My name is Vova, and I`m a kubernetes admin ...

Practice Requirements

- AWS EC2
  - Frankfurt
  - Ubuntu Server 18.04 LTS (HVM)
  - t2.micro 1 instance
  - 1 Public IP
  - Security:
    - ssh from your public IP
    - 8080 http (tcp) from your public IP
  - Install Docker: snap install docker
  - *JFYI: ssh user: ubuntu, to become rootuse: “sudo su -”*

Lection 1: Container - What Are You?

Prepare: AWS, Frankfurt, Ubuntu 18.04 LTS, Docker: snap install docker; Public: ssh, 8080(tcp)

OS Level User Process Isolation

Became meaningful on multitasking introduction.

Initial low-level understanding:

Process isolation is a set of different hardware and software technologies[1] designed to protect each process from other processes on the operating system.

...

Security is easier to enforce by disallowing inter-process memory access, in contrast with less secure architectures such as DOS in which any process can write to any memory in any other process.

WIKI

Prepare: AWS, Frankfurt, Ubuntu 18.04 LTS, Docker: snap install docker; Public: ssh, 8080(tcp)

Unix/Linux Resource Isolation Tools History

1979 Unix
1982 BSD
(later on Linux - now not yet invented:)

Chroot

Substituting root point in file tree for process

2000 FreeBSD

Jails

2001 Linux

clear-cut separation between its services in “jails” own IP for each jail (processes in it)

2004 Solaris

vServer

Jail + resource partitioning for file systems, network addresses, memory

Containers

resource controls and boundary separation provided by zones snapshots, cloning from ZFS

2005 Linux

VPS buttle with KVM, Xen, VMWare

OpenVZ

Operating system-level virtualization: isolation, resource management (IPCs, devices) and checkpointing

2006 Linux

CGroup → 2008 Linux LXC →

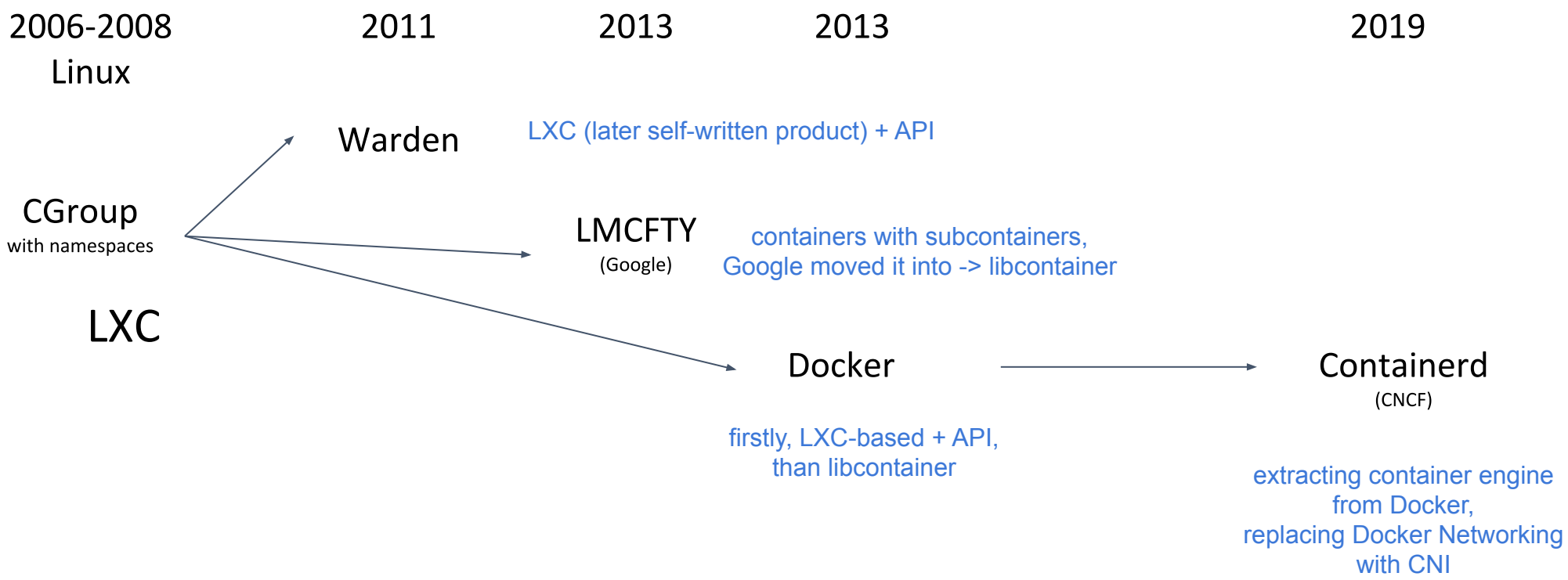
(Control Group by Google)

limiting, accounting and isolating resource usage (CPU, memory, disk I/O, network) of a collection of processes

\+ namespaces
\+ (1 more level of abstraction)

Prepare: AWS, Frankfurt, Ubuntu 18.04 LTS, Docker: snap install docker; Public: ssh, 8080(tcp)

Unix/Linux Resource Segregation ToolsHistory



Prepare: AWS, Frankfurt, Ubuntu 18.04 LTS, Docker: snap install docker; Public: ssh, 8080(tcp)

Chroot is The Father of Containers

Prepare: AWS, Frankfurt, Ubuntu 18.04 TLS, Docker: snap install docker; Public: ssh, 8080(tcp)

Docker: Beginnig

Hands On: Docker Run, Docker ps

```
# docker run centos echo "hello world"
hello world

# docker ps
CONTAINER ID        IMAGE               COMMAND             CREATED             STATUS              PORTS               NAMES

# docker ps -a
CONTAINER ID        IMAGE               COMMAND                  CREATED             STATUS                      PORTS    NAMES
08c65bc171c3        centos              "echo 'hello world'"     4 minutes ago       Exited (0) 4 minutes ago             boring_wiles

# docker ps -as
CONTAINER ID        IMAGE               COMMAND                  CREATED             STATUS                      PORTS    NAMES    SIZE
08c65bc171c3        centos              "echo 'hello world'"     4 minutes ago       Exited (0) 4 minutes ago             boring_wiles  0B (virtual
220MB)
```

If have created more than one - remove other by executing “docker rm” following by removing docker IDs:

```
# docker rm 1fcee9605349 08c65bc171c3
1fcee9605349
08c65bc171c3
```

Hands On: Docker start, image

```
# docker start 08c65bc171c3
08c65bc171c3

# docker ps
CONTAINER ID        IMAGE               COMMAND             CREATED             STATUS              PORTS               NAMES

# docker logs -f 08c65bc171c3
hello world
hello world

# docker image ls
REPOSITORY          TAG                 IMAGE ID            CREATED             SIZE
centos              latest              0f3e07c0138f        4 weeks ago         220MB

# docker image rm 0f3e07c0138f
Error response from daemon: conflict: unable to delete 0f3e07c0138f (must be forced) - image is being used by stopped container 08c65bc171c3
```

Hands on: Key Points

- If process(es) executed in Docker container are finished - docker container stopped.
- Stopped docker containers are not removed automatically - keeping tying Docker container Resources (image, logs, volumes etc.)
- So docker container could be started again referenced by docker ID or container name!

Hands On: -it, -d, exec

```
# docker run centos /bin/bash
# docker run -it centos /bin/bash
[root@b504891d0e11 /]# yum list rpm
…
[root@b504891d0e11 /]# exit
exit
# docker ps
CONTAINER ID        IMAGE               COMMAND             CREATED             STATUS              PORTS               NAMES

# docker run -d centos /bin/bash
#
b504891d0e114152980bb3dc300f6110f8860b083f8b7d32ecfaca95859ded91
# docker ps
CONTAINER ID        IMAGE               COMMAND             CREATED             STATUS              PORTS               NAMES
b504891d0e11        centos              "sleep 1200"        9 minutes ago       Up 9 minutes                            nifty_sammet

# docker exec -it b504891d0e11 /bin/bash
[root@b504891d0e11 /]# ps -aux
USER        PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root          1  0.0  0.1  23024  1380 ?        Ss   11:28   0:00 /usr/bin/coreutils --coreutils-prog-shebang=sleep /usr/bin/sleep 1200
root         21  6.3  0.3  12028  3224 pts/0    Ss   11:37   0:00 /bin/bash
root         34  0.0  0.3  46340  3248 pts/0    R+   11:37   0:00 ps -aux
```

Hands On Key Points

Containers:

- Containers are made to run application(s) inside them. No app running - container stopping.
- Containers allow to start on same host in different containers code with unexpected or conflicting dependencies
- What has happened in container stays in container.

Docker:

- docker simplifies log handling: just redirect all your app logs to STDOUT (standard output) - dockerd catches this and stored as log for this container

Linux Namespaces

Namespace - it`s context separation of resource management.

Now Linux kernel support 7 such types of separated contexts:

- Cgroups, IPC, Network, Mount, PID, User, UTS

Visualize namespaces for some process:

```
# ls -l /proc/2068/ns
total 0
lrwxrwxrwx 1 root root 0 Nov  2 23:15 cgroup -> 'cgroup:[4026531835]'
lrwxrwxrwx 1 root root 0 Nov  2 23:15 ipc -> 'ipc:[4026532229]'
lrwxrwxrwx 1 root root 0 Nov  2 23:15 mnt -> 'mnt:[4026532227]'
lrwxrwxrwx 1 root root 0 Nov  2 23:11 net -> 'net:[4026532232]'
lrwxrwxrwx 1 root root 0 Nov  2 23:15 pid -> 'pid:[4026532230]'
lrwxrwxrwx 1 root root 0 Nov  2 23:15 pid_for_children -> 'pid:[4026532230]'
lrwxrwxrwx 1 root root 0 Nov  2 23:15 user -> 'user:[4026531837]'
lrwxrwxrwx 1 root root 0 Nov  2 23:15 uts -> 'uts:[4026532228]'
```

Create namespace forresource: unshare -u <binary> (u - UTS)

Docker Processes From Outside

Hipster Docker:

```
# docker ps
CONTAINER ID        IMAGE               COMMAND                  CREATED             STATUS              PORTS               NAMES
3cde514a5a0a        nginx               "nginx -g 'daemon of…"   3 minutes ago       Up 3 minutes        80/tcp              xenodochial_curie
31eab20249db        centos              "sleep 1200"             40 minutes ago      Up 40 minutes                           stupefied_bohr

# ps -ax --forest
...
    1 ?        Ss     0:03 /sbin/init
...
 2129 ?        Ssl    0:25 dockerd -G docker --exec-root=/var/snap/docker/384/run/docker --data-root=/var/snap/docker/common/var-lib-docker --pidfile=/var/snap
 2205 ?        Ssl    0:06  \_ docker-containerd --config /var/snap/docker/384/run/docker/containerd/containerd.toml
 8008 ?        Sl     0:00      \_ docker-containerd-shim -namespace moby -workdir /var/snap/docker/common/var-lib-docker/containerd/daemon/io.containerd.runti
 8030 ?        Ss     0:00      |   \_ /usr/bin/coreutils --coreutils-prog-shebang=sleep /usr/bin/sleep 1200
 9925 pts/0    Ss+    0:00      |   \_ /bin/bash
 9658 ?        Sl     0:00      \_ docker-containerd-shim -namespace moby -workdir /var/snap/docker/common/var-lib-docker/containerd/daemon/io.containerd.runti
 9685 ?        Ss     0:00          \_ nginx: master process nginx -g daemon off;
 9723 ?        S      0:00              \_ nginx: worker process
```

Docker versus LXContainer

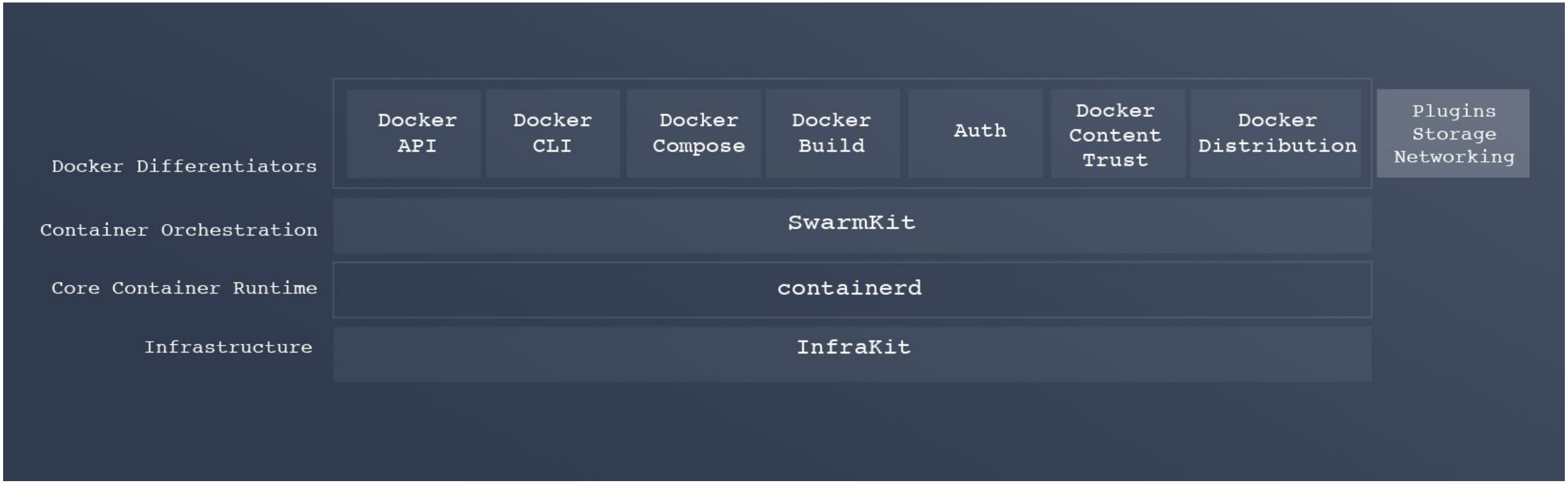
Hipster Docker:

```
    1 ?        Ss     0:03 /sbin/init
...
 2129 ?        Ssl    0:24 dockerd -G docker --exec-root=/var/snap/docker/384/run/docker --data-root=/var/snap/docker/common/var-lib-docker --pidfile=/var/snap
 2205 ?        Ssl    0:06  \_ docker-containerd --config /var/snap/docker/384/run/docker/containerd/containerd.toml
 9658 ?        Sl     0:00      \_ docker-containerd-shim -namespace moby -workdir /var/snap/docker/common/var-lib-docker/containerd/daemon/io.containerd.runti
 9685 ?        Ss     0:00          \_  nginx: master process nginx -g daemon off;
 9723 ?        S      0:00              \_  nginx: worker process
```

True LXC:

```
    1 ?        Ss     0:03 /sbin/init
...
 5495 ?        Ss     0:00  [lxc monitor] /var/lib/lxc nginx
 5512 ?        Ss     0:00  \_  /sbin/init
 5571 ?        S<s    0:00      \_ /lib/systemd/systemd-journald
 5576 ?        Ss     0:00      \_ /lib/systemd/systemd-networkd
 5605 ?        Ss     0:00      \_ /lib/systemd/systemd-resolved
 5606 ?        Ss     0:00      \_ /lib/systemd/systemd-logind
 5607 ?        Ssl    0:00      \_ /usr/bin/python3 /usr/bin/networkd-dispatcher --run-startup-triggers
 5608 ?        Ss     0:00      \_ /usr/bin/dbus-daemon --system --address=systemd: --nofork --nopidfile --systemd-activation --syslog-only
 5609 ?        Ssl    0:00      \_ /usr/sbin/rsyslogd -n
 5610 ?        Ss     0:00      \_ /usr/sbin/cron -f
 5613 pts/8    Ss+    0:00      \_ /sbin/agetty -o -p -- \u --noclear --keep-baud console 115200,38400,9600 vt220
 5614 pts/0    Ss+    0:00      \_ /sbin/agetty -o -p -- \u --noclear --keep-baud pts/0 115200,38400,9600 vt220
 5615 pts/1    Ss+    0:00      \_ /sbin/agetty -o -p -- \u --noclear --keep-baud pts/1 115200,38400,9600 vt220
 5616 pts/2    Ss+    0:00      \_ /sbin/agetty -o -p -- \u --noclear --keep-baud pts/2 115200,38400,9600 vt220
 5617 pts/3    Ss+    0:00      \_ /sbin/agetty -o -p -- \u --noclear --keep-baud pts/3 115200,38400,9600 vt220
 5622 ?        Ss     0:00      \_  nginx: master process /usr/sbin/nginx -g daemon on; master_process on;
 5623 ?        S      0:00          \_  nginx: worker process
 5624 ?        S      0:00          \_  nginx: worker process
 5625 ?        S      0:00          \_  nginx: worker process
 5626 ?        S      0:00          \_  nginx: worker process
```

Nowdays Docker Structure



Microservice Architecture Concept

What Mean Microservice

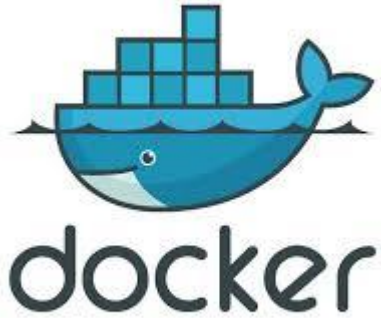
- Microservices are a software development technique —a variant of the service-oriented architecture (SOA) structural style— that arranges an application as a collection of loosely coupled services.[1] In a microservices architecture, services are fine-grained and the protocols are lightweight. [Wiki]

- For instance, Amazon's policy is that the team implementing a microservice should be small enough that they can be fed by two pizzas. [some more Wiki]

Microservice by Microservice.io

Microservices - also known as the microservice architecture - is an architectural style that structures an application as a collection of services that are

- Highly maintainable and testable
- Loosely coupled
- Independently deployable
- Organized around business capabilities
- Owned by a small team



The microservice architecture enables the rapid, frequent and reliable delivery of large, complex applications. It also enables an organization to evolve its technology stack.

Application Into Docker

Pushing App Into Containers

Ways how to put your app into container:

1. Take a look around - possibly someone already done this. Docker Hub.
2. Start container, add your code into it, commit. Docker image.
3. Build container with your code from scratch. Dockerfile.
4. If your app code is changed during execution OR/AND logic is not separated from data OR/AND you just don`t want to put it into container but should - use volumes.

1. Docker Hub

1. Official Docker Repo
2. Image could be both pulled and pushed to.
3. Free for some size.

To pull image:

```
# docker pull ubuntu:19.10
```

Running container from not pulled image automatically pulls it:

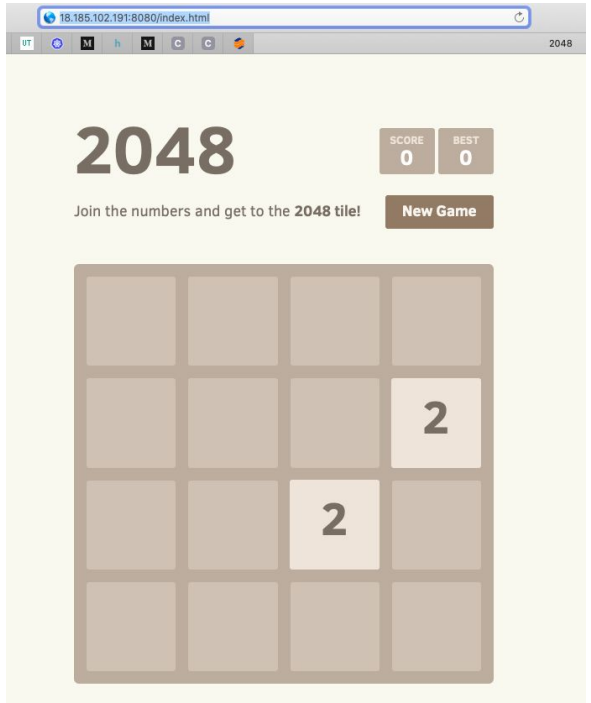
```
# docker run -d --name daydreaming_newton nginx
Unable to find image 'nginx:latest' locally
latest: Pulling from library/nginx
8d691f585fa8: Pull complete
5b07f4e08ad0: Pull complete
abc291867bca: Pull complete
Digest: sha256:922c815aa4df050d4df476e92daed4231f466acc8ee90e0e774951b0fd7195a4
Status: Downloaded newer image for nginx:latest
b28340a80ba178ace4bcd59fa153a7fc149743a340d9cf19db543f8f220274b8
```

2. Hands On: Docker COPY, Commit

```
# docker run -d -p 8080:80 nginx
1fbe97d9c731.......

# git clone https://github.com/gabrielecirulli/2048.git
# cd 2048/; docker cp ./ 1fbe97d9c731:/usr/share/nginx/html
```

http://18.185.102.191:8080/index.html




```
# docker image ls
nginx          latest          2622e6cca7eb      10 days ago       132MB

# docker ps -s
#docker commit a45630804dc1
sha256:a53cd93bc1b89232c6ecf91eb50a22320fca5183e76df5453e8768148cee7e15

# docker image ls
REPOSITORY      TAG             IMAGE ID        CREATED           SIZE
<none>          <none>          a53cd93bc1b8    About a minute ago   133MB
nginx           latest          2622e6cca7eb    10 days ago       132MB
#docker stop 1fbe97; docker run -p 8080:80 -d a53cd93bc1b8
```

3. Hands On: Dockerfile

```
# mkdir docker; git clone https://github.com/gabrielecirulli/2048.git docker/2048; vim Dockerfile
```

```
FROM nginx
COPY 2048/ /usr/share/nginx/html/
```

```
~/docker# docker build ./ -t 2048game
Sending build context to Docker daemon  1.346MB
Step 1/2 : FROM nginx
 ---> 540a289bab6c
Step 2/2 : COPY 2048/ /usr/share/nginx/html/
 ---> 960c02a8cf80
Successfully built 960c02a8cf80
Successfully tagged 2048game:latest

~/docker# docker image ls
REPOSITORY          TAG                 IMAGE ID            CREATED             SIZE
2048game            latest              0bc5c1e414d8        13 seconds ago      133MB
<none>              <none>              a53cd93bc1b8        14 minutes ago      133MB
nginx               latest              2622e6cca7eb        11 days ago         132MB

# docker run -p 8080:80 -d 0bc5c1e414d8
```

3. Docker Image Layers

~/docker# docker image ls

```
REPOSITORY      TAG          IMAGE ID       CREATED          SIZE
2048game        latest       cbc77a65d75a   13 seconds ago   133MB
<none>          <none>       05b3d60c717d   14 minutes ago   133MB
nginx           latest       2622e6cca7eb   11 days ago      132MB
```

~/docker# docker image inspect cbc77a65d75a

```
...
      "RootFS": {
         "Type": "layers",
         "Layers": [
            "sha256:13cb14c2acd3...",
            "sha256:d4cf327d8ef50...",
            "sha256:7c7d7f446182...",
            "sha256:9040af41bb66...",
            "sha256:f978b9ed3f26a...",
            "sha256:61fe62a4f2901.."
         ]
      },
...
```

~/docker# docker image inspect 05b3d60c717d

```
...
      "RootFS": {
         "Type": "layers",
         "Layers": [
            "sha256:13cb14c2acd3...",
            "sha256:d4cf327d8ef50...",
            "sha256:7c7d7f446182...",
            "sha256:9040af41bb66...",
            "sha256:f978b9ed3f26a...",
            "sha256:85fc12c04ec79..."
         ]
      },
```

 # docker ps -as

CONTAINER ID	IMAGE	COMMAND	CREATED	STATUS	PORTS	NAMES	SIZE
4c11769c2cf6	nginx	"/docker-entrypoint.…"	4 minutes ago	Exited (0) 8 seconds ago		thirsty_meitner	1.29MB (virtual 133MB)

Image: Layers, Dockerfile

Docker images are layered.
Hash of each layer includes files changes made before layer is finished and semi-hash from previous layers.

1 commit = 1 layer
1 line of Dockerfile = 1 Layer

```
FROM ubuntu:18.04
VOLUME /app
VOLUME /data
ENV TZ=Europe/Kiev
RUN apt-get update && apt-get install --no-install-recommends --no-install-suggests -y git python3 python3-pip python3-setuptools python3-dev python3-psycopg2
RUN pip3 install mysql-connector pyyaml
RUN pip3 install docker-py
RUN pip3 install psycopg2
COPY ./app/ /app/
CMD /app/cycle.sh
```

Put upper basic non frequently changed parts

Put at the end more frequently changed parts

4. Hands On: Docker Volumes

Volume in Docker is looking like mount -bind directory.

```
~# docker ps -as
...
~# mkdir -p registry-storage;
~# docker run -d -p 5000:5000 -v registry-storage:/var/lib/registry registry:2
dee2ac82f8ff9896987059f64f4a6dc25e5cbe998417f5ba2ff77f6d7f980b9e

~# docker volume ls
DRIVER          VOLUME NAME
local           412b07e4ecf7c735e128458b33c3dd16735c66d0a799dbee5dd1da211740aeb0
local           85cb4930feab7b2663b5846a87e0adcf05f6ca0763c42ce34fb77e5e2f52fafd
local           9e698b47f5a2e24514418514fdec4deb60cac5bf4433689209d87bc5a15ef4ca
local           registry-storage
```

If volume declared in Dockerfile and not mounted on start - Docker automatically creates volume on write access to declared Volume mount point.

```
FROM ubuntu:18.04
VOLUME /app
```

Volumes could be mounted from outside using drivers like NFS. And same volume could be mounted to more than on Docker container!

Hands On: Docker App Distributing, Tag, Registry

Tagging is advertised for images management

Docker Registry - your own Docker Hub.

```
~# docker ps | grep registry
dee2ac82f8ff       registry:2        "/entrypoint.sh /etc…"   2 minutes ago      Up 2 minutes       0.0.0.0:5000->5000/tcp   nervous_kare
```

Docker Tag, Push

```
~# docker tag a53cd93bc1b8 2048game:v01
~# docker tag a53cd93bc1b8 localhost:5000/2048game:v01
~# docker image ls
REPOSITORY          TAG             IMAGE ID         CREATED          SIZE
2048game            latest          0bc5c1e414d8     11 hours ago     126MB
2048game            v01             a53cd93bc1b8     12 hours ago     128MB
localhost/2048game  v01             a53cd93bc1b8     12 hours ago     128MB

~# docker push localhost:5000/2048game:v01
The push refers to repository [localhost:5000/2048game]
c64aa9c614dd: Pushed
a89b8f05da3a: Pushed
6eaad811af02: Pushing [==========================>                ]  29.77MB/56.98MB
b67d19e65ef6: Pushing [===================>                       ]  26.54MB/69.23MB
```

Hands on: Basic Docker Networking

Exposing a port (making it available - doesn`t mean forwarding is working)

```
FROM ubuntu:18.04
RUN apt-get update; apt-get install nginx
EXPOSE 80
```

Forwarding a port

```
#  docker run -d -p 8080:80 --name nginx nginx
c2fcf6b9017b47ffd45d774697ba350f23cc972065b911e8711a096569c196c1
# docker ps
CONTAINER ID        IMAGE               COMMAND                  CREATED             STATUS              PORTS                   NAMES
c2fcf6b9017b        nginx               "nginx -g 'daemon of…"   3 seconds ago       Up 2 seconds        0.0.0.0:8080->80/tcp    nginx
```

Available 3 types of Docker networking:

1) To docker default bridge (default behaviour, worked because Docker running DHCP)
2) Docker to physical interface
3) Docker without network (unmapped)

Docker Networking: iptables, bridging

```
~# brctl show docker0
bridge name  bridge id        STP enabled interfaces
docker0      8000.0242827baa10   no          vetheb31987

~# iptables -vnL -t nat
…

~# iptables -vnL
…
```

What Makes Docker in Containers a Xerox in Copy Machines

Out of the box:

- simple networking (automation of bridging, iptables*)
- Dockerfiles (from code management point of view)
- encapsulating code into images
- dockerd adoption of images on different systems
- cool layering of images
- containers distributing hub (global and local)
- volumes (shared folders)
- simplified logging.

Next Sections

Section 2. Docker: something from under the hood

- Dockerbuild file: more options, more pain.
- More than 1 App Achievements:
  - Environment Variables, Secrets; Volumes sharing;
  - Docker Link.
- Docker Networking;

Section 3. Kuber: beginning

- Microservice App Achievements
  - App Upstart Dependencies;
  - Service Discovery;
  - DNSing.
- Docker Compose.
- Docker Swarm.
- Kuber: Docker ambitions cutter.
- Container.d: Docker dissolver.

Howe Work 1

Home Task: https://github.com/ask4ua/DKN/blob/master/Hometask/Section1/README.md

Email: volodymyr.volkov@globallogic.com

Deadline: 1 week - Next Friday

Q&A

Section 2: Docker: More From Under The Hood.

Practice Requirements

- AWS EC2
  - Frankfurt
  - Ubuntu Server 18.04 LTS (HVM)
  - t2.micro 1 instance
  - 1 Public IP
  - Security:
    - ssh from your public IP
    - 80,8080 http (tcp) from your public IP
  - Install Docker: snap install docker
  - *JFYI: ssh user: ubuntu*

Docker Networking

Type	Docker run Option	How it works	Peculiarities
Hosted	--net=host	Mapping all hypervisor interfaces into container (same network namespace from host referenced into container ns)	If container not priveleged - only could occupy free ports on iface. If privileged - all could be done including changing ifaces IPs
None	--net=none	No network interfaces created inside container.	But dedicated namespace still created on start (at least was so)
Default: bridged + private networks	<nothing> + --net=somenetname	(mostly named docker0)	Private Networks organized by internal Docker DNS on 127.0.0.11 address and iptables.
Mapped from another container		All interfaces (namespaces) from one container reused in another - like in Hosted Type	Different containers could communicate with each other trough any IP/iface - even through 127.0.0.1. Ports shouldn`t override

Hands On: Docker Networking Hosted

in hypervisor:

:$ ip addr

```
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    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
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 9001 qdisc fq_codel state UP group default qlen 1000
    link/ether 06:2c:a5:cc:29:00 brd ff:ff:ff:ff:ff:ff
    inet 172.31.40.231/20 brd 172.31.47.255 scope global dynamic eth0
       valid_lft 3163sec preferred_lft 3163sec
    inet6 fe80::42c:a5ff:fecc:2900/64 scope link
       valid_lft forever preferred_lft forever
3: docker0: <NO-CARRIER,BROADCAST,MULTICAST,UP> mtu 1500 qdisc noqueue state DOWN group default
    link/ether 02:42:2e:e7:33:cd brd ff:ff:ff:ff:ff:ff
    inet 172.17.0.1/16 brd 172.17.255.255 scope global docker0
       valid_lft forever preferred_lft forever
```

:$ docker run -it --rm --net=host centos /bin/bash

/$ ip addr

/$ ip addr add 10.0.0.1/24 dev eth0

RTNETLINK answers: Operation not permitted

Hands On: Docker Networking None

```
:$  docker run -it --rm --net=none centos /bin/bash

/$ ip addr

1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
   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
```

Hands On: Docker Bridged

```
:$ ip addr show docker0
3: docker0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP group default
    link/ether 02:42:2e:e7:33:cd brd ff:ff:ff:ff:ff:ff
    inet 172.17.0.1/16 brd 172.17.255.255 scope global docker0
       valid_lft forever preferred_lft forever
    inet6 fe80::42:2eff:fee7:33cd/64 scope link
       valid_lft forever preferred_lft forever

:$ docker run -it --rm centos /bin/bash
[root@60dcba2e9635 /]# ip addr show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    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
11: eth0@if12: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP group default
    link/ether 02:42:ac:11:00:02 brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 172.17.0.2/16 brd 172.17.255.255 scope global eth0
       valid_lft forever preferred_lft forever
```

Dockerfile - More Options

```
FROM openjdk:8-jdk-stretch
...
RUN apt-get update && apt-get upgrade -y && apt-get install -y ... && rm -rf ...
...
ARG user=jenkins
...
ENV JENKINS_HOME $JENKINS_HOME
...
RUN mkdir -p $JENKINS_HOME \
 && useradd -d "$JENKINS_HOME" -u ${uid} -g ${gid} -m -s /bin/bash ${user}
...
VOLUME $JENKINS_HOME
...
EXPOSE ${http_port}
...
USER ${user}
...
ENTRYPOINT ["/sbin/tini", "--", "/usr/local/bin/jenkins.sh"]
...
COPY install-plugins.sh /usr/local/bin/install-plugins.sh
ADD https://some.git.url
```

RUN - execute command inside container during building the image

ARG - local for dockerfile variable useful and overridable only in“docker build”, refrencable with ${ARG name}.

ENV - advertisese variable injected into Environment Variables in container by container start, overridable in “docker run”

VOLUME - creating directory that could be referenced in docker run command as volume mounting point by name (without full path).

EXPOSE - port container advertised to outside (needed for iptables auto-rules adding), mapping to real port is run option

USER - container will be executed as process of defined user

ENTRYPOINT, CMD - both could set binary/script started on container start, more details on the next slide

COPY - copy, path os source from building directory
ADD - enhanced COPY, supporting wildcards, --chown and URLs

Feel free to extend your knowledges with: https://docs.docker.com/engine/reference/builder/

Dockerfile - ENTRYPOINT, CMD

ENTRYPOINT, CMD - why 2 options to set an upstart command?

ENTRYPOINT - purposed to define binary for process #1 in container, if used - CMD is referred as it`s parameters. Could be overridden with --entrypoint option on start.

CMD - purposed to be redfinable on container start, set by the command in run line after image name: `docker run -it centos /bin/bash`. If used without ENTRYPOINT - substitute one.

Docker container goal	Dockerfile	docker run command	Executed on upstart script
Show time -no input options	FROM ubuntu ENTRYPOINT date	docker run date	/bin/sh date
		docker run date +%Z	/bin/sh date
	FROM ubuntu ENTRYPOINT [‘date’]	docker run date	date
Show time - options eligible and overridable	FROM ubuntu ENTRYPOINT [‘date’] CMD [‘+%A’]	docker run date	date +%A
		docker run date +%Y	date +%Y
Show time - run script overridable	FROM ubuntu CMD date	docker run date	/bin/sh date
		docker run /bin/bash	/bin/bash

Dockerfile - FROM

FROM could use not just some image from repository but also:

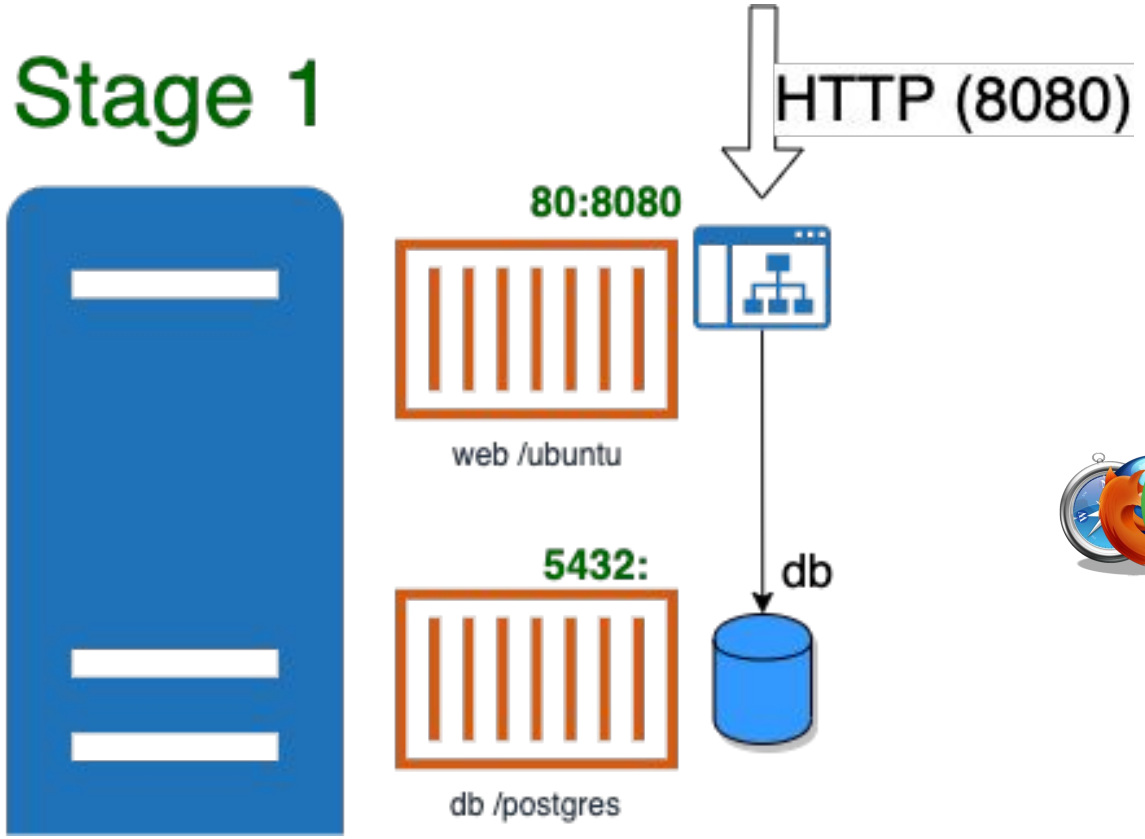
- defined "from scratch" for minimal images,
- use artifacts from intermediate image constructed in the same manifest - named as multistage

```
FROM scratch
COPY hello /
CMD ["/hello"]
```

```
FROM golang:1.7.3 AS builder
WORKDIR /go/src/github.com/alexellis/href-counter/
RUN go get -d -v golang.org/x/net/html
COPY app.go    .
RUN CGO_ENABLED=0 GOOS=linux go build -a -installsuffix cgo -o app .

FROM alpine:latest
RUN apk --no-cache add ca-certificates
WORKDIR /root/
COPY --from=builder /go/src/github.com/alexellis/href-counter/app .
CMD ["./app"]
```

Hands On: Small Web App With DB, Stage 1




```
:$ git clone https://github.com/ask4ua/DKN
:$ docker network create mynet

Stage1/web:$ docker build ./ -t web
Stage1/web:$ docker run -p 8080:80 -d --name web --net mynet web

Stage1/db:$ docker build ./ -t db
Stage1/db:$ docker run  -d --name db --net mynet db
```

Serving host ec99fa097683

Time: 2019-11-08 17:41:29

Accessed path: /

Writing to DB status: Fail

Hands On: Docker Limitations

Docker Doesn`t Containers Upstart Dependedencies

```
:$ docker logs -f web
Mon Jul 13 15:33:58 2020 webapp: HTTP Server Starts
Mon Jul 13 15:33:58 2020 webapp: Initiating connection to DB

DB ERROR: Something is wrong in connecting to DB: could not translate host name "db" to address: Temporary failure in name resolution

:$ docker stop web
:$ docker start web
```

Docker Bridged --net

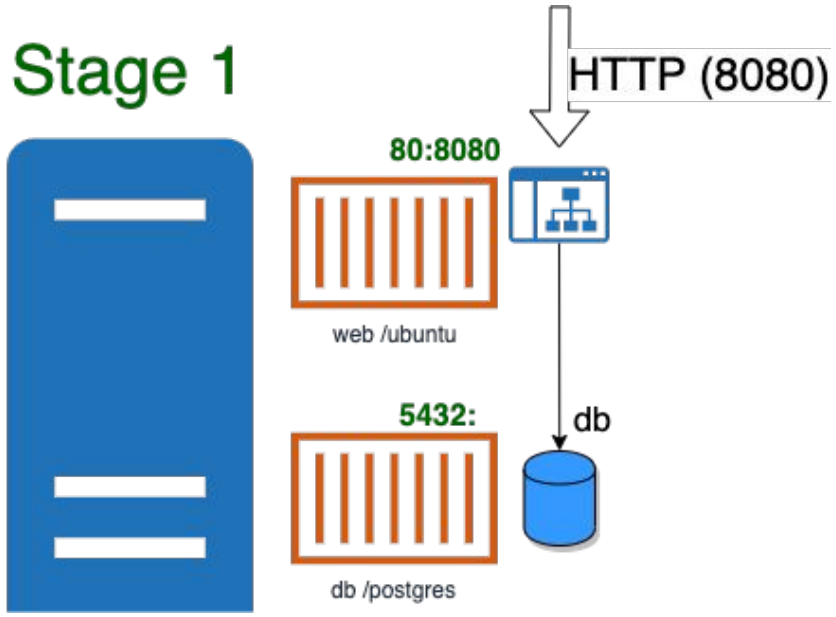
```
:$ docker ps
CONTAINER ID   IMAGE   COMMAND                  CREATED          STATUS          PORTS                    NAMES
ee9d1bfda40f   web     "python3 -u /app/web…"   4 minutes ago    Up 27 seconds   0.0.0.0:8080->80/tcp     web
14833ca9e600   db      "docker-entrypoint.s…"   5 minutes ago    Up 32 seconds   5432/tcp                 db

:$ docker network ls
NETWORK ID     NAME      DRIVER    SCOPE
5ee8868a7c3e   bridge    bridge    local
be73f6f78fd0   host      host      local
22100c68614f   mynet     bridge    local
dba2602e072d   none      null      local

:$ docker network inspect mynet

$ brctl show
bridge name     bridge id               STP enabled     interfaces
br-22100c68614f         8000.0242823f7f96       no              veth178a6e0
                                                        vethda68891
```

How Docker -p Port Forwarding --net Are Working



Sysctl ip_forward enables forwarding between All interfaces.

Dockerd creates bridges, connects to them containers, dockerd like DHCP assign them IPs

Each Bridged network could have own IP space, Gateway, DNS

Dockerd manages IPtables to simulate containers isolation and to set Port Forwarding

--net mynet shared between containers has dedicated brifge and just disabling of some iptables isolation rules by iptables (no namespaces magic)

dockerd runs DNS on ip 127.0.0.11 to enable resolving IPs between containers in the same --net mynet by container names

Dockerfiles For The App

```
FROM postgres
ENV POSTGRES_USER='DBUSER' POSTGRES_DB='DBNAME' POSTGRES_PASSWORD='DBPASS'
COPY ./upstart.sh /docker-entrypoint-initdb.d
```

```
FROM ubuntu
RUN apt-get update && apt-get install --no-install-recommends --no-install-suggests -y git python3
python3-pip python3-setuptools python3-dev python3-psycopg2 stress
RUN pip3 install psycopg2
ENV DBUSER='DBUSER' DBPASS='DBPASS' DBNAME='DBNAME'
ENV DBHOST='db' DBPORT='5432'
ARG APPDIR='/app'
VOLUME ${APPDIR}
COPY src ${APPDIR}
ENTRYPOINT ["python3","-u","/app/webapp.py"]
```

Secrets Forwarding Into Container

	Environment Variables key = value	**Volume** Files with key=value, csv, archeive etc.

On Build	Via arguments override:
	--
	`--build-arg ARG1=Va --build-arg ARG2=Lue`
	
	For compatibility with on run redefine could be used in dockerfile:
	
	`ARG SecretArg=password`
	`ENV SecretENV=${SecretArg}`
		Dockerfile:
		
		`export DOCKER_BUILDKIT=1`
		`RUN --mount=type=secret,id=mysite.key command-to-run`
		
		or just VOLUME mount and some RUN commands

On Run	Via Environemnt variable redefine: `docker run -e EnvVariable=SomePass -e AnotherEnvVeriable=pass2`	Application should be able to read and parse files from volume

Docker Link

Docker link enables to start few containers on the same hosts with shared both Volumes and Environment variables.

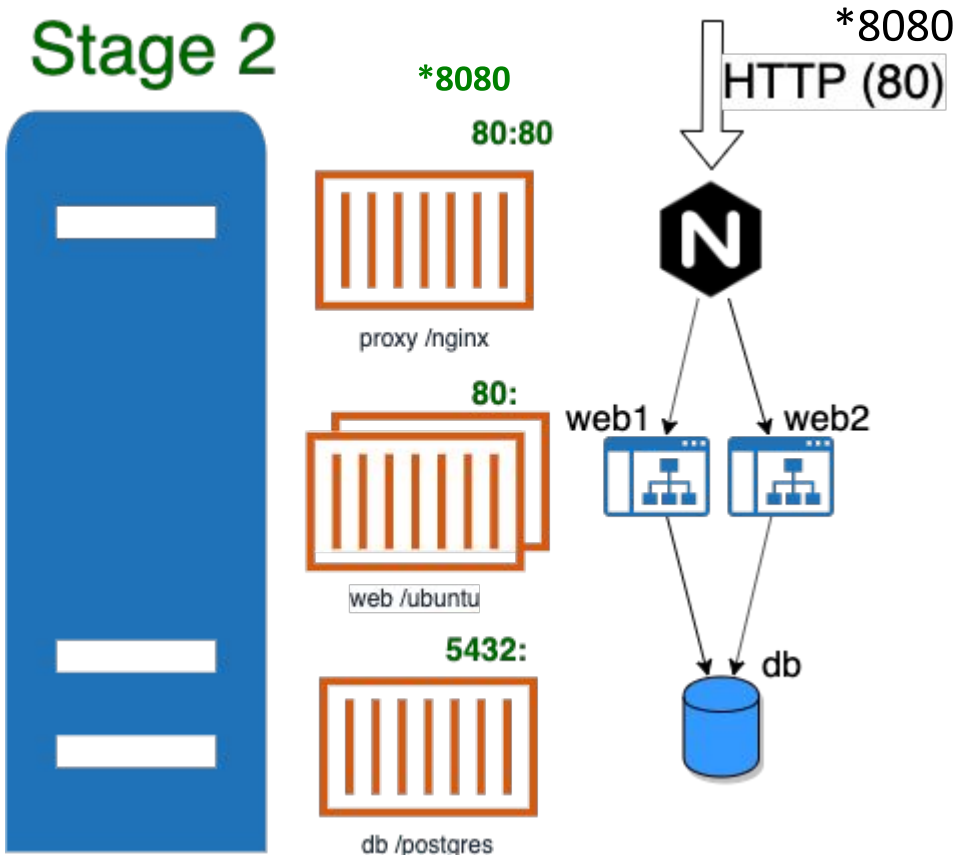
Magic is done by Docker transparently by:

- reinjecting variables on start appending them with container name prefix followed by underscore,
- DNS records are filled into /etc/hosts of container.

```
:$ docker run -d --name database -e MYSQL_ROOT_PASSWORD=root mysql
:$ docker run -d --link database:db --name webapp web

:$ docker exec -ti webapp env | grep MYSQL_ROOT_PASSWORD
DB_ENV_MYSQL_ROOT_PASSWORD=root
```

Hands On: Small Web App With DB, Stage 2




```
:$ docker stop web webapp

:$ docker run -d --name web1 --net mynet web
:$ docker run -d --name web2 --net mynet web

Stage2/proxy:$ docker build ./ -t proxy

:$ docker run -p 8080:80 -d --name proxy --net mynet proxy
```

Serving host ec99fa097683

Time: 2019-11-08 17:41:29

Accessed path: /

Writing to DB status: Success

Serving host 78fe3f2c0be4

Time: 2019-11-08 17:41:29

Accessed path: /

Writing to DB status: Success

Hands On: Small Web App With DB, Stage 2

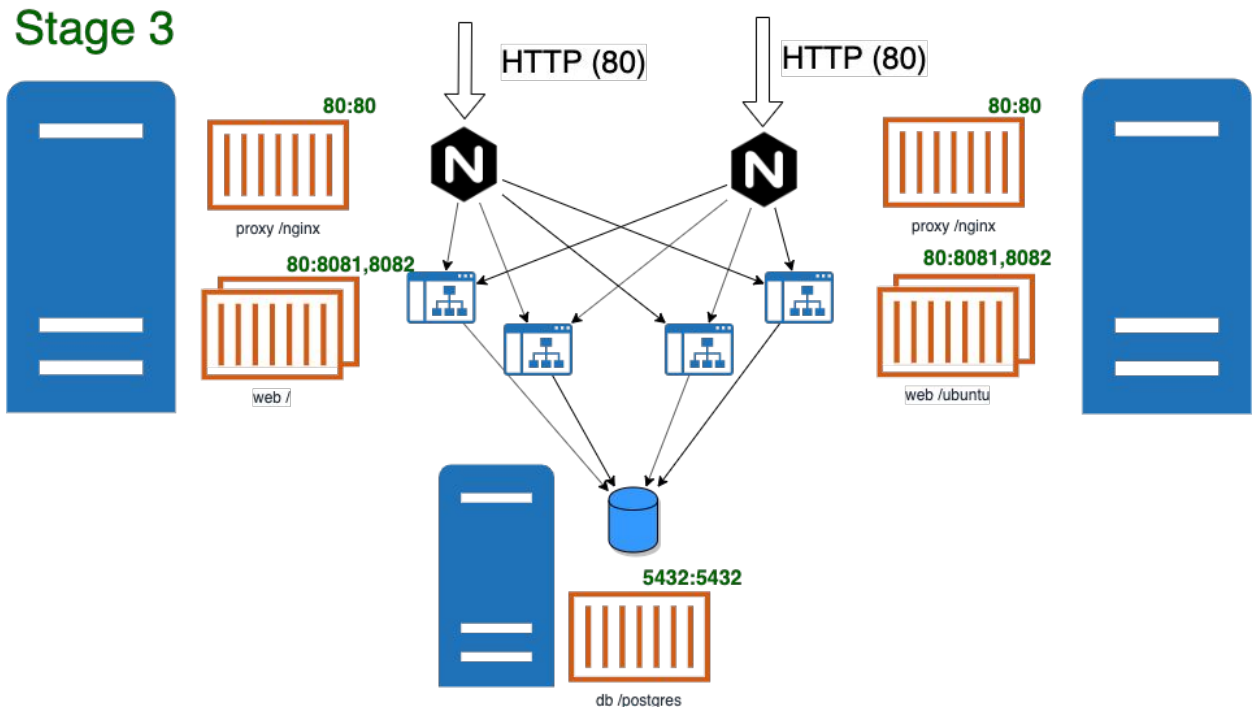
```
FROM nginx
COPY nginx.conf /etc/nginx/nginx.conf
```

nginx.conf:

```
events { }
http {
    upstream webapp {
        server web1:80;
        server web2:80;
        keepalive 10;
    }

    server {
        resolver 127.0.0.11 valid=10s;
        listen 80;
        location / {
            proxy_pass http://webapp;
        }
    }
}
```

Lection2 Home Task



Please try to: provide DB IP (docker --net DNS not working outside of host) and Secrets into docker WebApp config by ENV variable on docker run.

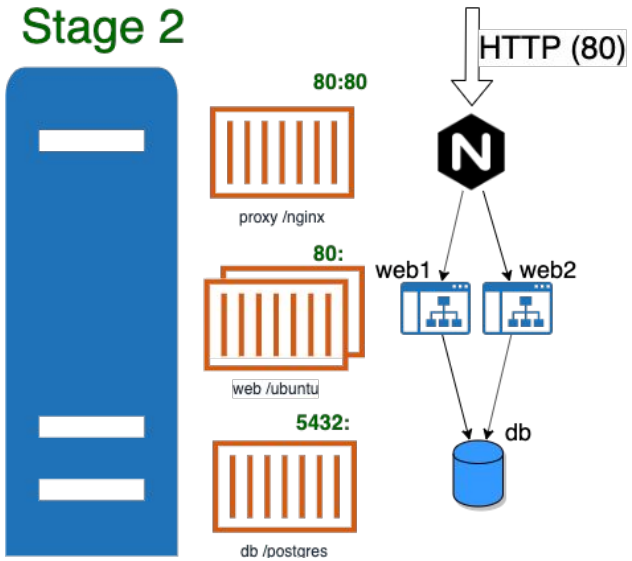
P.S.: Local host networking will not work for WebApps from other server!

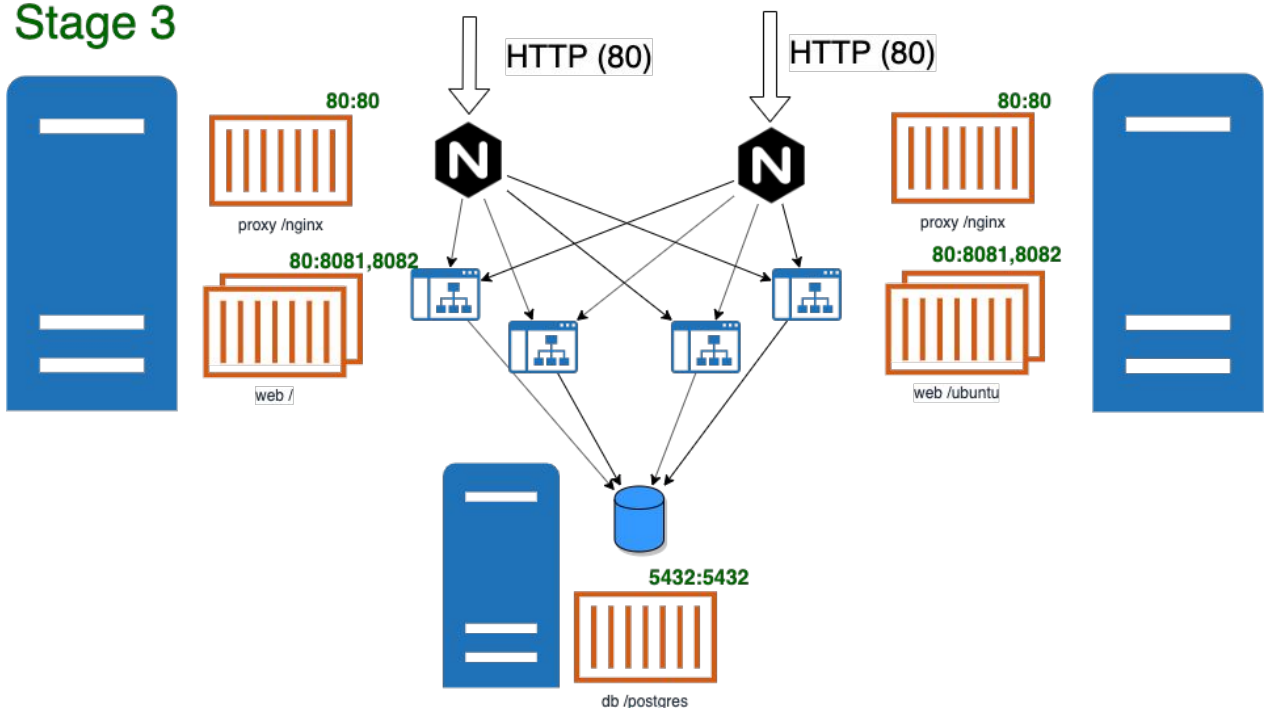
P.P.S.: Nginx Configs ok to hardcode - free NGINX doesn`t support keepalives - so WebApp should be running.

Q&A

Section 3: Docker Compose, Docker Swarm, Kubernetes

Growing Service





Service Orchestration on Dockerd Requirements

What is missed in traditional docker

- Containers Upstart Dependencies,
- Network shared between Few Hosts, Network Isolation,
- DNS in shared network, DNS isolation,
- Scaling like a DNS++ = Service discovery
- Secrets Management

Docker Compose

Docker Compose - systemd for docker containers.

- Handles Upstart Dependencies.
- Support Scaling of Containers.
- Tracking containers status.
- Rolling updates.
- Keeping DNS Records.
- Isolating resources by namespaces (not kernel - just DNS)

But all of this only around single node (hypervisor).

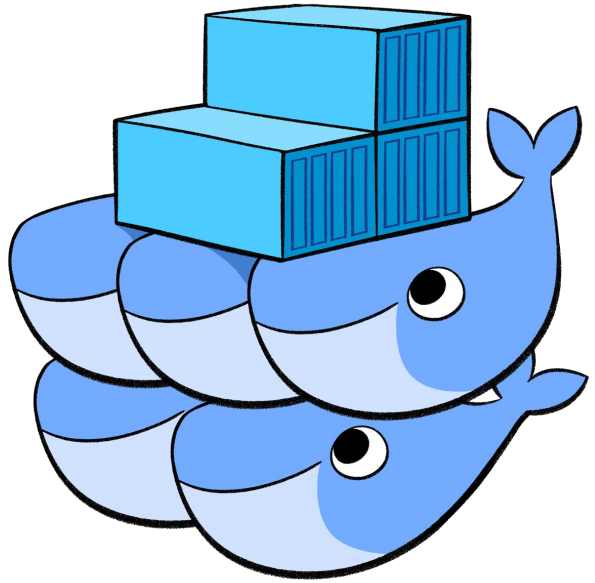
Docker Compose Config Example

```
version: "3"

services:
  whir-data:
    image: localhost:5000/whir-data
    deploy:
      replicas: 2
      update_config:
        parallelism: 2
        delay: 10s
        order: stop-first
    volumes:
          - "/home/volk/GIT/whir:/app"
          - "/home/volk/txt:/data"
    networks:
      - whirnet
...
```

```
...
  whir-parser:
        image: localhost:5000/whir-parser
        depends on:
          - whir-parser
        deploy:
          replicas: 1
          resources:
            limits:
              cpus: "0.5"
              memory: 128M
          restart_policy:
            condition: on-failure
        volumes:
          - "/home/volk/GIT/whir:/app"
          - "/home/volk/txt:/data"
        networks:
          - whirnet
networks:
        whirnet:
```

Docker Swarm



Connects few nodes(hypervisors),
roles: management, worker.

to firstly advertised in compose features added:

+ Multi-host networking,
+ Service Discovery + Load Balancing

But :

- not includes upstart sequence like docker compose.

Docker Swarm, Compose - Secrets Management

```
    postgres:
        image: docker.ask4ua.com/whir-db
        ports:
            - 5432:5432
        volumes:
            - postgres_vol:/var/lib/postgresql/data
        secrets:
            - whir_db_password
            - root_db_password
        #  mounted into: /run/secrets/secret-name

#environment:
        #      - POSTGRES_USER=whir
        #       - POSTGRES_DB=whir
        #       - POSTGRES_PASSWORD=password

        networks:
            - whirnet
        deploy:
            replicas: 1
            restart_policy:
                condition: any
secrets:
    whir_db_password:
        external: true
        #file: db_root_password.txt
    root_db_password:
        external: true
volumes:
    data_vol:
    postgres_vol:
networks:
    whirnet:
```

```
echo password | docker secret create whir_db_password -
```

Kubernetes