Distributed Systems Study Group

Second Meeting: Dec 10rd, 2019

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Agenda (approximately)

- Hands-on
- Recap (for new folk, ~5 min)
- More on Docker and Kubernetes (Presentation by Gerry, ~ 60 min)
- Hands-on time

Goals for Hands-On Tonight

- VMs (or external machines)
  - Set up with the appropriate network inter-connectivity
  - Install Linux (Headless, ie no desktop interface, only ssh)
- Have docker properly installed (including a private registry)
  - Building docker images, pushing to private registry, running docker containers
- Have a Kubernetes cluster installed
  - Configure/Deploy application in Kubernetes

Distributed Systems Study Group

- Get a deeper understanding of Distributed Systems
  - Architectural Patterns
  - Today's "standard" technology
  - Technology 'Internals'
- Collaborate with others to get Software installed/running
- Design and Build a Distributed Application from Scratch
- Maintain a public/shared Journal of what we have learned

This is a Study Group

- Everyone has something to contribute
  - Prepare and Give presentations
  - Help others in the group with their work
  - Take/Post notes to be posted onto our Shared Journal (git repo)
- Format
  - Hands-on / Networking
  - Questions for the Group
  - Presentation
  - Hands-on
- Not everyone will go the same speed
  - Each time we meet there will be hands-on time to help people catch up
  - You should always be able to follow the presentations

It Takes a Village

- Sharing/memorializing our experience

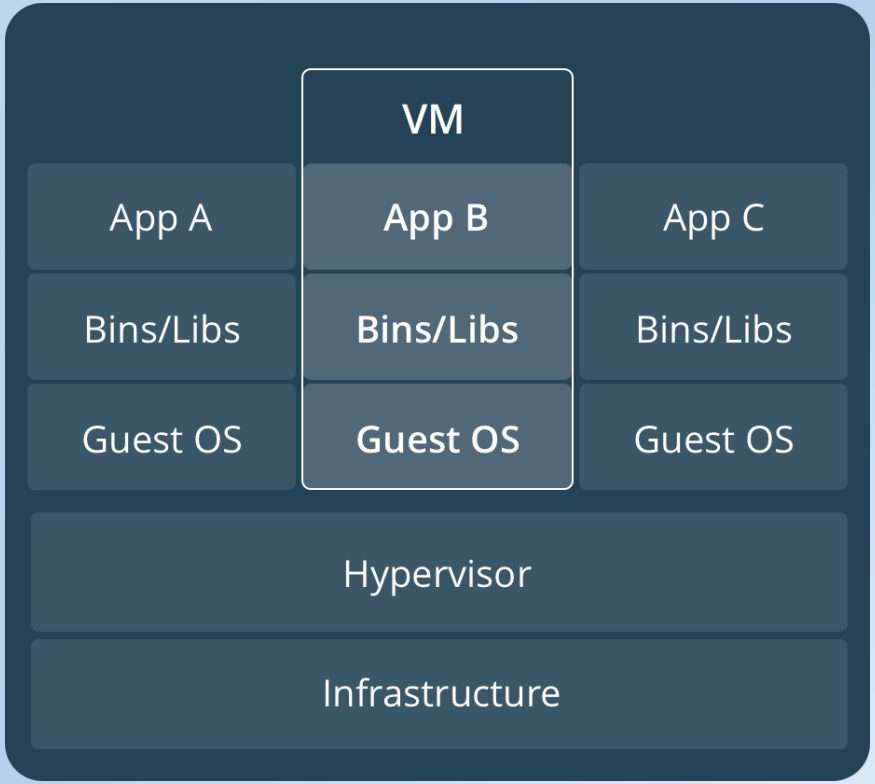
https://github.com/GerrySeidman/Distributed-Systems-Study-Group

Software Packaging and Deployment

- Developer writes some code, tests it locally and we're ready to deploy
  - But where?
  - How to deliver it?
- Zip it up and install it on some dedicated machine
  - Oh yeah.. There's also configuration files
- You need a machine to handle peak load of that machine
  - How much Disk? RAM? Network? GPU? Fast Processor?
  - Hard Allocation of Resources

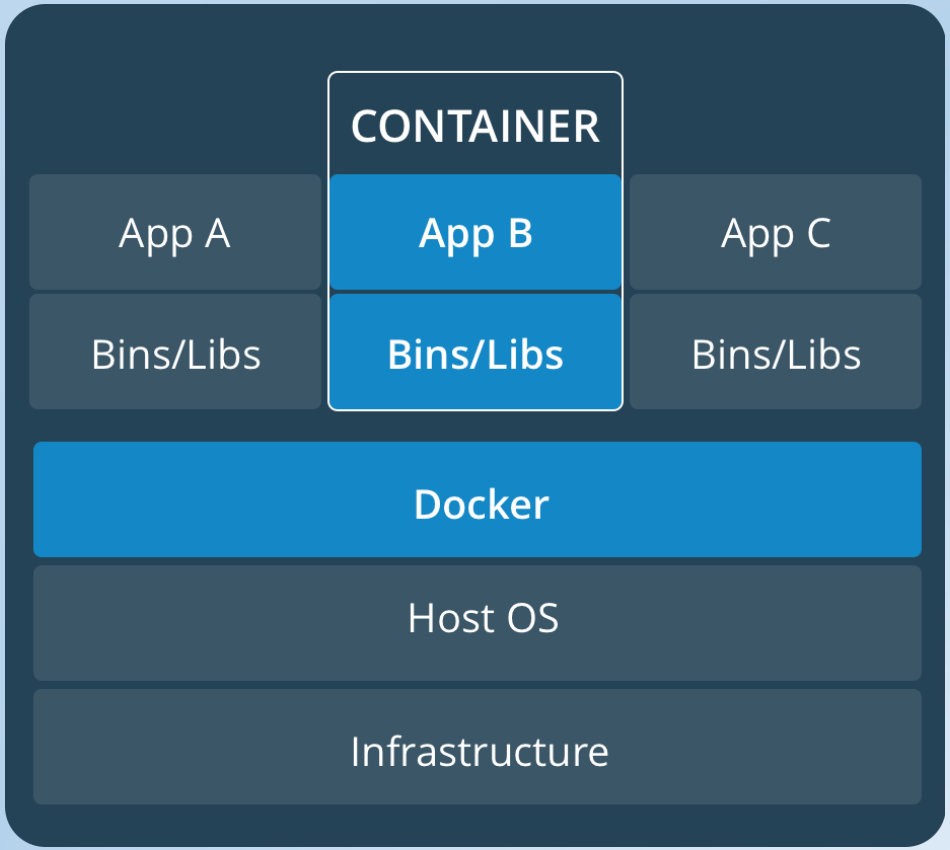
Virtual Machine

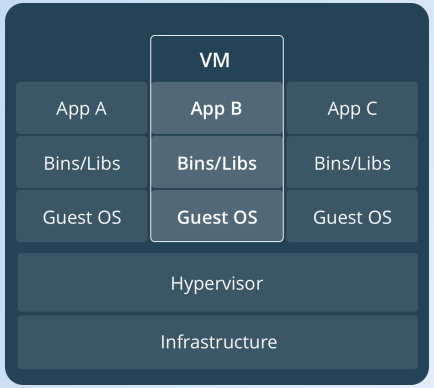
- Unit of deployment a VM Image
  - Just a big TAR file
  - When running it is a VM
- Semi-Soft Allocation of Resources
  - Disk, Memory, Network
- Slow to load
- Strong Security Boundary
- Hard to maintain
  - Same amount of work as a dedicated Machine
  - Security patches



Container

- Unit of deployment a Container Image
  - Just a big TAR file
  - When running it is a Container
- Soft Allocation of Resources
  - Disk, Memory
  - Some shared across Containers
- Fast to load
  - Run as a Host Process
- Pretty Strong Security Boundary
  - Linux Kernel
- Easier to maintain
  - Host OS



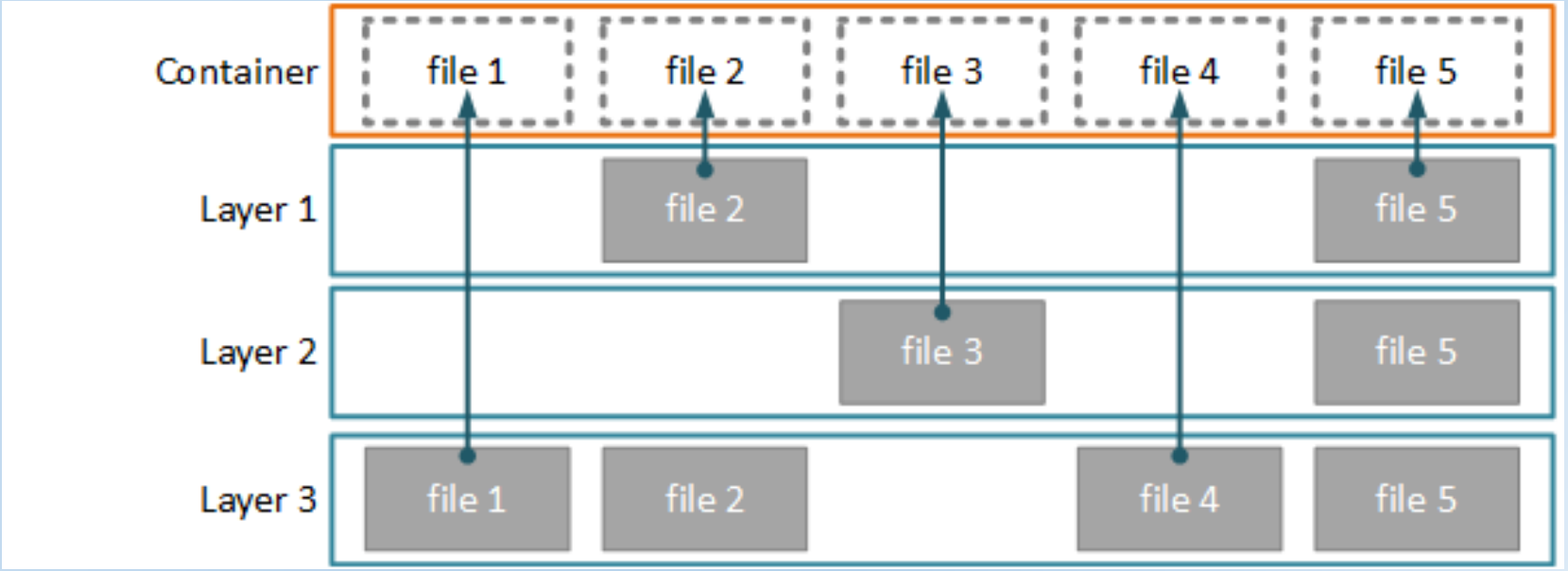


What is Docker

- Docker File Format for Container Images
- Docker Container Image builder
  - Must have Root access to build
- Docker Runtime ‘server’
  - dockerd
    - REST or CLI Client
  - Must have Root access to launch containers
- Docker Registry
- Other Container implementations
  - Singularity
  - Podman/Buildah

Overlay File System – Container Image Layers

- Copy on Write File System



Container Resource Management

- Container Isolation
  - Control Groups (cgroups)
  - Namespaces

Namespaces

- The pid namespace: Process isolation (PID: Process ID).
- The net namespace: Managing network interfaces (NET: Networking).
- The ipc namespace: Managing access to IPC resources (IPC: InterProcess Communication).
- The mnt namespace: Managing filesystem mount points (MNT: Mount).
- The uts namespace: Isolating kernel and version identifiers. (UTS: Unix Timesharing System).

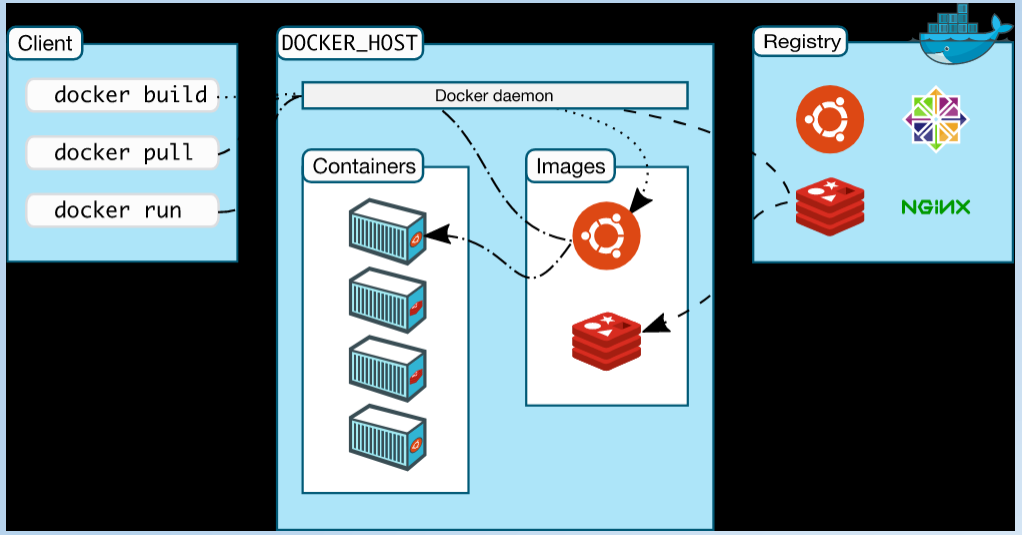
Docker Simplest Example

```
$ sudo docker run -i -t debian /bin/bash
```

```
$ docker run debian echo hello-world
hello-world
```

- http://containertutorials.com/

Docker Notes



- Docker Object
  - Images
    - docker build
  - Containers
    - docker run -i -t ubuntu /bin/bash
- Will pull from configured registries
- Repositories and Registries
  - Git analogy (repo vs github)
    - The thing to remember here is a Docker repository is a place for you to publish and access your Docker images. Just like GitHub is a place for you to publish and access your git repos
  - Push/pull
- Need to do everything as root

Understanding Images

- Registry vs local Repository
  - Public (dockerhub) vs Private registries
  - docker search alpine-apache
- docker images
  - Image variants [image]:[tag]
  - docker image
- docker build
- docker pull

Pull the alpine image,

```
$ docker pull alpine
```

Check IP Address of the container

```
$ docker run alpine ifconfig
```

Launching a bash shell

```
$ docker run -i -t alpine /bin/bash
```

Docker Build Example

1. Create a Dockerfile

```
FROM smebberson/alpine-apache
ADD ./public-html/myindex.html /var/www/localhost/htdocs
```

2. Create a directory public_html with the following content in `myindex.`

```
<html>
<body>
Hi There - Static page served by Apache Server
</body>
</html>
```

3. Your directory should look like this

```
$ tree .
.
├── Dockerfile
└── public-html
    └── myindex.html
```

4. Create a Docker image

```
$ docker build -t my-apache2-alpine .
```

This will create a `my-apache2` image.

5. Create a Docker Container running this image

```
docker run  -p 80:80 --name my-apache2-alpine-1  my-apache2-alpine
```

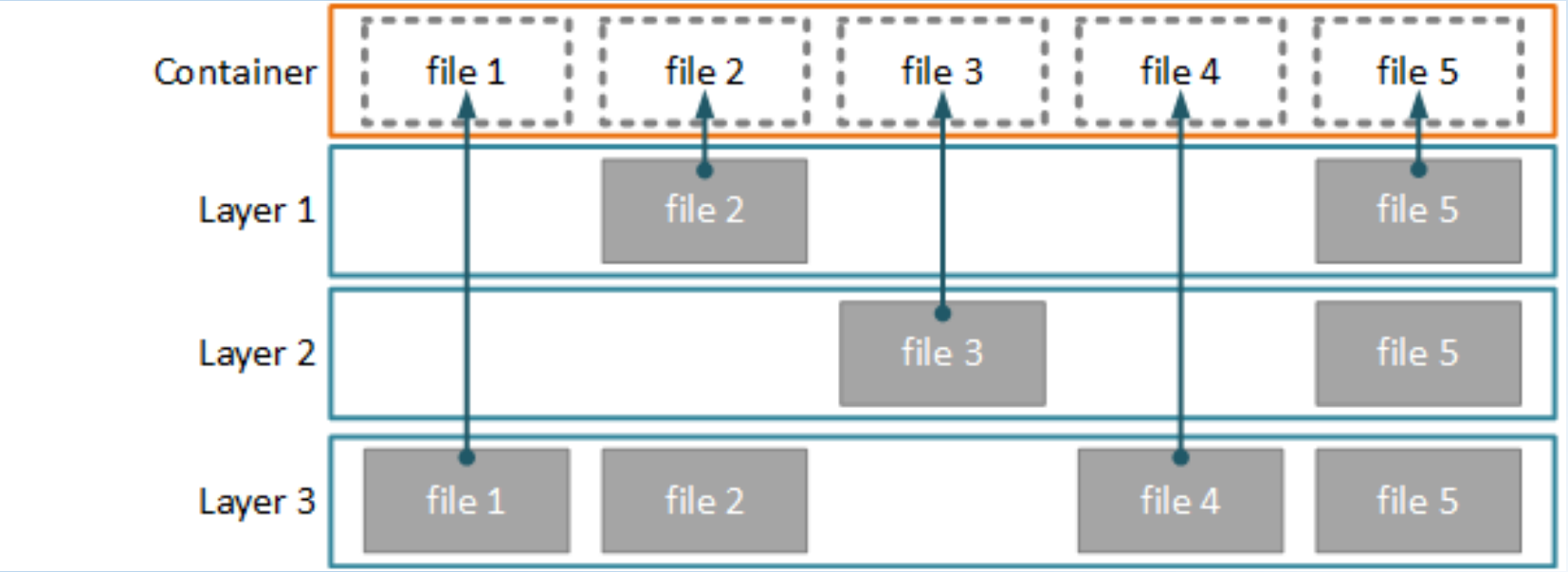
Docker Commands

- http://containertutorials.com/get_started
- docker <cmd>
  - info
    run
    run –it
    attach
    ps
    start
    stop
    logs
    rm
    pause/unpause
    network ls
    rename

Dockerfile

- Commands
  - FROM
  - ADD
  - RUN
  - COPY
  - EXPOSE
  - ENVIRONMENT

- Each RUN creates a Layer
  - To Reduce Layers use “&”
    - RUN <cmd> & <cmd> & <cmd>

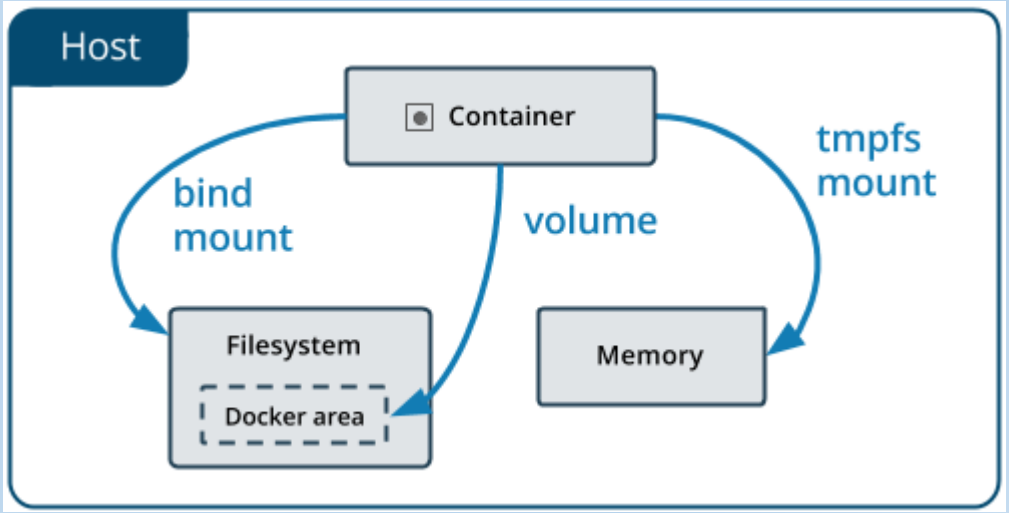


Important Topics

- Docker Logs
  - Where does stdout and stderr go?
  - When should
- Docker Repository Cleanup
- Docker Registry Cleanup

Volumes and Network Port Binding

- Mount Host Directory as a ‘volume’
  - Ugh overloaded term.. hear ‘volume’ means a rooted directory tree.



- Networking
  - Bind Host port to container port

Container Tutorial Walkthrough

- http://containertutorials.com/index.html
- http://containertutorials.com/get_started/index.html
- http://containertutorials.com/alpine.html
- http://containertutorials.com/images.html
- http://containertutorials.com/registry.html
- http://containertutorials.com/docker-compose/index.html

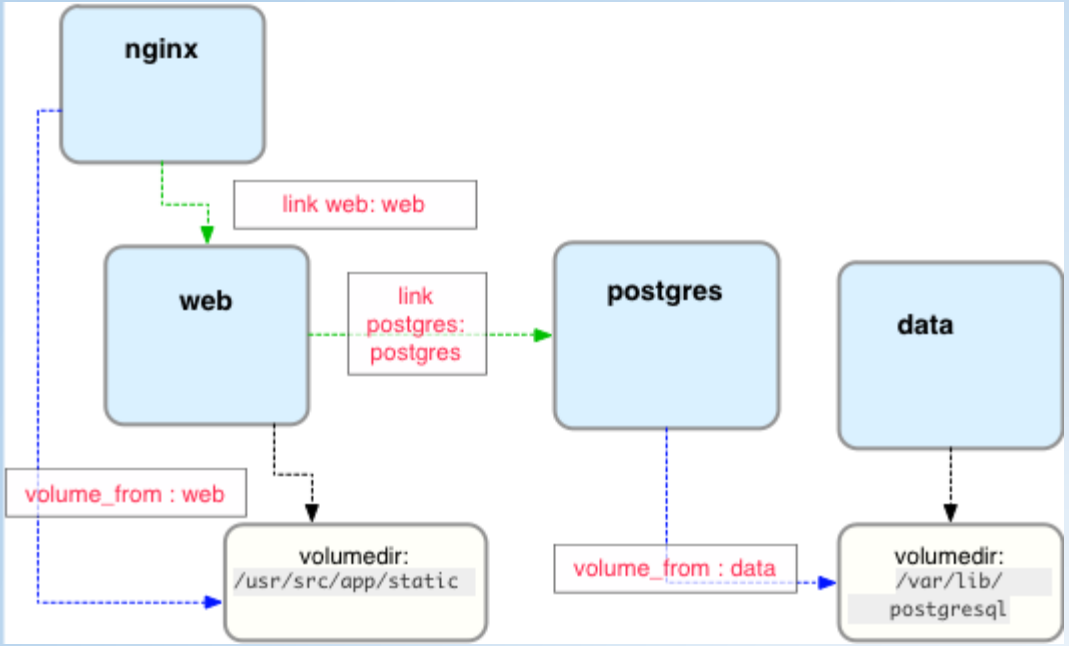
Some of Gerry's Scripts

- bcp: Build - Tag - Push
- dr: Docker Run
- rdi: Remove Docker Images
- drt: Tag
- sdi: Show Docker Images
- rdxi: Remove Exited Images
- drs: Docker Registry Show
- drm: Docker Registry Manifest
- drx:
- drgcdr:

Docker Compose

- http://containertutorials.com/linked/docker_compose.html

- Remember Flask servers are simple
  - Examples
  - Docker Compose with 2 ports/base



- http://containertutorials.com/docker-compose/spring-boot-app.html

Examples

- From

1. Create a `Dockerfile` with the following content

```
FROM debian:wheezy

RUN apt-get update && apt-get install -y cowsay fortune
```

2. Go to the directory container `Dockerfile` and execute the following command to build a image

```
$ docker build -t test/cowsay-dockerfile .
```

You will see output as shown below

```
Sending build context to Docker daemon 2.048 kB
Sending build context to Docker daemon
Step 0 : FROM debian:wheezy
wheezy: Pulling from debian
7a3e804ed6c0: Pull complete
b96d1548a24e: Already exists

Status: Downloaded newer image for debian:wheezy
 ---> b96d1548a24e
Step 1 : RUN apt-get update && apt-get install -y cowsay fortune
 ---> Running in 4404353a3643
Get:1 http://security.debian.org wheezy/updates Release.gpg [1554 B]
Get:2 http://security.debian.org wheezy/updates Release [102 kB]
Get:3 http://httpredir.debian.org wheezy Release.gpg [2390 B]
.....
Setting up perl (5.14.2-21+deb7u2) ...
update-alternatives: using /usr/bin/prename to provide /usr/bin/rename
 ---> ca3618d10f2a
Removing intermediate container 4404353a3643
Successfully built ca3618d10f2a
```

3. Check that image has been created

```
$ docker images
REPOSITORY                  TAG                 IMAGE ID            CREATED             VIRTUAL S
test/cowsay-dockerfile      latest              ca3618d10f2a        3 minutes ago       126.9 MB
docker-dev                  dry-run-test-2      db155754d7fc        6 days ago          1.571 GB
<none>                      <none>              b01392d005bb        6 days ago          1.571 GB
debian                      wheezy              b96d1548a24e        7 days ago          84.97 MB
debian                      latest              df2a0347c9d0        7 days ago          125.2 MB
dockerswarm/dind-master     latest              bb4cd757411e        7 days ago          159 MB
<none>                      <none>              f672d2db20f6        7 days ago          1.571 GB
<none>                      <none>              1fe07c1fdf52        8 days ago          1.571 GB
dockerswarm/swarm-test-env  latest              01e6a0da0825        2 weeks ago         515.5 MB
ubuntu                      14.04               07f8e8c5e660        3 weeks ago         188.3 MB
hello-world                 latest              91c95931e552        5 weeks ago         910 B
busybox                     latest              8c2e06607696        5 weeks ago         2.433 MB
```

4. Run the cowsay program using the built image

```
$ docker run test/cowsay-dockerfile /usr/games/cowsay "Hi!"
```

This will execute and show the output

```
 _____
< Hi! >
 -----
        \   ^__^
         \  (oo)\_______
            (__)\       )\/\
                ||----w |
                ||     ||
```

5. Removing a Docker Image : Docker image can be removed using the following command

```
$ docker rmi test/cowsay-dockerfile
```

Overview of Kubernetes

- Declarative System
  - What I want
  - Where I am
  - Important events
- Primary Services
  - Master Node
  - Worker Node
    - Kubelet
  - etcd
- Controllers & Operators

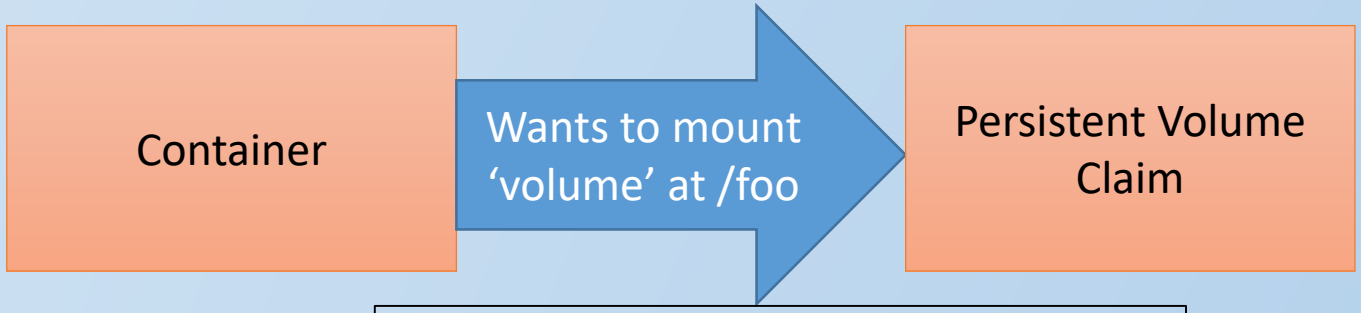
Understanding Kubernetes Objects

- There are Many Confusing Kubernetes Objects
  - Pod
  - Deployment, StatefulSet, DaemonSet
  - Volume
  - PersistentVolumeClaim
  - PersistentVolume
  - PersistentVolumeAttachment
  - StorageClass
  - CSIDriver
  - Oh my…

Where are the Containers?

- Pod
  - One or more Containers Running with a shared ‘localhost’
- Deployment
  - A Template for deploying several Pods over multiple nodes (interchangeably)
- StatefulSet
  - A Template for deploying several Pods over multiple nodes (sticky id)
- DaemonSet
  - Template for running several Pods one per Node (or subset of Nodes)
- Others: ReplicaSet, CronJob, Job

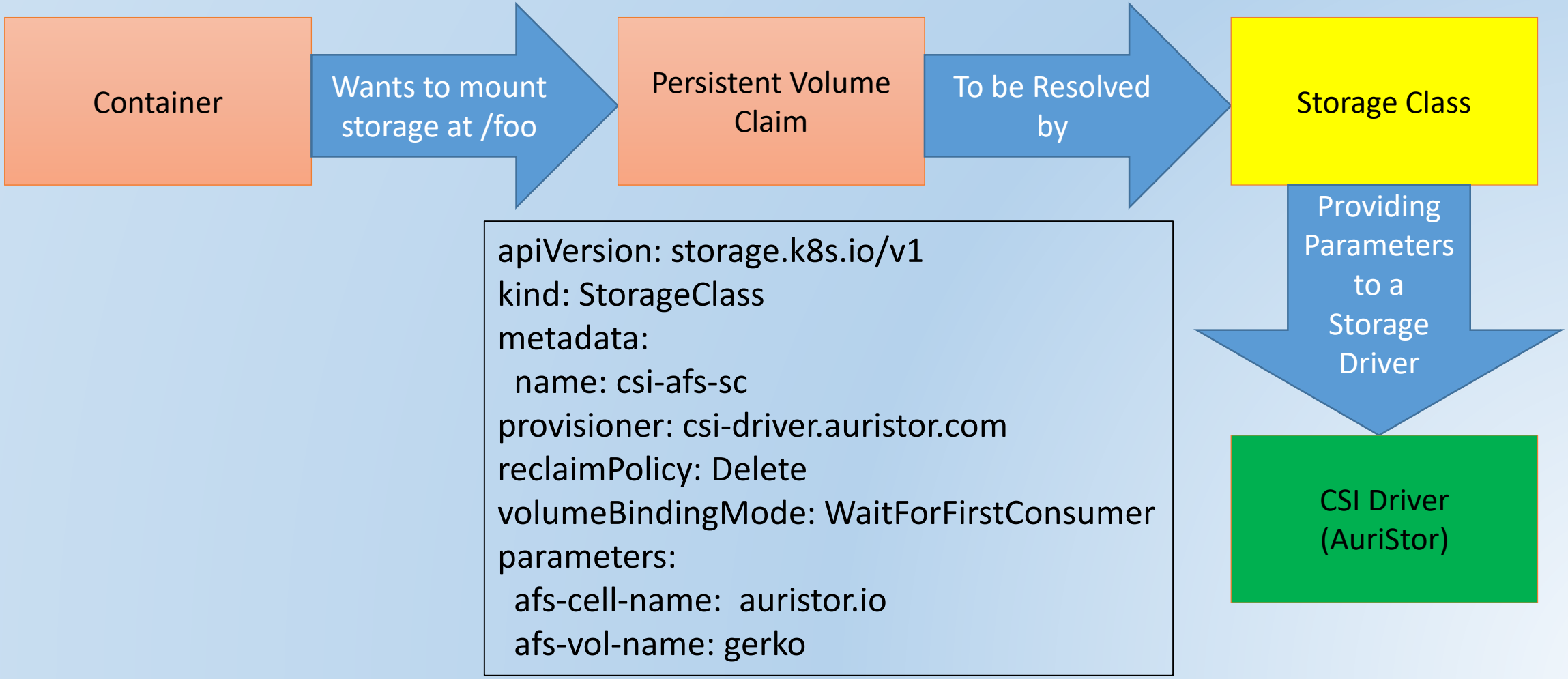
Not Quite Simplest Example



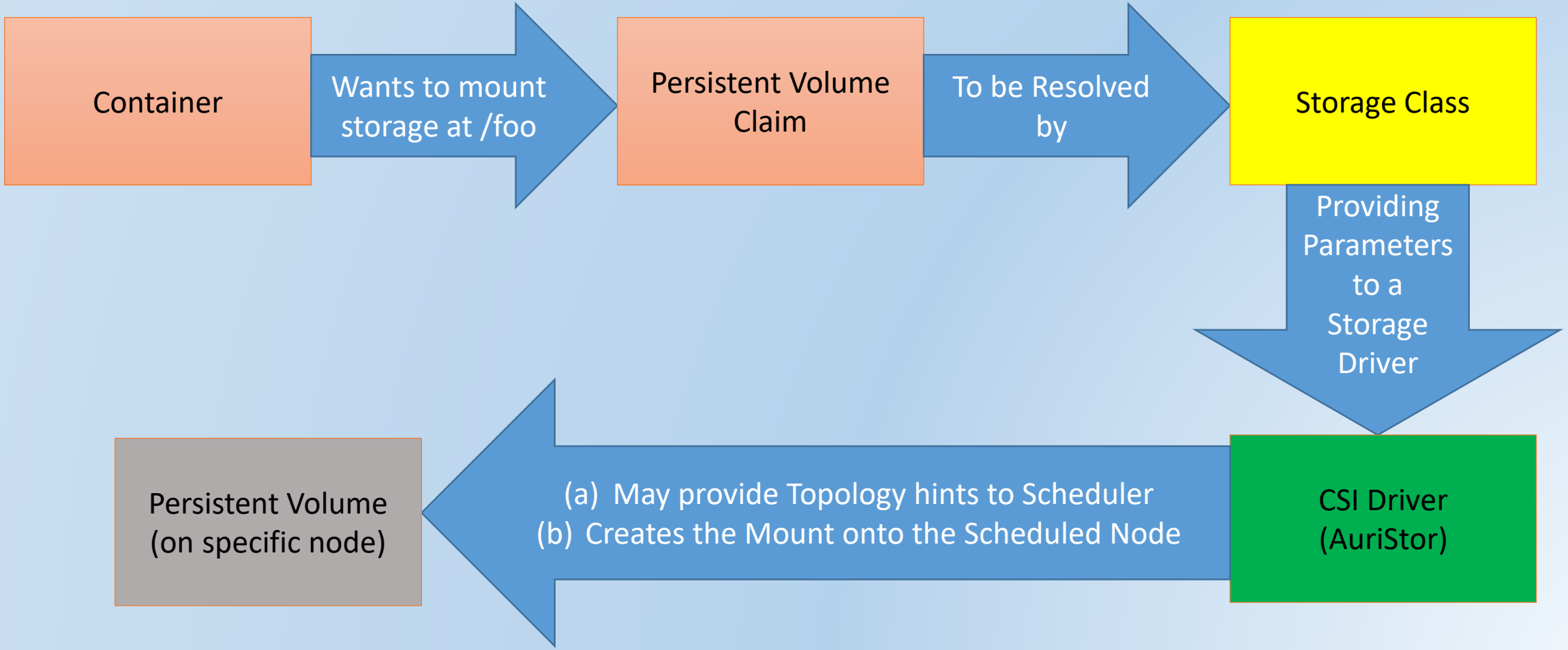

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: csi-pvc
spec:
  accessModes:
  - ReadWriteOnce
  resources:
    requests:
      storage: 1Gi
  storageClassName: csi-afs-sc
```

```
kind: Pod
apiVersion: v1
metadata:
  name: my-csi-app
spec:
    containers:
    - name: my-frontend
      image: busybox
      volumeMounts:
      - mountPath: "/data"
        name: my-csi-volume
      command: [ "sleep", "1000000"
]
  volumes:
    - name: my-csi-volume
      persistentVolumeClaim:
        claimName: csi-pvc
```

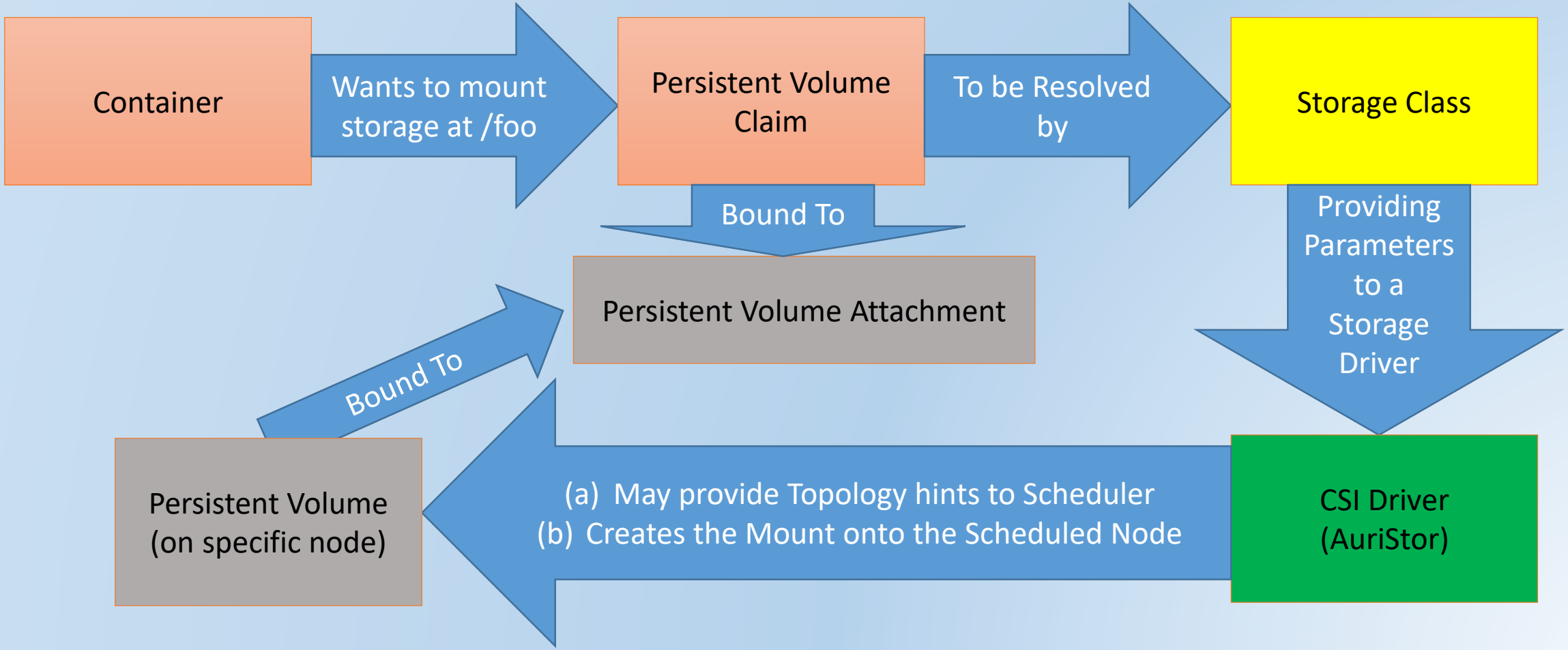
What the Cluster (Storage) admin Specifies



What the Kubernetes CSI Driver Does



What the external-attacher does



The Storage Class Parameters to CSI Driver

- AuriStor Driver Specific
  - Volume:
    - Existing Cell + Volume
    - Scratch + Quota
  - Topology
    - Don’t care where the volume is
    - Schedule ‘near’ a File Server (ie Rack) with Volume (Replicate if necessary)
      - Do not Start until replication competes
      - Start immediately if none, but also start replication

Network Objects

- Endpoints / EndpointSlice
  -
- Service
  - An abstract way to expose an application running on a set of Pods as a network service.
- Ingress
  - Ingress can provide load balancing, SSL termination and name-based virtual hosting.

Security Objects

- ServiceAccount
- ClusterRole
- ClusterRoleBinding
- Secret
- Role
- RoleBinding

Persistent Storage Objects

- Volume
- PersistentVolumeClaim
- PersistentVolume
- PersistentVolumeAttachment
- StorageClass
- CSIDriver

Setting Up Kubernetes Cluster with kubeadm

- https://kubernetes.io/docs/setup/production-environment/tools/kubeadm/install-kubeadm/

Kubernetes Guides

- Kubernetes Concepts
  - https://kubernetes.io/docs/concepts/
- Kubernetes Tasks
  - https://kubernetes.io/docs/tasks/
- Kubernetes Tutorials
  - https://kubernetes.io/docs/tutorials/

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First Meeting: Dec 3rd, 2019

Questions?

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