Introduction to Containers and Kubernetes

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A bit about Ruben

- Software developer
- Have been helping customers run cloud tech in production for about 7 years
- PSF Fellow since ‘17
- Presently work as Software QA Engineer at Heptio

Administrative Stuff

- Format: two main parts of two subparts each (concepts and practice).
- We'll take a coffee/Tea break somewhere ~ halfway
- If you have already been playing with either of the technologies here, you might *NOT* get much value out of this workshop

My Q + A “rules” 

- Do you know the answer to this question?
- Is it really a comment but with a question mark tacked on?
- Is the question rhetorical?
- Trying to show off how much you know about the subject?

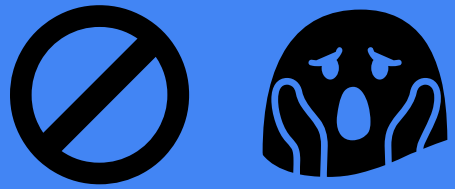
Our Q + A “rules”

- Speed of delivery
- Not understanding
- Request to repeat explanation
- Anything immediately related to the topic(s) at hand

Objectives

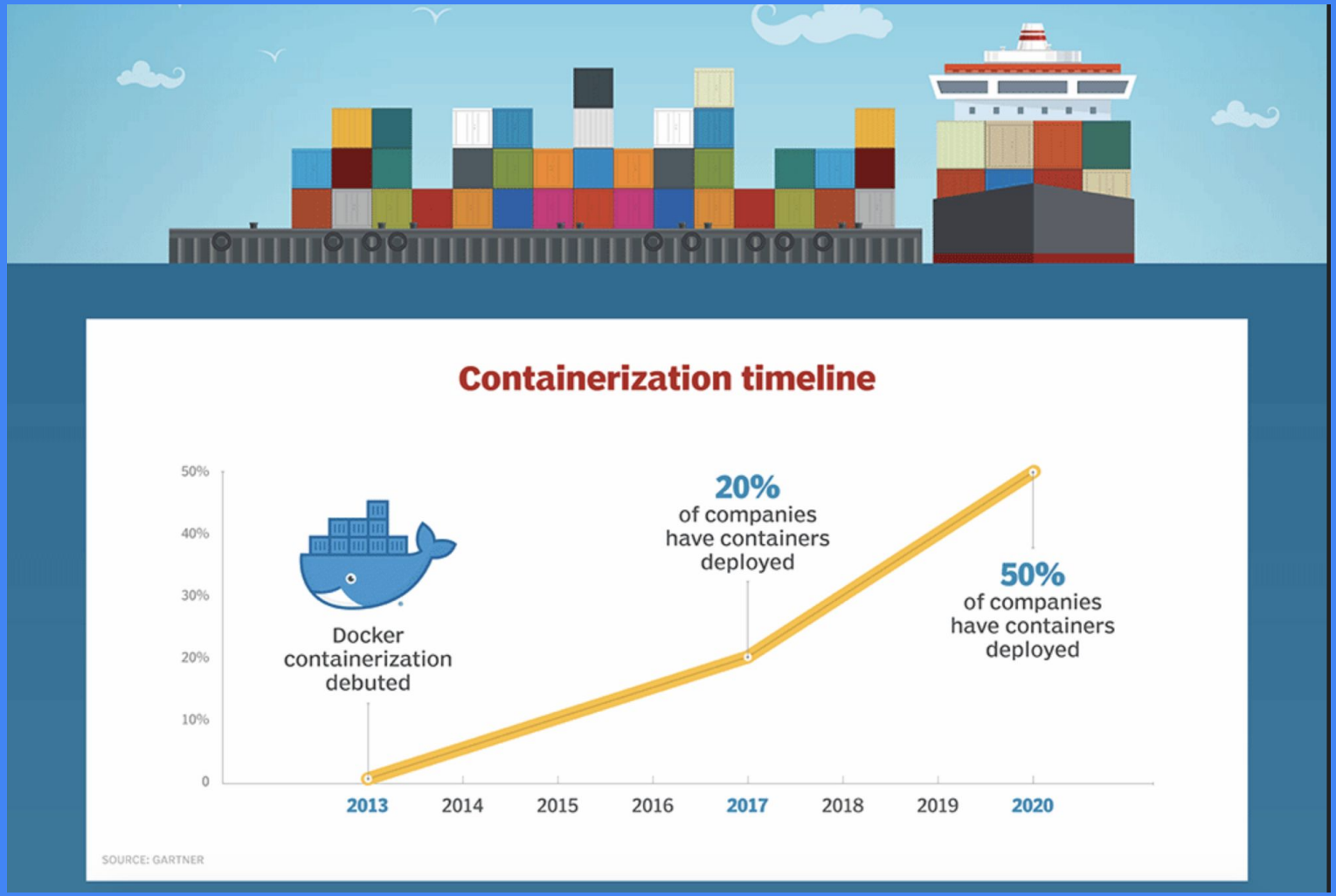
- Technical background of the technologies herein.
- Overview of the important pieces
- How they work together
- A bit of hands-on experience
- If the workshop succeeds, you'll end up with more questions than answers!

DON'T
PANIC



Why this Workshop?

Container adoption has been rather dramatic in the last 4 years.

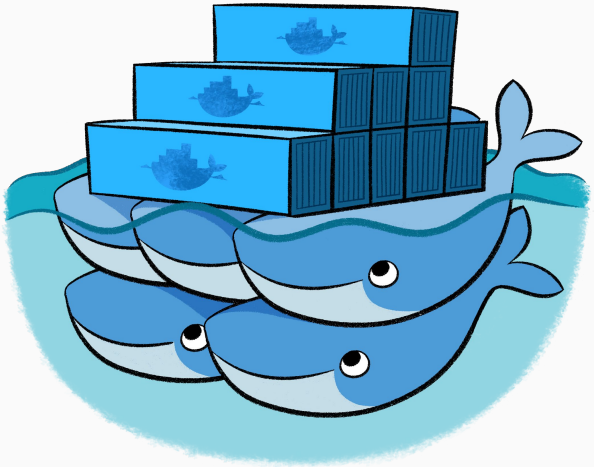

Containerization timeline
50%
40%
30%
20%
10%
0
Docker containerization debuted
20%
of companies have containers deployed
50%
of companies have containers deployed
2013
2014
2015
2016
2017
2018
2019
2020
SOURCE: GARTNER

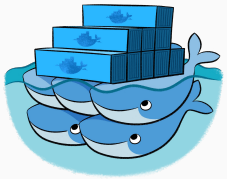
However, containers by themselves are an incomplete story...

Containers

Need a story for ...

- Deployment at scale
- Orchestration
- Observability
- Scheduling



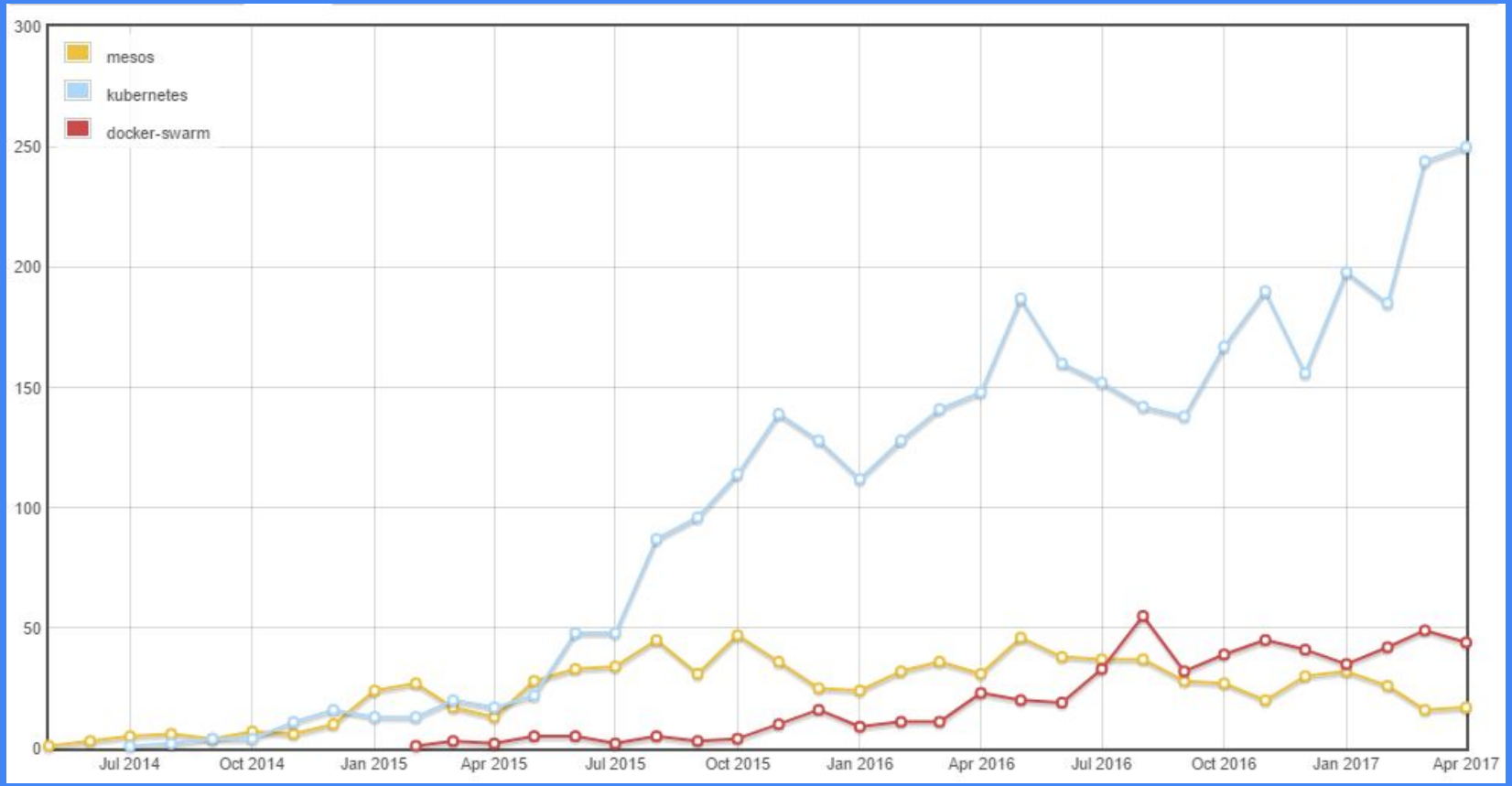


- Tightly coupled to Docker runtime
- Too opinionated
- Project open source but governed by Docker, inc.

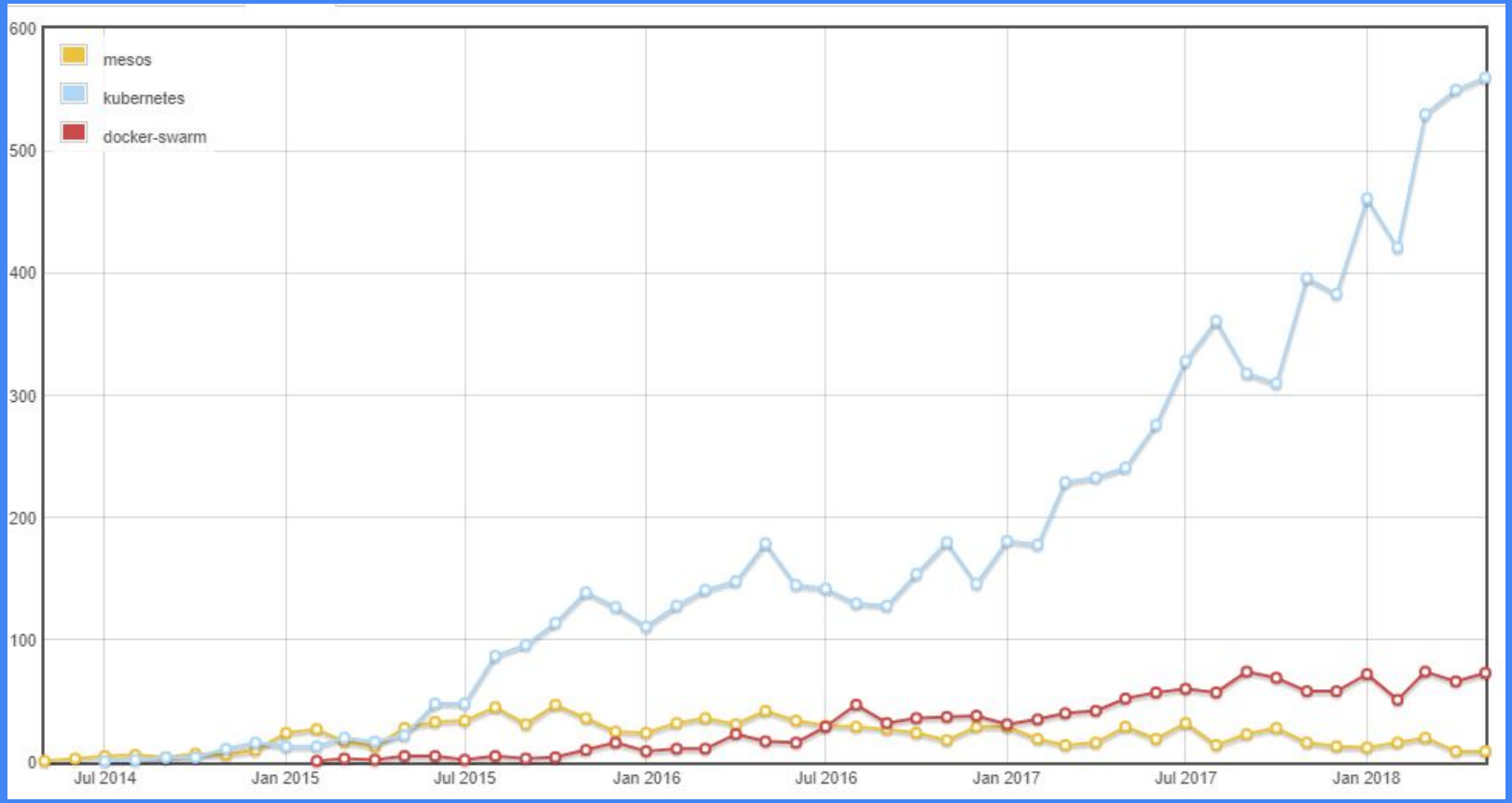
- Not container specific
- Substantial learning curve
- Scheduler too generic
- Major parts written in different languages
- Overkill for most deployments

kubernetes

Up To May, 2017



Up To June, 2018!



- Solved a lot of the issues other orchestrators had
- Gentler learning curve
- Container runtime independent
- … but much more detail about this later

Part I. Containers

Containers are not really a new thing.

Abridged History

2000 “Jails” are included in FreeBSD.

2001-ish, the precursor to Virtual Private Server is introduced to the Linux ecosystem

2004 Sun adds “Zones” to Solaris.

2006-ish early precursors of cgroups raise to the fore

2008 Kernel namespaces and LXC (Linux Containers)

2013 Docker is released (informally at PyCon!)

Runtime Alternatives

Main Benefits

- Velocity
- Portability*
- Reliability
- Efficiency
- Isolation
- Infrastructure as code

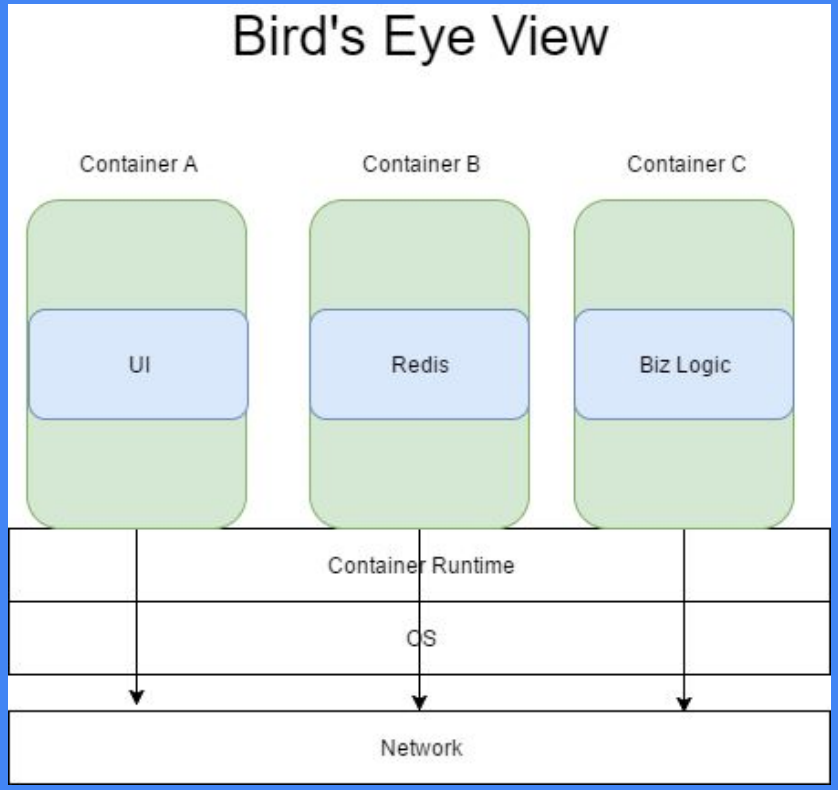
*mostly =)

Containers aren’t VMs

- Full OS on virtualized hardware
- “Hypervisor Tax”
- Provisioning can take a long time (relatively speaking)
- Images are immutable and monolithic.
- Substantial config work

- Decouples application from underlying OS
- Composable Images
- Lean
- Very fast provisioning times
- Very “Disposable”

“All great stuff,
but now with less
hand waving, pls”


Bird's Eye View
Container A
Container B
Container C
UI
Redis
Biz Logic
Container Runtime
OS
Network

The Container Model

- Shares resources with other processes, but constrained to high degree of isolation
- Can access persistent storage as volumes
- Can share/pass context

Container Images

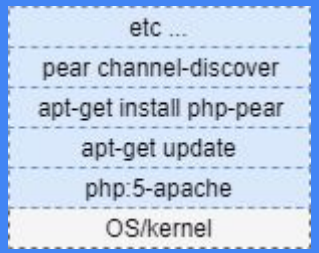
- Different concept than VM images, OS images, etc.
- In Containerland an image is a bundle of layers that together form only logical unit
- 1:N (image:containers)

Container Images (Dockerfile)

- In the Docker ecosystem they are named and labeled as follows:
  <repo>/<imagename>:<tag>
  Ex: ruben/introtock:latest (not an actual thing)
- Generally speaking images default to ‘latest’

Container Images

- Almost every instruction in a Dockerfile creates a layer in the image




```
FROM php:5-apache

RUN apt-get update
RUN apt-get install -y
php-pear
RUN pear channel-discover
```

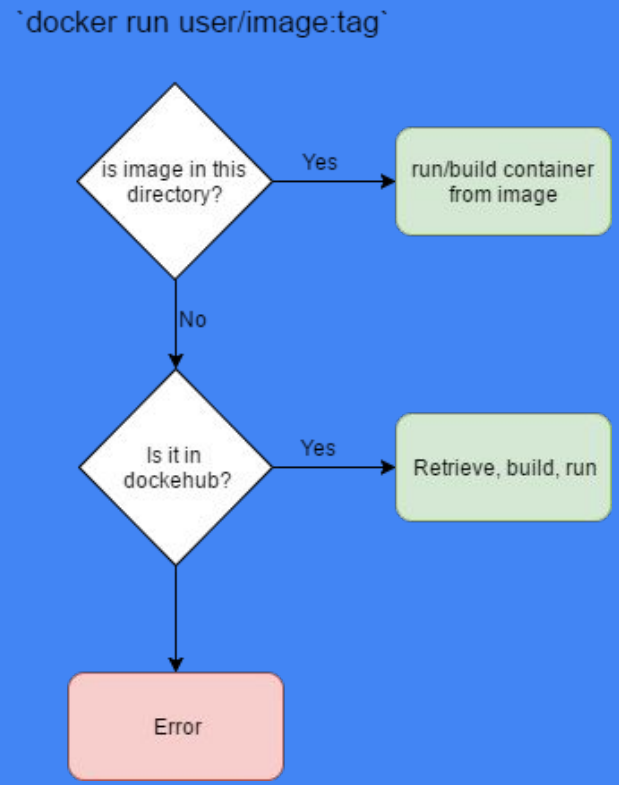
Container Images

- The layered file system is key to images being composable
  - Key difference between container and traditional VM/OS images
  - All layers are presented as one logical unit

Image Registries

- Registries are network storage for images
- You can publish (push) to or download (pull) from them
- Registries can be public, private and local

Image Registries



Dockerfile: a quick primer

- The basis to describe the structure and contents of a docker image
- Series of imperative statements
- Many instructions create a layer
- Also describe initial settings and behaviors of a container

Dockerfile: a quick primer

- Must be named ‘Dockerfile’ (no extensions)
- Most common statements:
  - FROM
  - WORKDIR
  - ADD/COPY
  - CMD/RUN

Let’s hit the shell

Quiz Time!

- Create a new directory
- Create Dockerfile that builds on python:3 and prints to stdout The Zen of Python (hint ‘this’ module)
  - Hint: it only takes 2 lines (one for FROM and one for CMD)
- Build/tag the image
- Push Image to local registry
- Delete image from local cache
- Run container

“I thought you said Kubernetes. Where’s the Kubernetes?”

The Motivation

- Google calculated “human errors” were root cause of over 99% of outages
- Continuous system changes
- Lack of deployment consistency and scalability

- Google creates Borg to address these issues for their own infrastructure
- Insane learning curve
- Engineer and operator ramp-up was (still is!) lengthy

- But 99.99% of users aren’t Google
  - infinitesimal scale in comparison
  - Budget, talent, etc.
  - Line of business

- A group of Googlers (Joe*, Brendan, et al) saw the opportunity
  - General applicability
  - Open Source

Full disclosure: * now CTO at Heptio

Design Principles

- Strong focus on developer and operator experience
- Easily extensible, with few opinions
- A subset of Borg, but for the masses

What can it do?

- Aggregate virtual and bare metal infrastructure into a cluster
- Container orchestration within clusters
- Provide straightforward app lifecycle management

Key Features

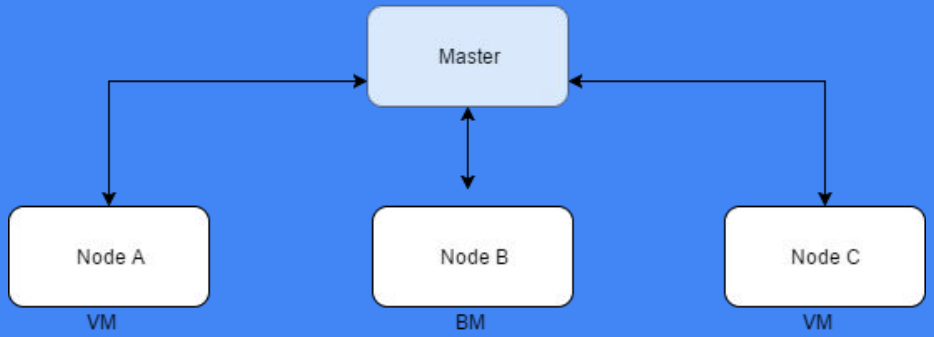
- Automatic bin packing
- Straightforward horizontal scaling
- Automatable rollouts/rollbacks
- Deployment “medic”
- Highly Fault Tolerant (including itself!)

Key Features

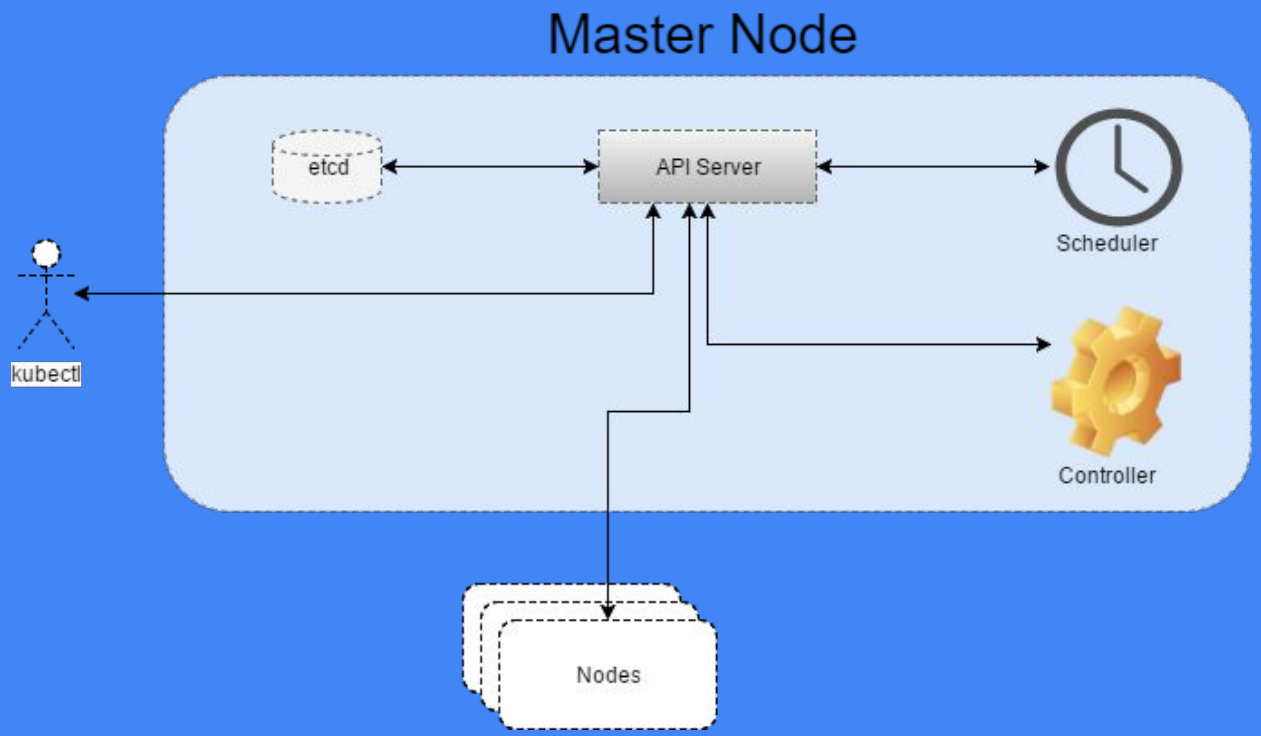
- Service discovery
- Load balancing
- Secret management
- And a lot more!

“Nice. But would like more specifics, though”

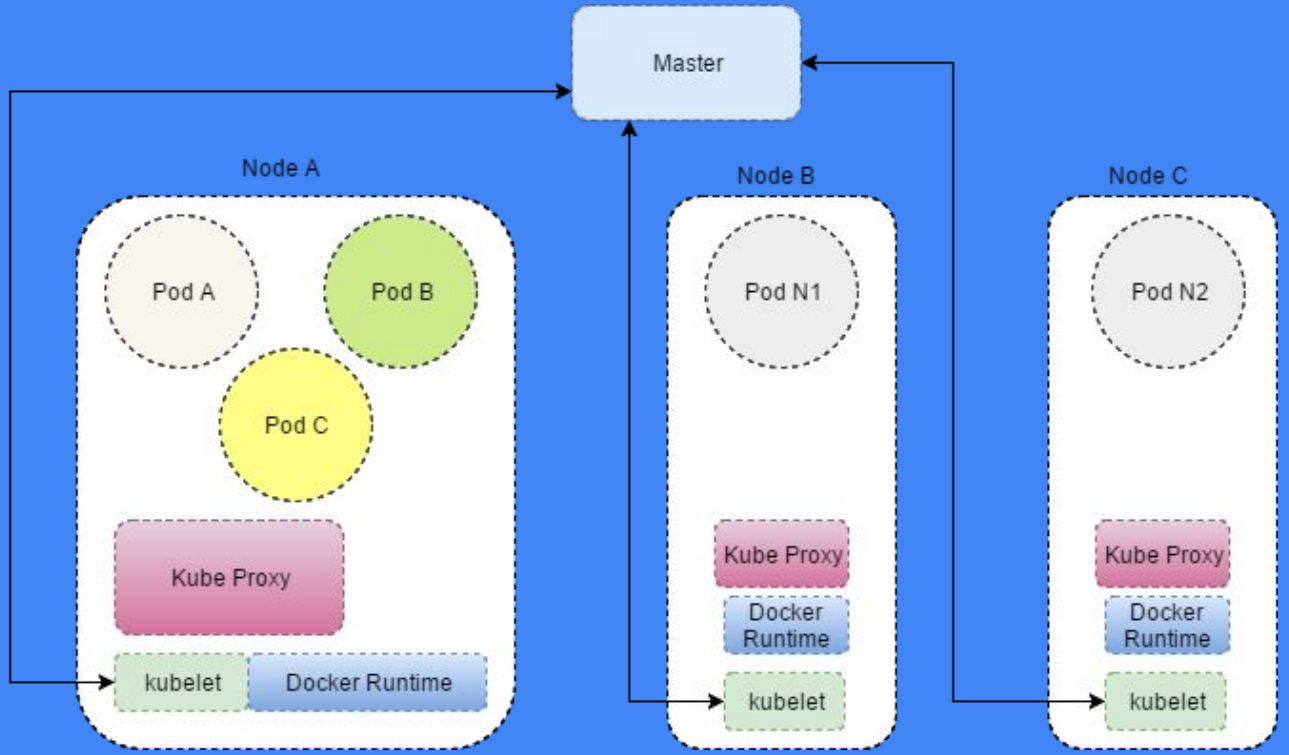
Orbital View



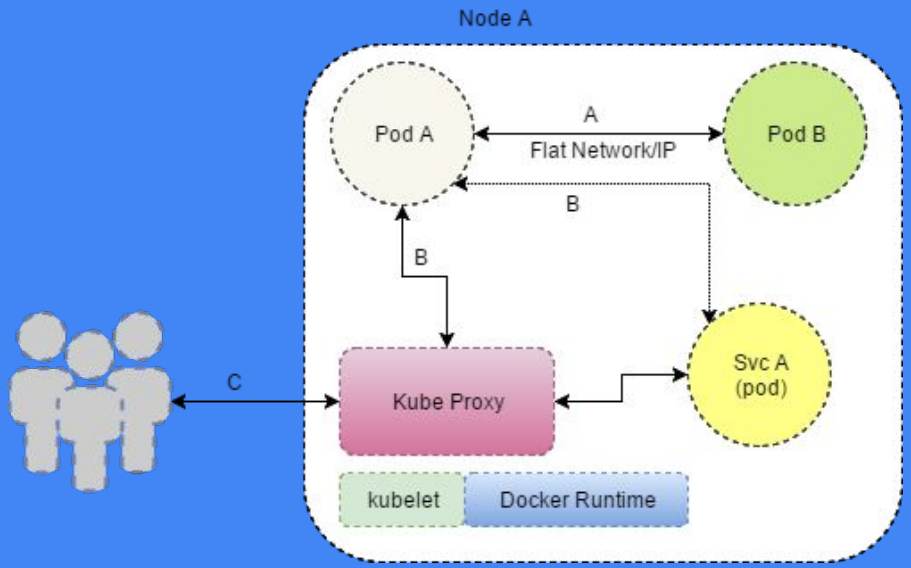
Zoom...enhance....


Master Node
etcd
API Server
Scheduler
kubectl
Controller
Nodes

Worker Nodes "Node" Zoom



Networking


Node A
Pod A
A
Flat Network/IP
Pod B
B
B
C
Kube Proxy
Svc A
(pod)
kubelet
Docker Runtime

Networking

- Scenario A: pod-to-pod (flat network, basic IP)
- Scenario B: Pod-to-Service (virtual-IP, through kubeproxy)
- Scenario C: External-to-service (fronted by a LB -- not shown -- and routed by kubeproxy)

Main Components: Objects

- Objects are persistent entities that manage and represent the state of certain parts of the system
  - Node
  - Service
  - Pod
  - Deployment … etc.

Main Components: Objects

- Objects describe state of:
  - What deployments/services are running
  - Node status
  - Services, storage
  - Deployments
  - Namespaces … etc.

A Necessary Segue:

Declarative	Imperative
● Describes the what ● How-agnostic ● It’s the main configuration paradigm used by Kubernetes (manifests)	● Denotes the how ● Context “illiterate” ● Dockerfiles ● Command line

A Necessary Segue:

Declarative	Imperative
Type: Command Action: printToConsole What: listContents Dir: app/v1	Linux: `ls /var/app/v1` Win: `dir c:\www\app\v1`

Pods

- Smallest unit of compute that can be managed by Kubernetes
  - Containers within pods run as if they’re in a single host
  - Share namespaces, IP addr and port space
  - Comms through localhost:port or over IPC
  - Mount/use same volumes

Labels

- Key/value pairs that are associated to objects and carry semantic value within Kubernetes
- Organize and select resources
- Commonly used to ID releases, environment, tiers
- Can be used as query selectors

Annotations

- Somewhat similar to Labels, except:
  - Can’t be queried (i.e. not indexed)
  - Usually good for bespoke/extended metadata

Services

- Fronts a group of Pods running on the cluster
  - Load balancing
  - Service Discovery
  - Enables gradual deployments/upgrades

Deployments

- Best object for deploying and managing applications in Kubernetes
- Manages the update process
- More

Back to the shell ...

Before we go ...

The End.

Tweet me @rdodev with comments or questions!

All material (including this slideshow, code, etc.) will be posted (in the conference Schedule) so that you can go back and run the examples on your own.