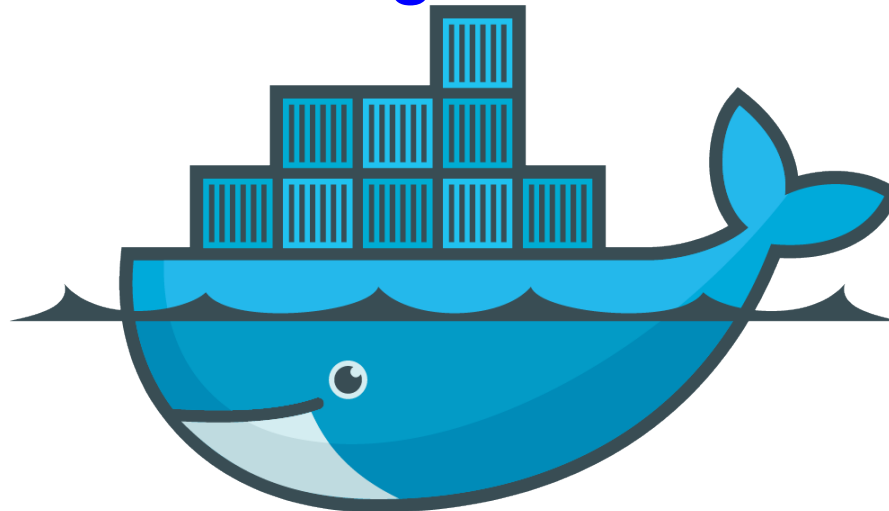


# Docker

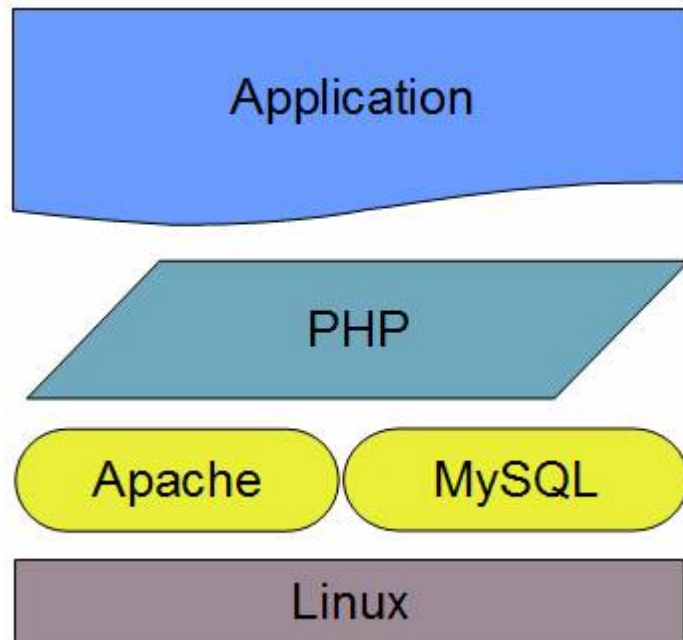
## Please contain your excitement

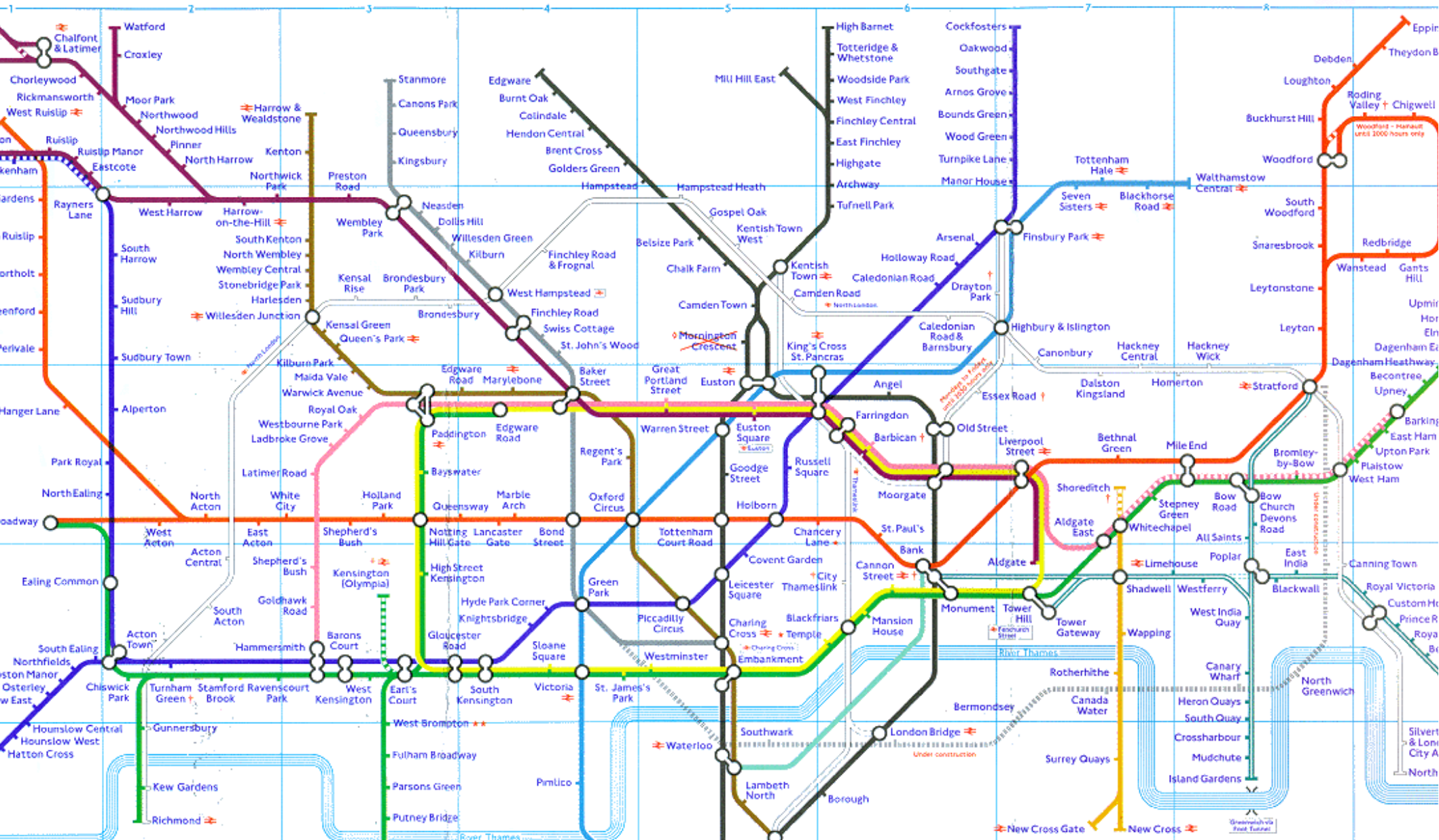
John Leach  
[john@brightbox.com](mailto:john@brightbox.com)  
[@johnleach](#)

Brightbox Cloud  
[www.brightbox.com](http://www.brightbox.com)









**Lines**

- Bakerloo
- Central
- Circle
- District
- East London
- Hammersmith & City
- Jubilee
- Metropolitan
- Northern
- Piccadilly
- Victoria
- Waterloo & City †
- Docklands Light Railway †
- British Rail

**Key to symbols**

- Interchange stations
- ≡ Connections with British Rail
- ≡ Connections with British Rail within walking distance
- ✚ Airport interchange
- ★ Closed Sundays
- ★ Closed Saturdays and Sundays
- ◊ Mornington Crescent closed for rebuilding

**These stations are open at the following times**

- Barbican** All day Mondays to Fridays 0715 to 2345 Saturdays, 0800 to 2345 Sundays.
- Cannon Street** Until 2045 Mondays to Fridays. Closed Saturdays and Sundays.
- Chigwell** Until 2000 daily.
- City Thameslink** 0600 to 2045 Mondays to Fridays. Closed Saturdays and Sundays.
- Docklands Light Railway** Poplar – Beckton, until 2130 Mondays to Fridays only. All stations between Tower Gateway, Bank, Stratford and Island Gardens, buses replace trains at day Saturdays and Sundays.
- Drayton Park** Until 2030 Mondays to Fridays. Closed Saturdays and Sundays.
- Essex Road** Until 2030 Mondays to Closed Saturdays and Sundays.
- Grange Hill** Until 2000 daily.
- Heathrow Terminal 4** Until 2345 Mondays to Saturdays and 0700 to 2030 Fridays, Saturdays and Sundays during Christmas.
- Roding Valley** Until 2000 daily.
- Shoreditch** Monday to Friday peak hours only. Closed Saturdays, 0800 to 1415 Sunday mornings and late evening Mondays to day Sundays.
- Waterloo & City Line** 0630 to 2130 Fridays, 0800 to 1345 Saturdays, 0800 to 2130 Sundays.

**Certain stations are closed on public holidays.**

**UNDERGROUND**

# Virtualisation

# Docker

# Linux Namespaces

**unshare command**



# Mount Namespace

```
root@dogen:~# ls /foo
root@dogen:~# unshare --mount bash
root@dogen:~# mount -n / /foo -o bind
root@dogen:~# ls /foo
bin    cdrom  etc    home    initrd.img.old  lib64  mnt    proc    run
boot  dev    foo    initrd.img  lib      media  opt    root    sbin
root@dogen:~# exit
root@dogen:~# ls /foo
root@dogen:~# █
```

# Network Namespace

```
root@dogen:~# ip link
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN mode DEFA
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
2: eth0: <NO-CARRIER,BROADCAST,MULTICAST,UP> mtu 1500 qdisc pfifo_fast state
    link/ether 3c:97:0e:92:d8:8a brd ff:ff:ff:ff:ff:ff
4: wlan0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP mode D
    link/ether 08:d4:0c:02:9e:00 brd ff:ff:ff:ff:ff:ff
5: docker0: <NO-CARRIER,BROADCAST,MULTICAST,UP> mtu 1500 qdisc noqueue state
    link/ether 56:84:7a:fe:97:99 brd ff:ff:ff:ff:ff:ff
8: tun1: <POINTOPOINT,MULTICAST,NOARP,UP,LOWER_UP> mtu 1350 qdisc pfifo_fast
    link/none
308: tun0: <POINTOPOINT,MULTICAST,NOARP,UP,LOWER_UP> mtu 1500 qdisc pfifo_fas
    link/none
317: wwan0: <BROADCAST,MULTICAST,NOARP> mtu 1500 qdisc noop state DOWN mode D
    link/ether fa:ef:c5:19:e3:57 brd ff:ff:ff:ff:ff:ff
root@dogen:~#
root@dogen:~#
root@dogen:~# unshare --net bash
root@dogen:~# ip link
1: lo: <LOOPBACK> mtu 65536 qdisc noop state DOWN mode DEFAULT group default
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
root@dogen:~# █
```

# Process Namespace

```
root@dogen:~# echo $$
19189
root@dogen:~# unshare --fork --pid --mount-proc bash
root@dogen:~# echo $$
1
root@dogen:~# ps auxf
USER      PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root         1  0.8  0.1  32188  10720 pts/14    S      11:38   0:00 bash
root        38  0.0  0.0   22644   2588 pts/14    R+     11:38   0:00 ps auxf
root@dogen:~# █
```

# UTS Namespace

```
root@dogen:~# uname -n
dogen
root@dogen:~# unshare --uts bash
root@dogen:~# hostname mycontainer
root@dogen:~# uname -n
mycontainer
root@dogen:~# exit
root@dogen:~# uname -n
dogen
root@dogen:~# █
```

# User Namespace

```
john@dogen:~$ unshare --user bash
nobody@dogen:~$ whoami
nobody
nobody@dogen:~$ id
uid=65534(nobody) gid=65534(nogroup) groups=65534(nogroup)
nobody@dogen:~$ echo $$
21522
```

```
john@dogen:~$ echo 0 1000 1 > /proc/21522/uid_map
john@dogen:~$ █
```

```
nobody@dogen:~$ whoami
root
nobody@dogen:~$ id
uid=0(root) gid=65534(nogroup) groups=65534(nogroup)
nobody@dogen:~$ █
```

# IPC Namespace

**cgroups**

# **Namespaces + cgroups**

How can we bring this all together?



# LXC – Linux Containers

```
root@srv-q0a9e:/root# lxc-create -t ubuntu -n ubuntu1
Checking cache download in /var/cache/lxc/utopic/rootfs-amd64 ...
Installing packages in template: ssh,vim,language-pack-en
Downloading ubuntu utopic minimal ...
I: Retrieving Release
I: Retrieving Release.gpg
I: Checking Release signature
I: Valid Release signature (key id 790BC7277767219C42C86F933B4FE6ACC0B21F32)
I: Retrieving Packages
I: Validating Packages
I: Retrieving Packages
I: Validating Packages
I: Resolving dependencies of required packages...
I: Resolving dependencies of base packages...
I: Found additional base dependencies: language-pack-en-base libck-connector0 libedit2 libgpm2 lib
1 libkrb5-3 libkrb5support0 libpython2.7 libpython2.7-minimal libpython2.7-stdlib libwrap0 openssh
rver vim-runtime
I: Checking component main on http://archive.ubuntu.com/ubuntu...
I: Retrieving adduser 3.113+nmu3ubuntu3
I: Validating adduser 3.113+nmu3ubuntu3
I: Retrieving apt 1.0.9.2ubuntu2
I: Validating apt 1.0.9.2ubuntu2
I: Retrieving apt-utils 1.0.9.2ubuntu2
I: Validating apt-utils 1.0.9.2ubuntu2
I: Retrieving base-files 7.2ubuntu7
I: Validating base-files 7.2ubuntu7
I: Retrieving base-passwd 3.5.36
I: Validating base-passwd 3.5.36
I: Retrieving bash 4.3-11ubuntu1
I: Validating bash 4.3-11ubuntu1
I: Retrieving bsutils 1:2.25.1-3ubuntu4
I: Validating bsutils 1:2.25.1-3ubuntu4
I: Retrieving busybox-initramfs 1:1.22.0-8ubuntu1
I: Validating busybox-initramfs 1:1.22.0-8ubuntu1
```

# Docker vs. LXC

What makes Docker different?

# Docker

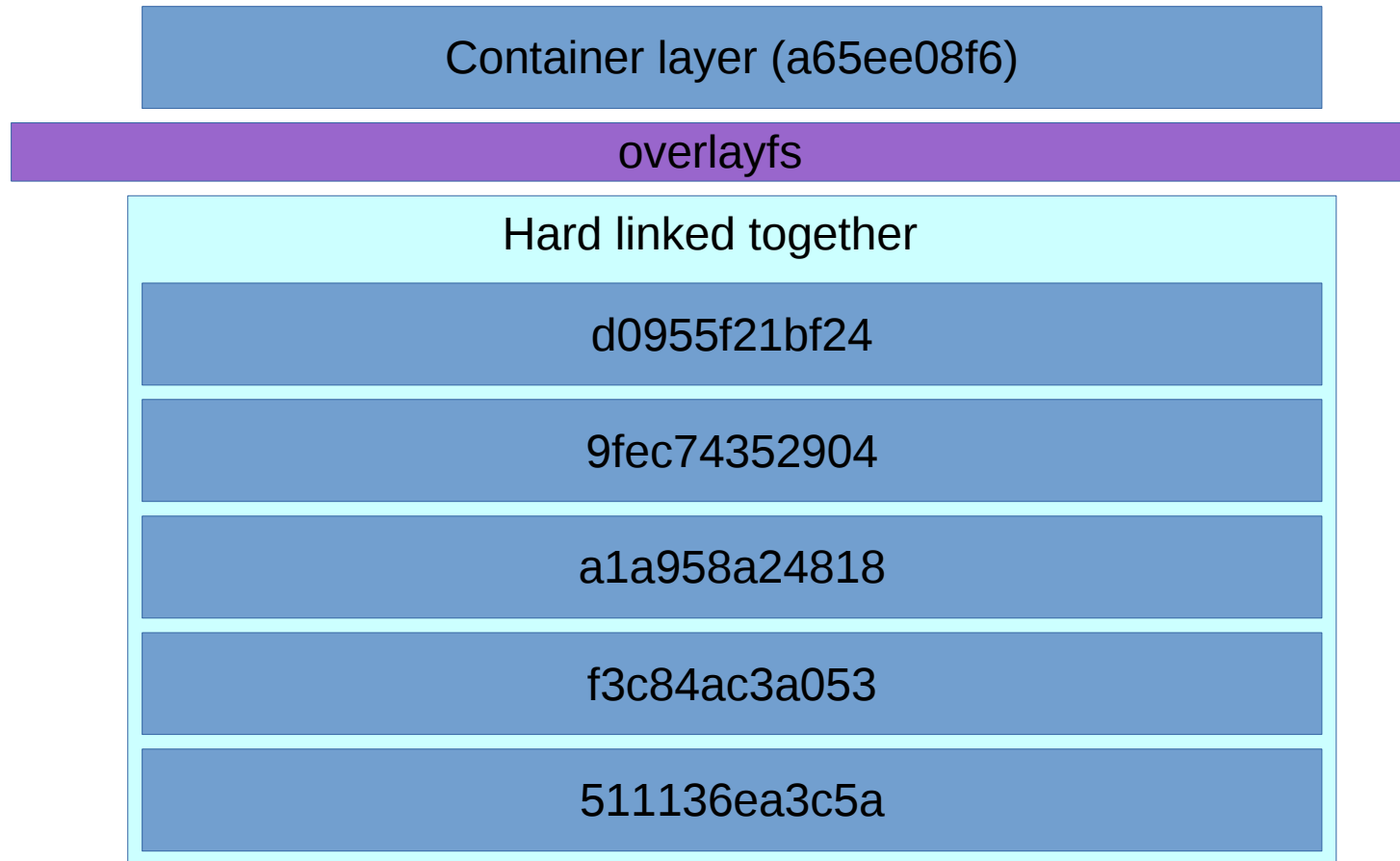
```
core@srv-7t29c ~ $ docker run -t -i ubuntu
Unable to find image 'ubuntu:latest' locally
511136ea3c5a: Pull complete
511136ea3c5a: Download complete
f3c84ac3a053: Download complete
a1a958a24818: Download complete
9fec74352904: Download complete
d0955f21bf24: Download complete
Status: Downloaded newer image for ubuntu:latest
root@a65ee08f6806:/# ps auxf
USER          PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root           1  0.0  0.3  18180  3408 ?        Ss   17:39   0:00 /bin/bash
root          18  0.0  0.2  15568  2184 ?        R+   17:42   0:00 ps auxf
root@a65ee08f6806:/# █
```

# Docker images

```
core@srv-7t29c ~ $ docker run -t -i ubuntu
Unable to find image 'ubuntu:latest' locally
511136ea3c5a: Pull complete
511136ea3c5a: Download complete
f3c84ac3a053: Download complete
a1a958a24818: Download complete
9fec74352904: Download complete
d0955f21bf24: Download complete
Status: Downloaded newer image for ubuntu:latest
root@a65ee08f6806:/# ps auxf
USER          PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root           1  0.0  0.3  18180  3408 ?        Ss   17:39   0:00 /bin/bash
root          18  0.0  0.2  15568  2184 ?        R+   17:42   0:00 ps auxf
root@a65ee08f6806:/# █
```

```
srv-7t29c docker # du -sh /var/lib/docker/overlay/*
8.0K    /var/lib/docker/overlay/511136ea3c5a64f264b78b5433614aec563103b4d4702f3ba7d4d2698e22c158
209M   /var/lib/docker/overlay/9fec74352904baf5ab5237caa39a84b0af5c593dc7cc08839e2ba65193024507
5.3M   /var/lib/docker/overlay/a1a958a248181c9aa6413848cd67646e5afb9797f1a3da5995c7a636f050f537
48K    /var/lib/docker/overlay/a65ee08f680611bdd8846d16a1ebf3495bb0cf2cf35549eea7b664efc357ffb1
40K    /var/lib/docker/overlay/a65ee08f680611bdd8846d16a1ebf3495bb0cf2cf35549eea7b664efc357ffb1-init
5.3M   /var/lib/docker/overlay/d0955f21bf24f5bffffd32d2d0bb669d0564701c271bc3dfc64cfc5adfdec2d07
5.5M   /var/lib/docker/overlay/f3c84ac3a0533f691c9fea4cc2ceAAF43baec22bf8d6a479e069f6d814be9b86
srv-7t29c docker # █
```

# Docker Images: Layers



# Container layers

```
core@srv-7t29c ~ $ docker diff a65ee08f6
C /root
A /root/.bash_history
core@srv-7t29c ~ $ sudo bash
srv-7t29c core # ls /var/lib/docker/overlay/a65ee08f6*/upper/root/ -lah
total 12K
drwx----- 2 root root 4.0K Mar 24 17:56 .
drwxr-xr-x 5 root root 4.0K Mar 24 17:39 ..
-rw----- 1 root root 8 Mar 24 17:56 .bash_history
srv-7t29c core # █
```

# docker commit

```
core@srv-7t29c ~ $ docker run -i -t ubuntu bash
root@f87ff71480e0:/# apt-get update -qq
root@f87ff71480e0:/# apt-get install -qq cowsay
Selecting previously unselected package cowsay.
(Reading database ... 11527 files and directories currently installed.)
Preparing to unpack .../cowsay_3.03+dfsg1-6_all.deb ...
Unpacking cowsay (3.03+dfsg1-6) ...
Setting up cowsay (3.03+dfsg1-6) ...
root@f87ff71480e0:/# exit
core@srv-7t29c ~ $ docker commit f87ff71480e0
5891ca42b6265ad41deadffc86c81e7cbcd30f66cef17d328ce64a3103faa8c0
core@srv-7t29c ~ $ docker tag 5891ca42b626 cowsay
core@srv-7t29c ~ $
```

# docker commit

```
core@srv-7t29c ~ $ docker images cowsay
REPOSITORY          TAG          IMAGE ID          CREATED
cowsay              latest      5891ca42b626     4 minutes ago
core@srv-7t29c ~ $
core@srv-7t29c ~ $ docker run cowsay /usr/games/cowsay go docker
_____
< go docker >
-----
      ^__^
      (oo)\_______
           (__)\       )\/\
                ||----w |
                ||     ||

core@srv-7t29c ~ $
```



# docker save

```
core@srv-7t29c ~ $ docker save -o cowsay-image.tar cowsay
core@srv-7t29c ~ $
core@srv-7t29c ~ $ mkdir cowsay && cd cowsay
core@srv-7t29c ~/cowsay $ tar xf ../cowsay-image.tar
core@srv-7t29c ~/cowsay $ find
.
./f3c84ac3a0533f691c9fea4cc2ceaaf43baec22bf8d6a479e069f6d814be9b86
./f3c84ac3a0533f691c9fea4cc2ceaaf43baec22bf8d6a479e069f6d814be9b86/layer.tar
./f3c84ac3a0533f691c9fea4cc2ceaaf43baec22bf8d6a479e069f6d814be9b86/VERSION
./f3c84ac3a0533f691c9fea4cc2ceaaf43baec22bf8d6a479e069f6d814be9b86/json
./511136ea3c5a64f264b78b5433614aec563103b4d4702f3ba7d4d2698e22c158
./511136ea3c5a64f264b78b5433614aec563103b4d4702f3ba7d4d2698e22c158/layer.tar
./511136ea3c5a64f264b78b5433614aec563103b4d4702f3ba7d4d2698e22c158/VERSION
./511136ea3c5a64f264b78b5433614aec563103b4d4702f3ba7d4d2698e22c158/json
./a1a958a248181c9aa6413848cd67646e5afb9797f1a3da5995c7a636f050f537
./a1a958a248181c9aa6413848cd67646e5afb9797f1a3da5995c7a636f050f537/layer.tar
./a1a958a248181c9aa6413848cd67646e5afb9797f1a3da5995c7a636f050f537/VERSION
./a1a958a248181c9aa6413848cd67646e5afb9797f1a3da5995c7a636f050f537/json
./9fec74352904baf5ab5237caa39a84b0af5c593dc7cc08839e2ba65193024507
./9fec74352904baf5ab5237caa39a84b0af5c593dc7cc08839e2ba65193024507/layer.tar
./9fec74352904baf5ab5237caa39a84b0af5c593dc7cc08839e2ba65193024507/VERSION
./9fec74352904baf5ab5237caa39a84b0af5c593dc7cc08839e2ba65193024507/json
./d0955f21bf24f5bffffd32d2d0bb669d0564701c271bc3dfc64cfc5adfdec2d07
./d0955f21bf24f5bffffd32d2d0bb669d0564701c271bc3dfc64cfc5adfdec2d07/layer.tar
./d0955f21bf24f5bffffd32d2d0bb669d0564701c271bc3dfc64cfc5adfdec2d07/VERSION
./d0955f21bf24f5bffffd32d2d0bb669d0564701c271bc3dfc64cfc5adfdec2d07/json
./5891ca42b6265ad41deadffc86c81e7cbcd30f66cef17d328ce64a3103faa8c0
```

# Dockerfile

```
FROM ubuntu
```

```
RUN apt-get update -qqy
```

```
RUN apt-get install -qqy cowsay
```

```
ENV MESSAGE "nothing to say"
```

```
CMD sh -c "/usr/games/cowsay $MESSAGE"
```

```
core@srv-7t29c ~/cowsay $ docker build .
Sending build context to Docker daemon 2.048 kB
Sending build context to Docker daemon
Step 0 : FROM ubuntu
----> d0955f21bf24
Step 1 : RUN apt-get update -qqy
----> Running in b2a4c5db8d0c
----> 1750b1fd3561
Removing intermediate container b2a4c5db8d0c
Step 2 : RUN apt-get install -qqy cowsay
----> Running in 3f77772d5145
debconf: unable to initialize frontend: Dialog
debconf: (TERM is not set, so the dialog frontend is not usable.)
debconf: falling back to frontend: Readline
debconf: unable to initialize frontend: Readline
debconf: (This frontend requires a controlling tty.)
debconf: falling back to frontend: Teletype
dpkg-preconfigure: unable to re-open stdin:
selecting previously unselected package cowsay.
(Reading database ... 11527 files and directories currently installed.)
Preparing to unpack ../cowsay_3.03+dfsg1-6_all.deb ...
Unpacking cowsay (3.03+dfsg1-6) ...
Setting up cowsay (3.03+dfsg1-6) ...
----> 7b3936a80d79
Removing intermediate container 3f77772d5145
Step 3 : ENV MESSAGE "Nothing to say"
----> Running in 9145c24c28c2
----> 158f2b92e533
Removing intermediate container 9145c24c28c2
Step 4 : CMD sh -c "/usr/games/cowsay $MESSAGE"
----> Running in 1639cda2f5ee
----> 68fcf7cffe61
Removing intermediate container 1639cda2f5ee
Successfully built 68fcf7cffe61
```

```
core@srv-7t29c ~/cowsay $ docker run 68fcf7cffe61
```

```
< Nothing to say >
```

```
-----  
  \  ^__^  
    (oo)\_____  
        (_____) )\/\  
            ||----w |  
            ||     ||
```

```
core@srv-7t29c ~/cowsay $ docker run -e MESSAGE="Hello world" 68fcf7cffe61
```

```
< Hello world >
```

```
-----  
  \  ^__^  
    (oo)\_____  
        (_____) )\/\  
            ||----w |  
            ||     ||
```

```
core@srv-7t29c ~/cowsay $ █
```

# docker push

```
core@srv-7t29c ~ $ docker tag 68fcf7cffe61 john1/cowsay
core@srv-7t29c ~ $ docker push john1/cowsay
The push refers to a repository [john1/cowsay] (len: 1)
Sending image list
Pushing repository john1/cowsay (1 tags)
511136ea3c5a: Image already pushed, skipping
f3c84ac3a053: Image already pushed, skipping
a1a958a24818: Image already pushed, skipping
9fec74352904: Image already pushed, skipping
d0955f21bf24: Image already pushed, skipping
1750b1fd3561: Image successfully pushed
7b3936a80d79: Image successfully pushed
158f2b92e533: Image successfully pushed
68fcf7cffe61: Image successfully pushed
Pushing tag for rev [68fcf7cffe61] on {https://cdn-registry-1
core@srv-7t29c ~ $ █
```

# docker pull

```
john@dogen:~$ docker pull john1/cowsay
Pulling repository john1/cowsay
68fcf7cffe61: Download complete
511136ea3c5a: Download complete
f3c84ac3a053: Download complete
a1a958a24818: Download complete
9fec74352904: Download complete
d0955f21bf24: Download complete
1750b1fd3561: Download complete
7b3936a80d79: Download complete
158f2b92e533: Download complete
Status: Downloaded newer image for john1/cowsay:latest
john@dogen:~$ docker run -e MESSAGE="welcome home" john1/cowsay
```

```
< welcome home >
```

```
-----
```

```
  \      ^__^
   (oo)\_____)
    (_____)  )\/\
              ||----w |
              ||     ||
```

```
john@dogen:~$ █
```

# mysql image

```
john@dogen:~$ docker run -e MYSQL_ROOT_PASSWORD=secret mysql
Running mysql_install_db ...
Installing MySQL system tables...2015-03-24 21:47:37 13 [Note] InnoDB:
2015-03-24 21:47:37 13 [Note] InnoDB: The InnoDB memory heap is disabled
2015-03-24 21:47:37 13 [Note] InnoDB: Mutexes and rw_locks use GCC atomic builtins
2015-03-24 21:47:37 13 [Note] InnoDB: Memory barrier is not used
2015-03-24 21:47:37 13 [Note] InnoDB: Compressed tables use zlib 1.2.7
2015-03-24 21:47:37 13 [Note] InnoDB: Using Linux native AIO
2015-03-24 21:47:37 13 [Note] InnoDB: Using CPU crc32 instructions
2015-03-24 21:47:37 13 [Note] InnoDB: Initializing buffer pool, size = 128M
2015-03-24 21:47:37 13 [Note] InnoDB: Completed initialization of buffer pool
2015-03-24 21:47:37 13 [Note] InnoDB: The first specified data file ./ibdata1 of size 12M
2015-03-24 21:47:37 13 [Note] InnoDB: Setting file ./ibdata1 size to 12M
2015-03-24 21:47:37 13 [Note] InnoDB: Database physically writes the file back to disk
2015-03-24 21:47:37 13 [Note] InnoDB: setting log file ./ib_logfile101 of size 10M
2015-03-24 21:47:37 13 [Note] InnoDB: setting log file ./ib_logfile1 of size 10M
```

# Networking

```
core@srv-7t29c ~ $ docker run -i -t ubuntu sh -c "ip addr ls dev eth0 | grep global"
    inet 172.17.0.56/16 scope global eth0
core@srv-7t29c ~ $ docker run -i -t ubuntu sh -c "ip addr ls dev eth0 | grep global"
    inet 172.17.0.57/16 scope global eth0
core@srv-7t29c ~ $ docker run -i -t ubuntu sh -c "ip addr ls dev eth0 | grep global"
    inet 172.17.0.58/16 scope global eth0
core@srv-7t29c ~ $ docker run -i -t ubuntu sh -c "ip addr ls dev eth0 | grep global"
    inet 172.17.0.59/16 scope global eth0
```



# Service discovery

```
core@srv-7t29c ~ $ docker run -t -i --link 3b0425eb9ca8:mysqlserver mysqlclient
root@1a5c813e0a0d:/# env | grep MYSQL
MYSQLSERVER_ENV_MYSQL_MAJOR=5.6
MYSQLSERVER_ENV_MYSQL_ROOT_PASSWORD=secret
MYSQLSERVER_PORT=tcp://172.17.0.62:3306
MYSQLSERVER_PORT_3306_TCP_PORT=3306
MYSQLSERVER_PORT_3306_TCP_PROTO=tcp
MYSQLSERVER_NAME=/clever_turing/mysqlserver
MYSQLSERVER_PORT_3306_TCP_ADDR=172.17.0.62
MYSQLSERVER_ENV_MYSQL_VERSION=5.6.23
MYSQLSERVER_PORT_3306_TCP=tcp://172.17.0.62:3306
root@1a5c813e0a0d:/# mysql -u root -p$MYSQLSERVER_ENV_MYSQL_ROOT_PASSWORD \
> -h mysqlserver
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 4
Server version: 5.6.23 MySQL Community Server (GPL)

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affiliates. Other names may be trademarks of their respective
owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

mysql> █
```

# Persistent storage with Volumes

```
core@srv-7t29c ~ $ mkdir mysqldata
core@srv-7t29c ~ $ docker run -d -e MYSQL_ROOT_PASSWORD=secret \
> -v /home/core/mysqldata:/var/lib/mysql mysql
8c977e958f1f66dc9f382691c74d4d4b6407ca8de2ee5d45e25b67bd769e2e8f
core@srv-7t29c ~ $ ls mysqldata
auto.cnf  ib_logfile0  ib_logfile1  ibdata1  mysql  performance_schema
core@srv-7t29c ~ $ █
```

# The unit of deployment

# The Future of Docker

# Docker

## Please contain your excitement

John Leach  
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[@johnleach](#)

Brightbox Cloud  
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