Containerization

Simplifying *Application Deployment* **with Containers**

Docker - Networking

Multi-Container Apps

- The power of Docker is realized when you compose your apps out of multiple containers.

- Docker provides two features:
  1. Docker Networking – A f**ramework for complex network namespace setup**
  2. Docker Compose -
     a) **Allows specification and setup of multi-container applications, and**
     b) **Establishes the network communication between them**

Docker Networking

- By default Docker comes with the following networks:

```
$ docker network ls
NETWORK ID    NAME      DRIVER
7fca4eb8c647  bridge    bridge
9f904ee27bf5   none     null
cf03ee007fb4   host     host
```

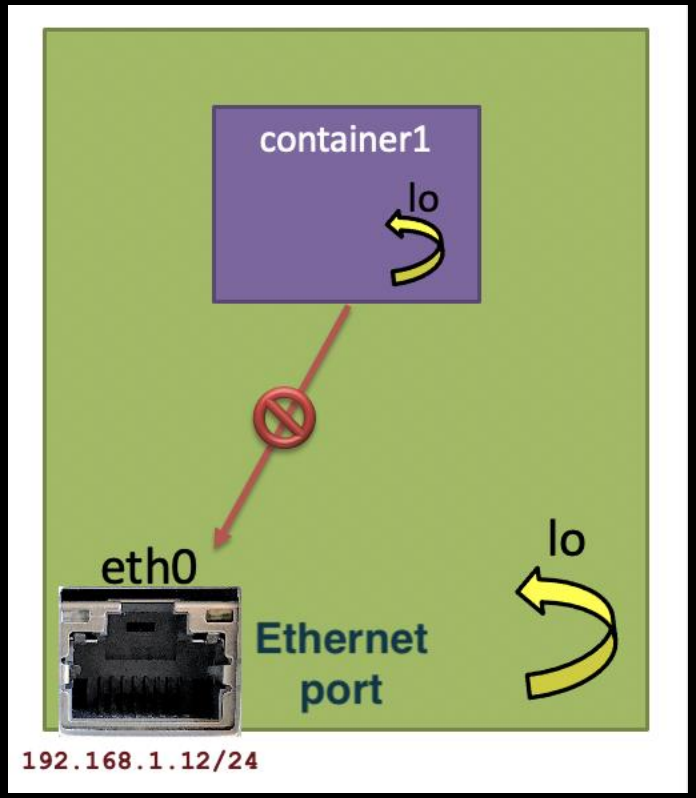
- Network Driver (Types):
  1. None - Its **container has no networking capabilities**
  2. Host - Its **container is not placed in a new network namespace.**
  3. **Bridge (default) - container is attached to a "bridge" (virtual bridge interface).**

The “none” Network

$ docker run \

--network=none ...

- **Container is in a new network namespace.**
- **Local loopback is enabled.**
- **No other network interfaces are supplied.**

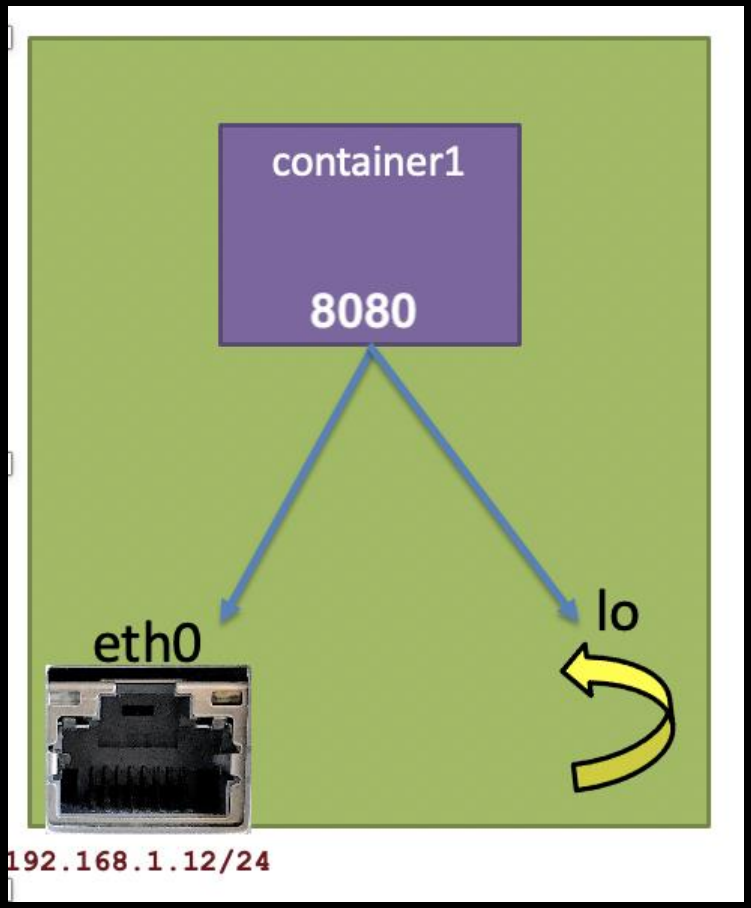


The “host” Network

$ docker run \

--network=host …

- **Container is in the host’s network namespace (i.e. no new network namespace created).**
- **Processes inside container have same access to network resources as those outside.**
- **Like adding a service to the host.**

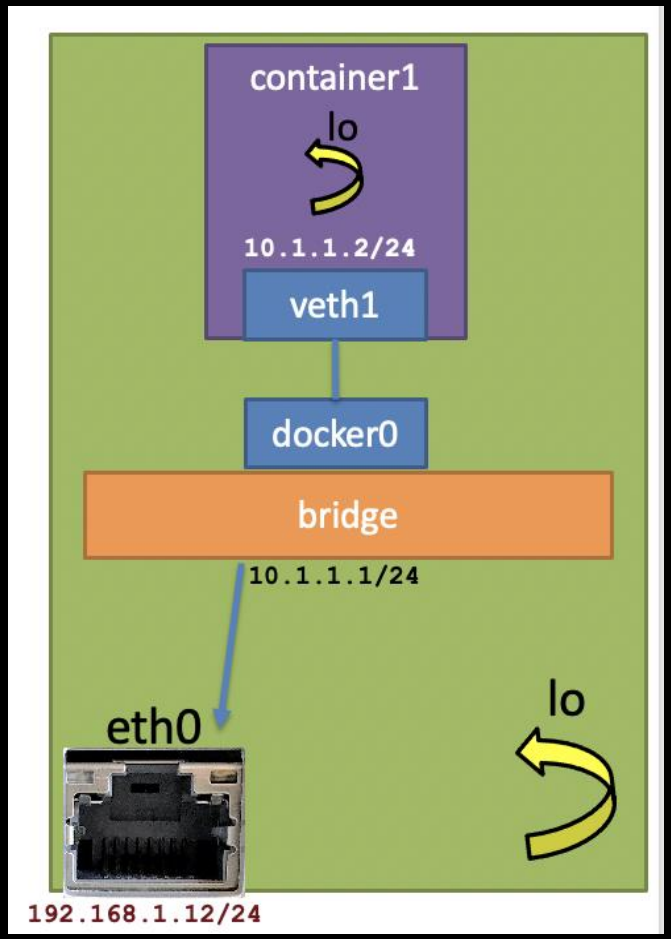


A “bridge” Network

$ docker run -it --rm

--network=bridge …

- **Default network type.**
- **Assigned a subnet IP address range.**
- **Sets up with NAT with a virtual bridge (bridge0) as a gateway.**
- **This enables a container to access the outside network**
- **Each container has a virtual ethernet i/f.**



Docker Network

- There can be multiple bridge networks.
  - Each assigned a different IP subnet range

```
diarmuidoconnor ~ ✔ docker network create mybridge1 bash at
4018c1071c50409865d00dc2e47f44698933c993bcc2a14cb06e825f4274a05b
diarmuidoconnor ~ ✔ docker network create mybridge2
6763c4d030c210722e125396756ff10162eb16e752dd089f81312841564a1820
diarmuidoconnor ~ ✔ docker network ls
NETWORK ID     NAME        DRIVER    SCOPE
60964a6b734c   bridge      bridge    local
8537f98578cd   host        host      local
4018c1071c50   mybridge1   bridge    local
6763c4d030c2   mybridge2   bridge    local
a72c3511f663   none        null      local
diarmuidoconnor ~ ✔ docker network remove mybridge1    in ba
mybridge1
diarmuidoconnor ~ ✔                                    in ba
```

- Inspect a network:

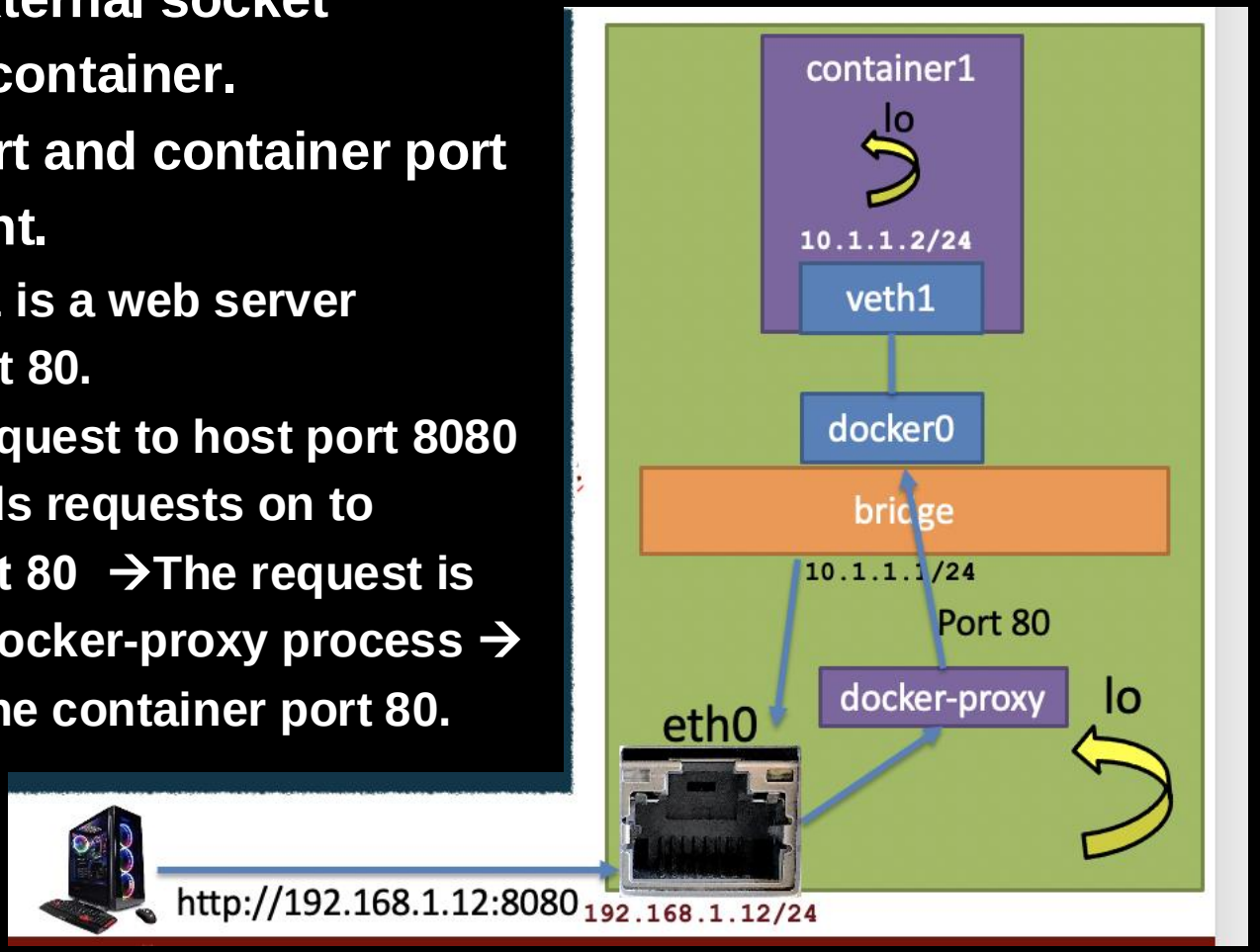
  $ docker inspect network <net_name>

  - Returns Lots of JSON-formatted information.

Port Forwarding.

- **Forwarding external socket requests to a container.**
- **Requested port and container port can be different.**
- **Ex.: Container1 is a web server listening on port 80.**

  Client sends request to host port 8080 → Host forwards requests on to container's port 80 →The request is received by a docker-proxy process → Forwarded to the container port 80.



Docker – Building images

Build A Docker Image.

- The normal way to create images is through a *Dockerfile* build description.

1. Create a Dockerfile, e.g.

```
FROM nginx
COPY index.html /usr/share/nginx/html/
```

2. Build the image and give it a name, e.g.

```
$ docker build -t my-nginx . (. current folder)
```

- Note:
  1. Place Dockerfile in project's base folder
  2. All paths are relative to the Dockerfile
  3. Each command in the Dockerfile creates a new temporary container
  4. Every creation step is cached, so repeated builds are fast.

DockerFile.

- FROM
  - Sets the Base Image for the newly created image
  - e.g. FROM nginx:15:04

- COPY - copy files from the project to to the image, i.e. COPY <src>... <dest>
  - Source can contain wildcards
  - If dest does not exist it will be created
  - Example:
    COPY service.config /etc/service/
    COPY service.config /etc/service/myconfig.cfg
    COPY *.config /etc/service/
    COPY cfg/ /etc/service/

DockerFile.

- CMD - specifies the default start-up command to execute at container runtime.
  - Form: CMD ["executable","param1","param2"]
  - Example: CMD ["nginx", "-g", "daemon off;"]
  - If supplied, the docker run arguments overwrite those of the CMD.

    docker run image executable params….
- RUN <command> - execute command(s) inside the container during build the process.
  - It is common to tie related commands together into one RUN command, using shell magic.

    RUN apt-get update && \

    apt-get install -y ca-certificates && \

    rm -rf /var/lib/apt/lists/*

DockerFile.

- ENV - sets environment variables which are present during container build and remain existent in the image. Form:

  ENV <key> <value>

  ENV <key>=<value> ...

- They can be overwritten at container runtime with the -e option:

  $ docker run -e key=value my_image

  e.g. $ docker run \

  -e message='The answer is' -e answer=42 \

  ubuntu \

  bash -c 'echo $message $answer’

  The answer is 42

DockerFile.

- ADD - can do the same as COPY with the following additions:
  1. If src is an URL, the file is downloaded, e.g.

     ADD https://download.elasticsearch.org/elasticsearch/elasticsearch-1.4.4.tar.gz /es/

     RUN cd /es && tar xvfz elasticsearch-1.4.4.tar.gz
  2. If src is a local tar archive, it will be extracted to destination, e.g.

     ADD configs.tar.gz /etc/service/
- WORKDIR path - set path as default directory inside the container, e.g.

  WORKDIR /usr/app

  COPY src . # Copy src folder to /usr/app/src

Designing good tests

- **Pre-requisite: A clear specification of the *required* behaviour (functionality) of the target.**
  - **We test the specification (What), not the implementation (How).**

- **Write tests in terms of: the expectations of the target's behavior for a given circumstance and specific inputs.**

  e.g. I expect to get result X when the input is Y and the database has data Z.

- **Test Target:**
  - **Unit testing– Function / Class.**
  - **System/Acceptance testing – End-to-end application.**