]\nport = 8101\nbind_address = 0.0.0.0" >
    /usr/local/etc/couchdb/local.d/docker.ini

EXPOSE 8101
CMD ["/usr/local/bin/couchdb"]
```

docker build -t jpetazzo/couchdb .

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Authoring images with a Dockerfile

- Minimal learning curve
- Rebuilds are easy
- Caching system makes rebuilds faster
- Single file to define the whole environment!

Do you even Chef? Puppet? Ansible? Salt?

Docker and Puppet

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OUTATIME

Docker and Puppet

- Get a Delorean
- Warm up flux capacitors
- Time-travel to yesterday
- Check Brandon Burton's lightning talk
- Check my talk

— *Or* —

- Get the slides, ask questions ☺

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Outline

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- **Docker future**

Coming Soon

- Network acceleration
- Container-specific metrics
- Consolidated logging
- Plugins (compute backends...)
- Orchestration hooks

Those things are already possible,
but will soon be part of the core.

Docker 1.0

- Multi-arch, multi-OS
- Stable control API
- Stable plugin API
- Resiliency
- Signature
- Clustering

Recap

Docker:

- Is easy to install
- Will run anything, anywhere
- Gives you repeatable builds
- Enables better CI/CD workflows
- Is backed by a strong community
- Will change how we build and ship software

Thank you! Questions?

http://docker.io/

http://docker.com/

@docker

@jpetazzo

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