



Containers with Google: from Borg to Kubernetes



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Google

A man with a beard and a flat cap is sitting at a desk in an office, wearing large black headphones. He is looking at a computer monitor displaying code. On his desk are two other monitors, a laptop, a keyboard, and a green mug. The background shows a whiteboard with sticky notes.

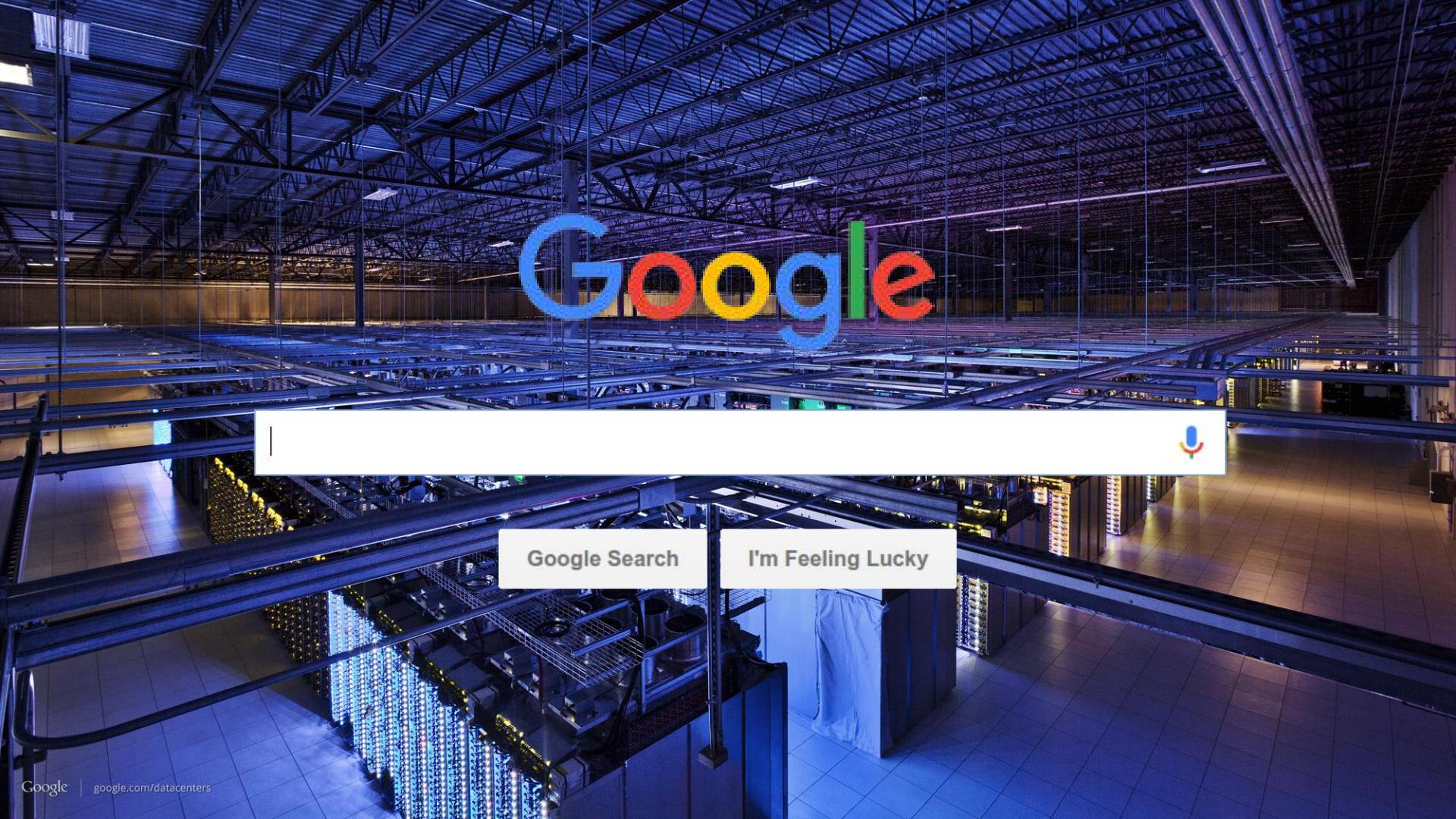
Better software, faster.

Google

A search bar with a blue cursor line on the left and a microphone icon with a red and blue gradient on the right.

Google Search

I'm Feeling Lucky

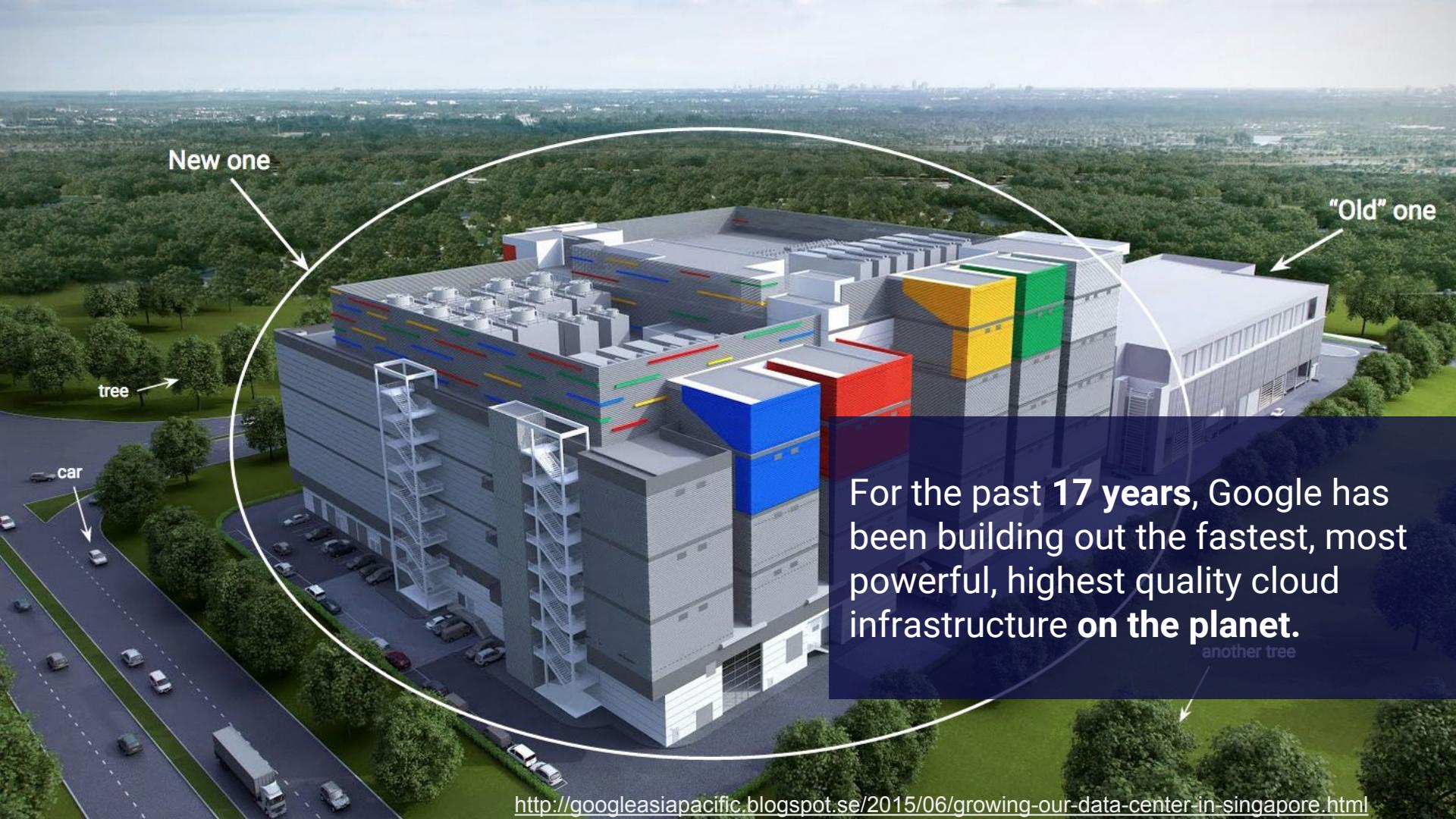


Google

Google Search

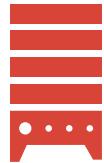
I'm Feeling Lucky





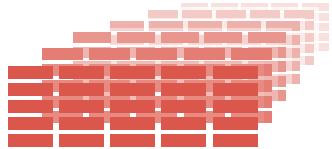
For the past **17 years**, Google has been building out the fastest, most powerful, highest quality cloud infrastructure **on the planet**.

Reliability comes from software



1 device

MTBF = 10 years



100K devices
(servers, routers, networking,
power supplies, cooling, ...)

MTBF =
1 hour



Now

Assembly required

1st Wave Colocation

Your kit, someone
else's building.
Yours to manage.



Storage



Processing



Memory



Network

2nd Wave Virtualized Data Centers

Standard virtual kit for
Rent. Still yours to
manage.

Next

True On Demand Cloud

3rd Wave An actual, global elastic cloud

Invest your energy in
great apps.



Clusters



Distributed Storage, Processing
& Machine Learning



Containers



Spotify®



Paul Lamere

@plamere

Follow

Google's BigQuery is *da bomb* - I can start with 2.2Billion 'things' and compute/summarize down to 20K in < 1 min.

RUN QUERY

Save Query

Save View

Format Query

Hide Options

Query complete (53.6s elapsed, 118 GB processed)

Stage 1	2,176,340,623	1,774,245,185
Stage 2	1,121,777,524	1,121,777,524
Stage 3	15,064,967	15,064,967
Stage 4	23,508,239	23,508,239
Stage 5	1,774,245,185	189,340,685
Stage 6	189,340,685	20,000

How Spotify is ahead of the pack in using containers | Gigaom

February 25, 2015

<https://gigaom.com/2015/02/22/how-spotify-is-ahead-of-the-pack-in-using-containers/>



Mattias P Johansson

@mpjme

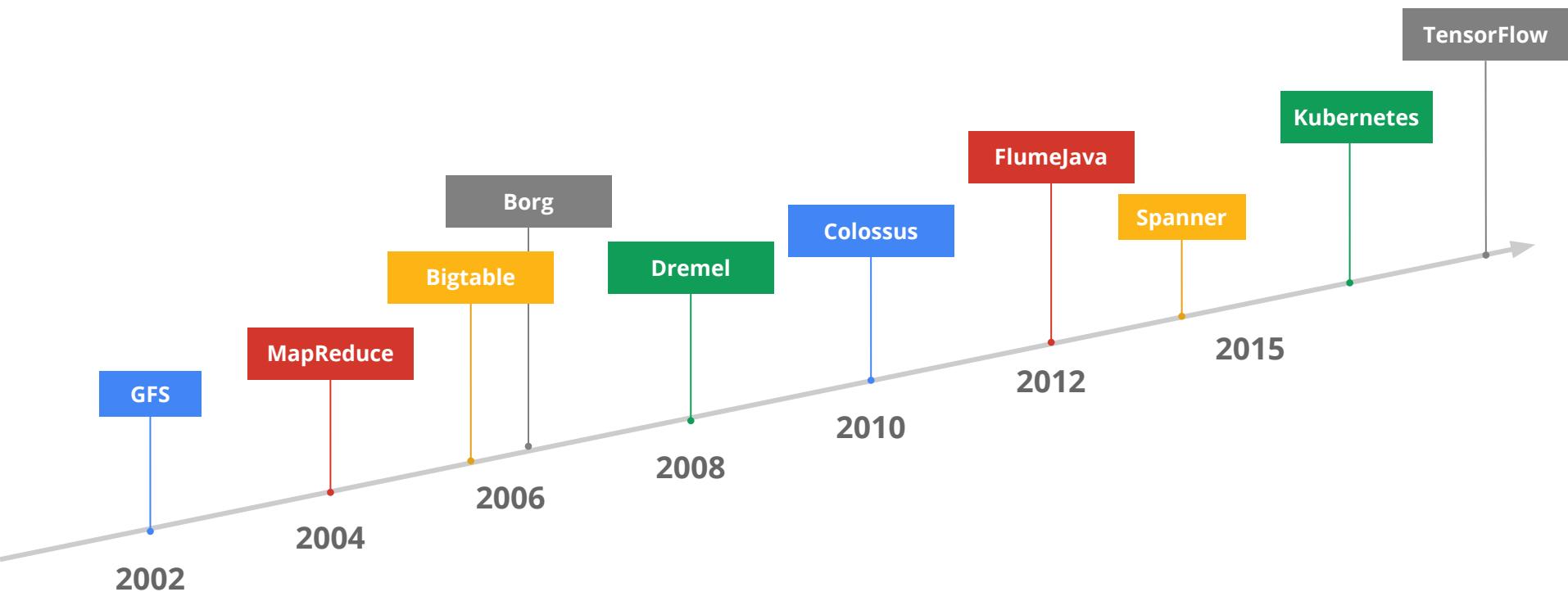
Follow

FINALLY I CAN TELL THE WORLD THAT
BIGQUERY IS THE BEST THING THAT HAS
EVER HAPPENED TO ME

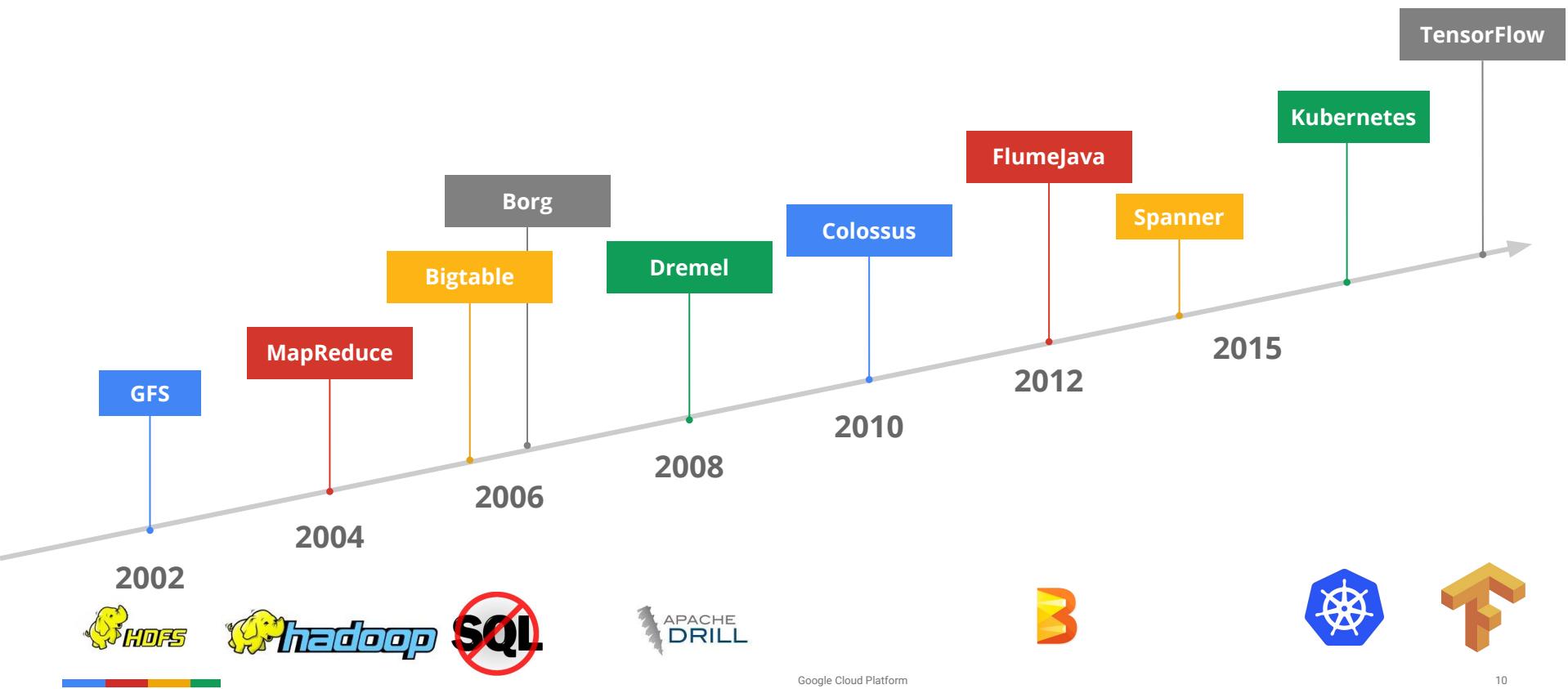
[news.spotify.com/us/2016/02/23/ ...](news.spotify.com/us/2016/02/23/)

@BigDataWizard

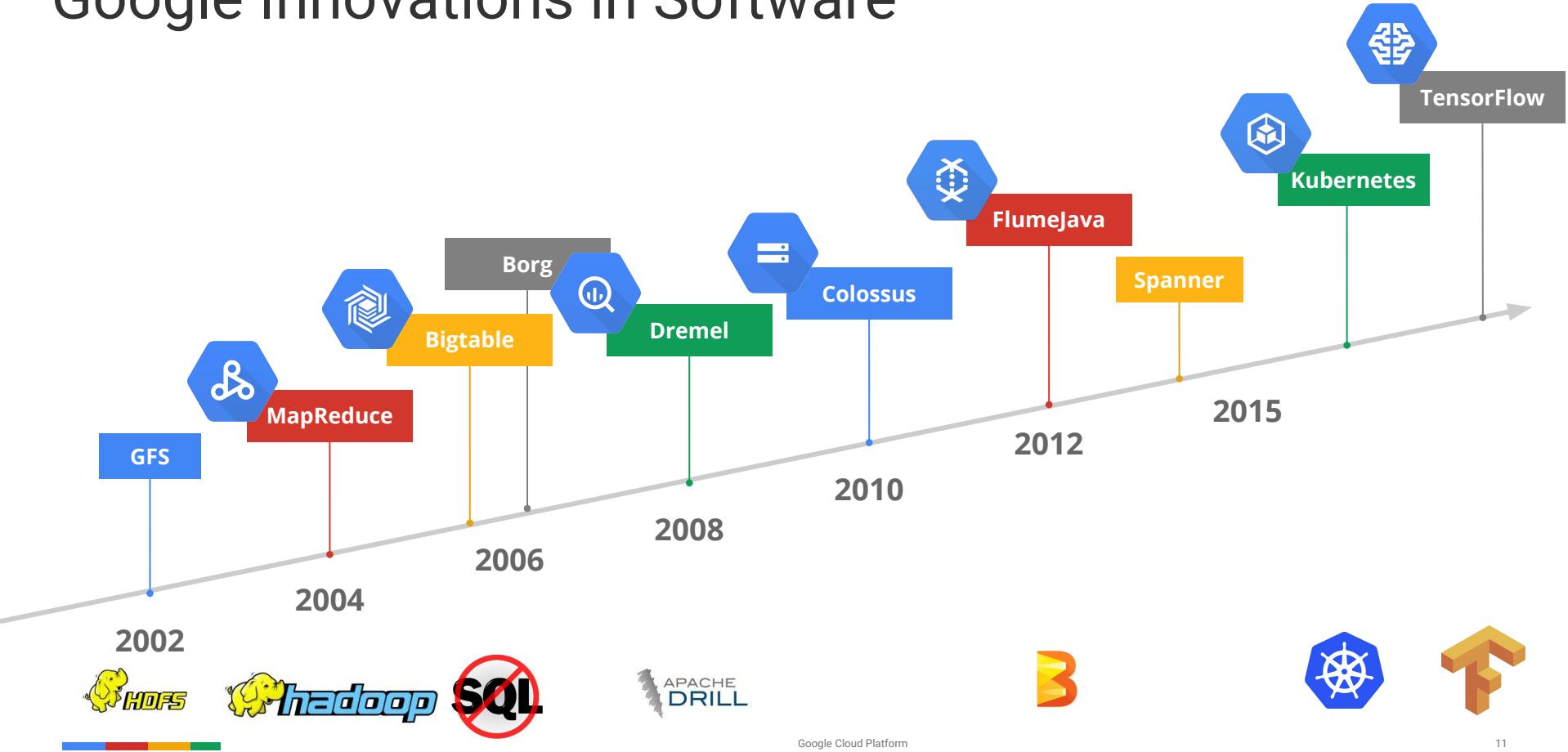
Google Innovations in Software



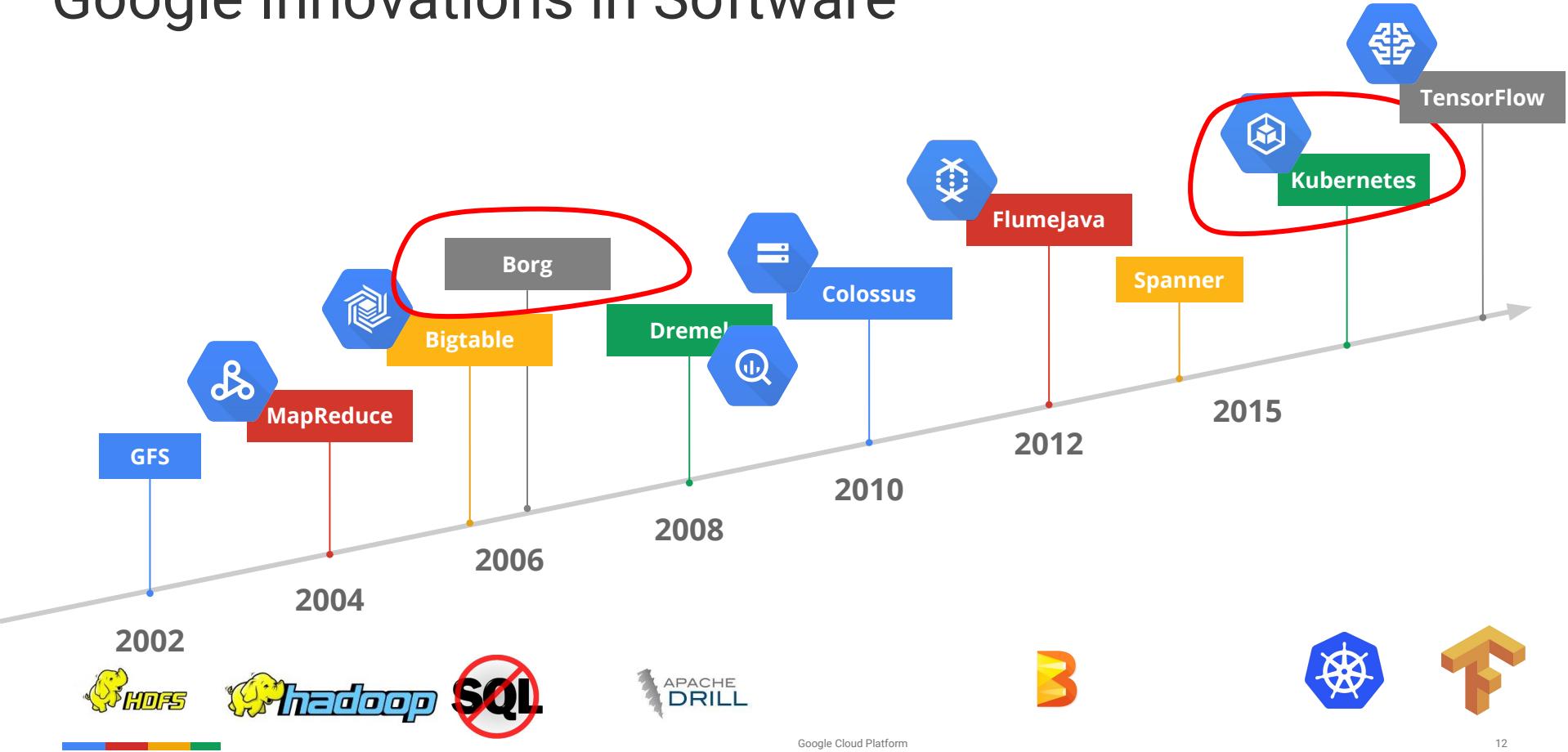
Google Innovations in Software



Google Innovations in Software



Google Innovations in Software



Containers

At Google, everything runs in a container



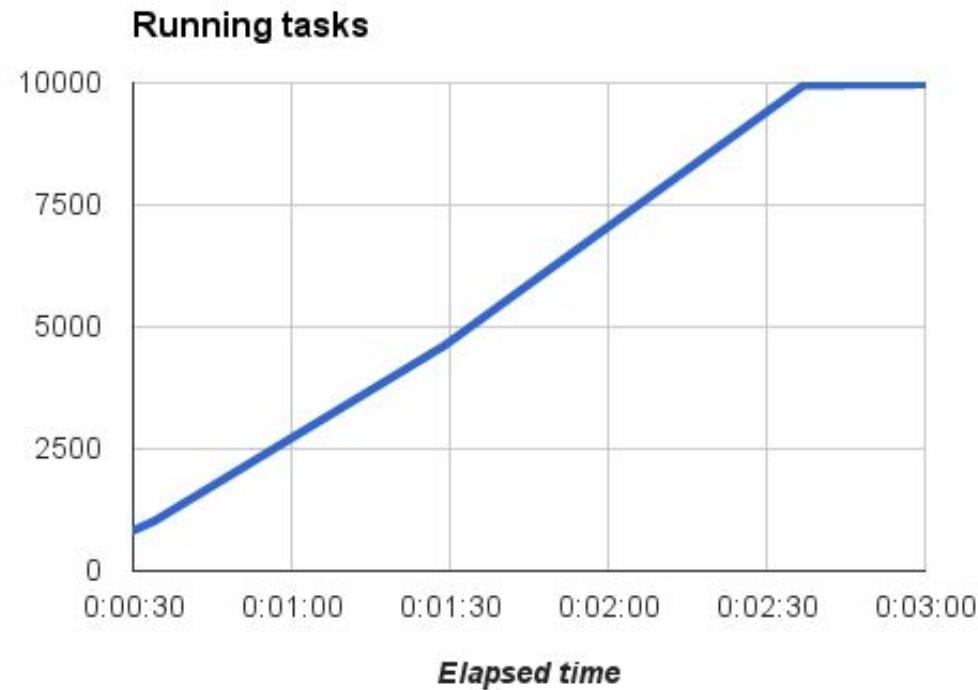
Image by Connie Zhou

Developer View

```
job hello_world = {
    runtime = { cell = 'ic' }                      // Cell (cluster) to run in
    binary = '.../hello_world_webserver'           // Program to run
    args = { port = '%port%' }                     // Command line parameters
    requirements = {                               // Resource requirements
        ram = 100M
        disk = 100M
        cpu = 0.1
    }
    replicas = 10000     // Number of tasks
}
```



Developer View



Developer View

What just
happened?

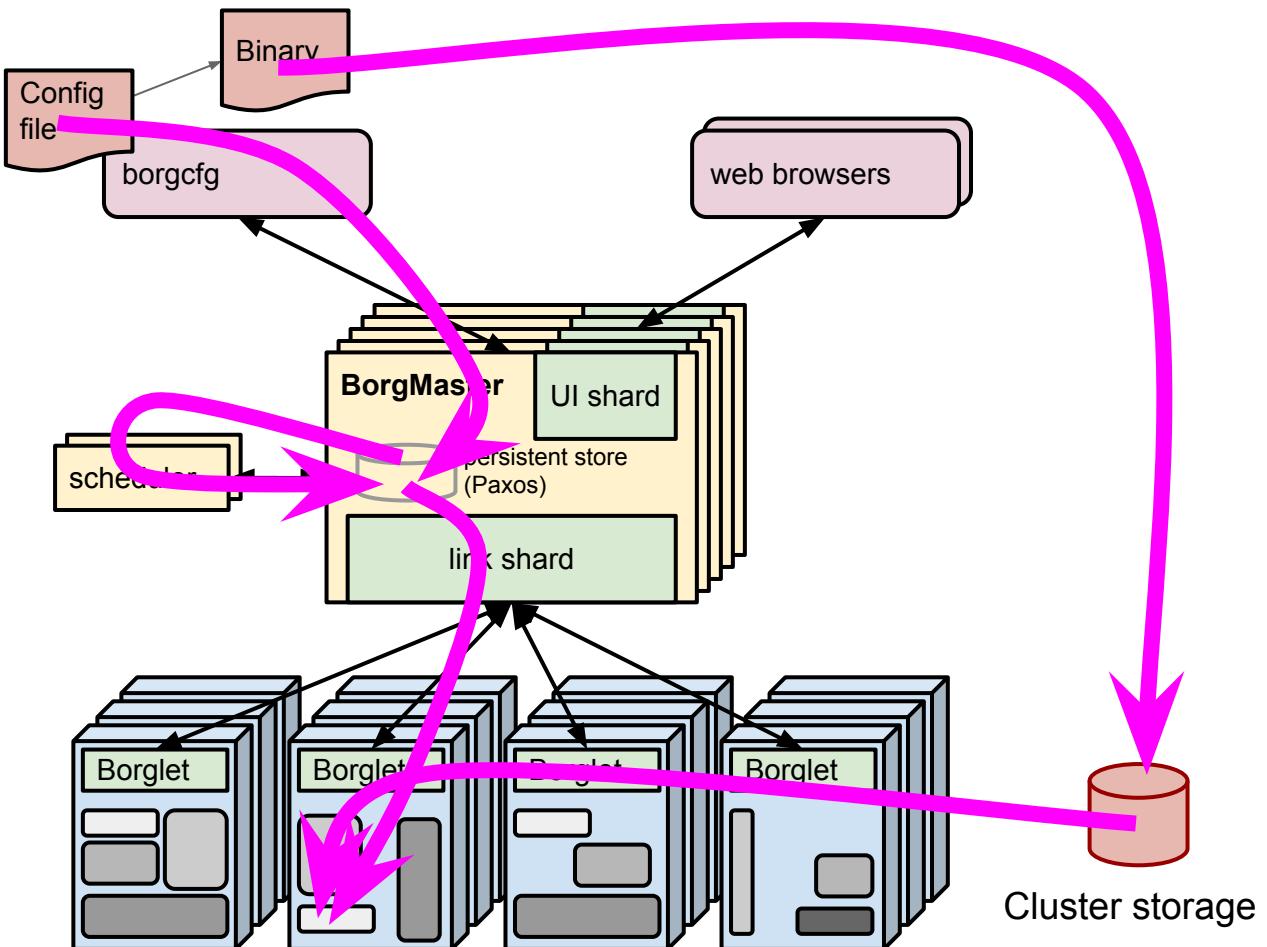


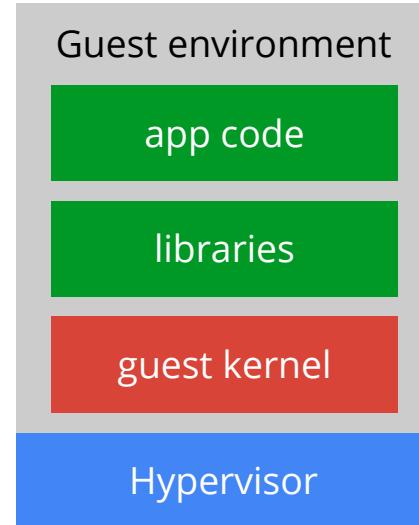


Image by Connie Zhou

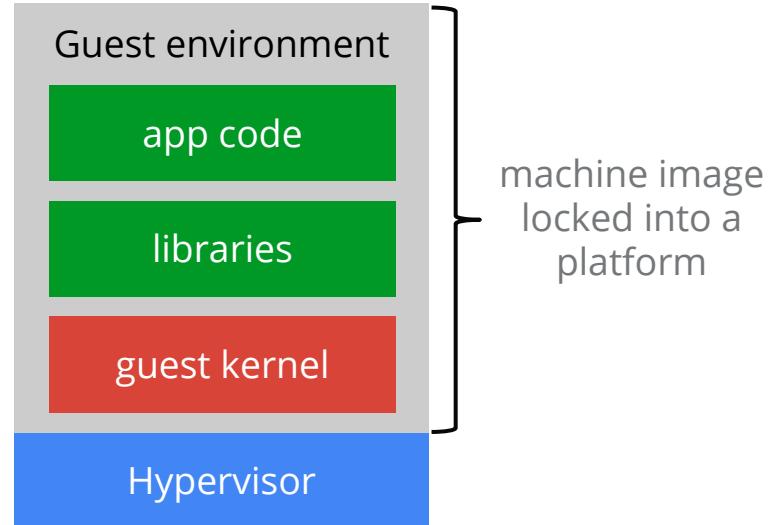
A wide-angle photograph of a massive server room. The space is filled with floor-to-ceiling server racks, their front panels glowing with various lights. A complex network of white plastic pipes runs across the ceiling and hangs from the structural beams below. The room is dimly lit, with most light coming from the equipment itself and some recessed lighting in the ceiling. The perspective is from one end of the room, looking towards the other.

So why containers?

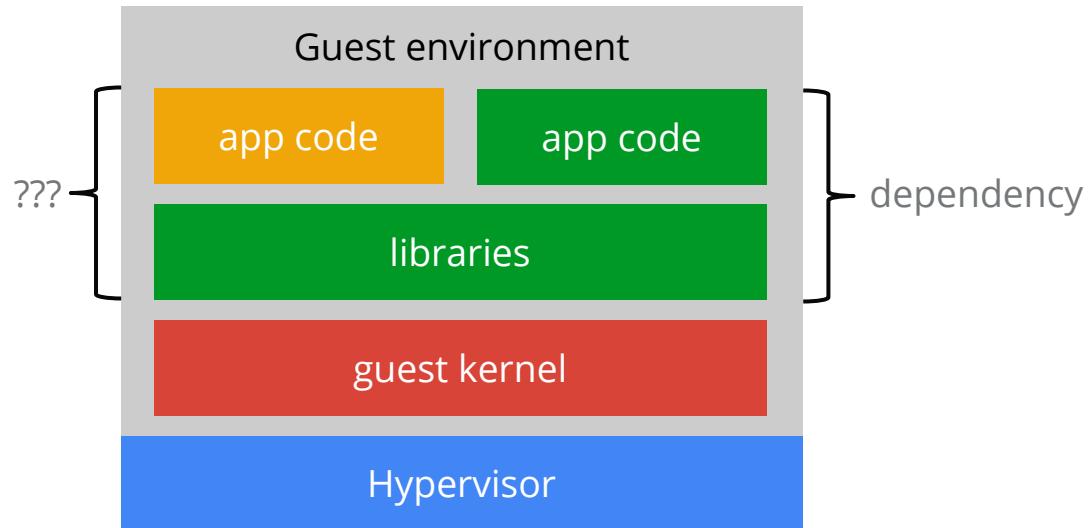
This is vanilla virtualization



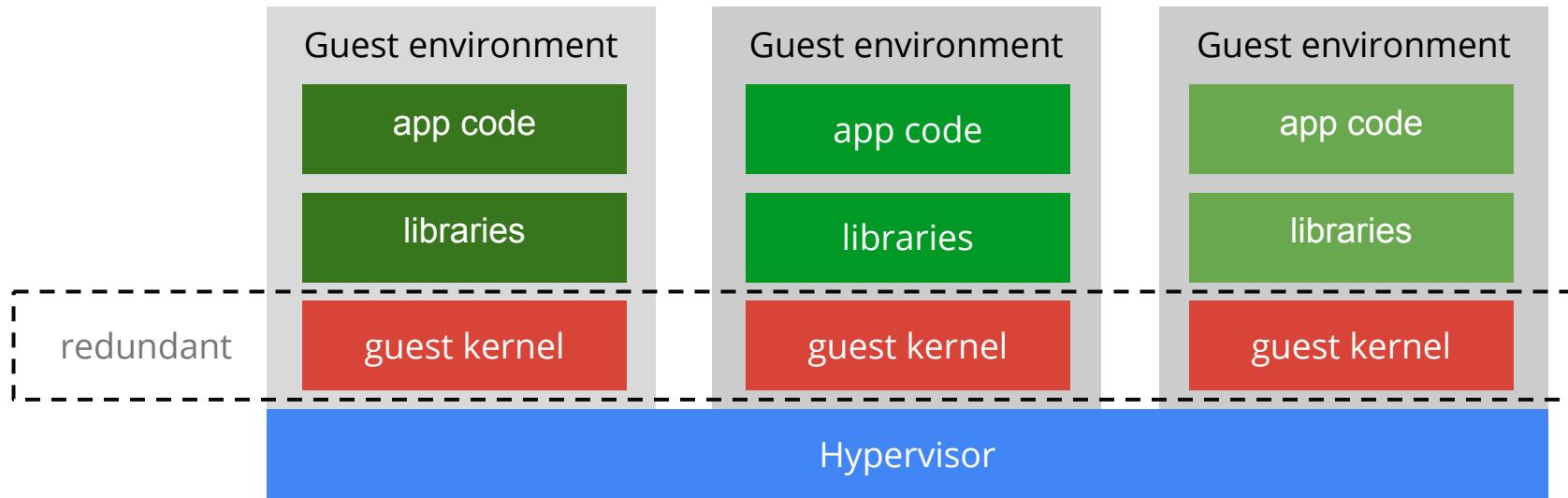
It has downsides:
Not portable & opaque



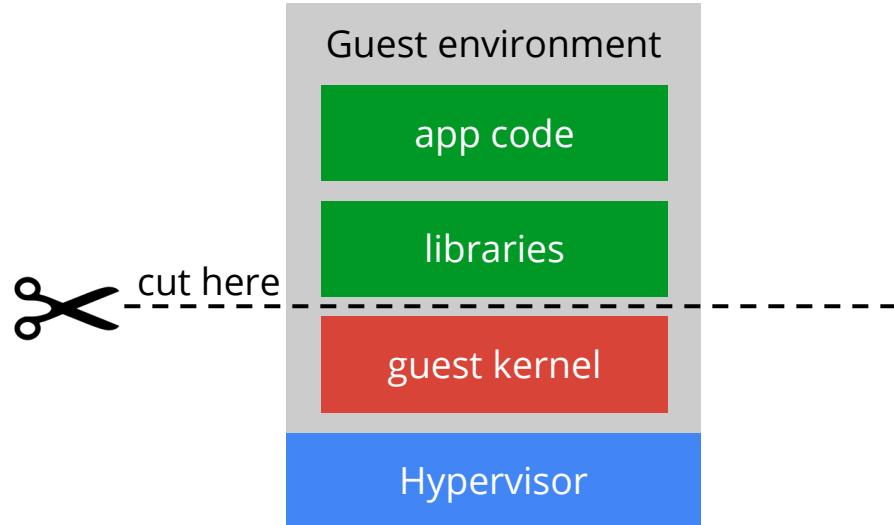
It has downsides: No Isolation



It has downsides:
Little Reuse



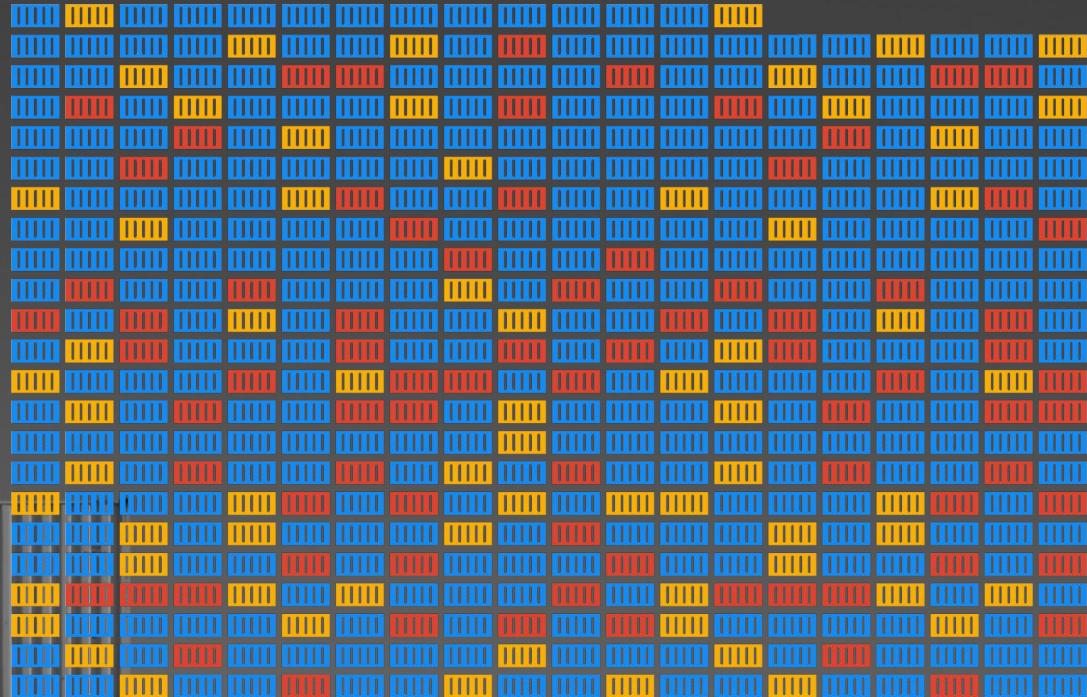
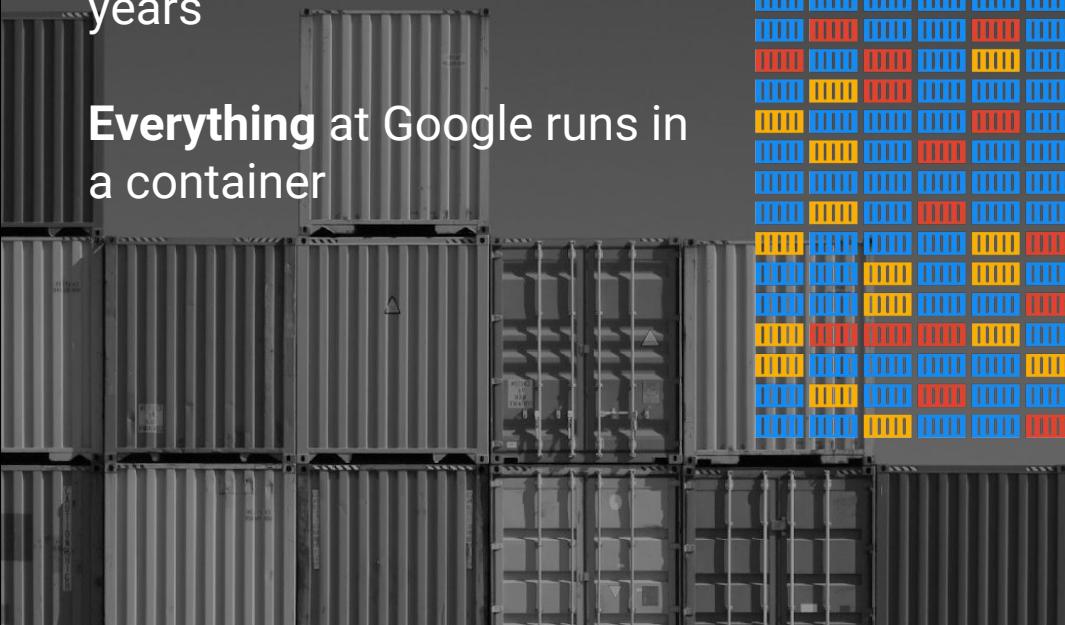
Containers create a better abstraction layer



Containers at Google

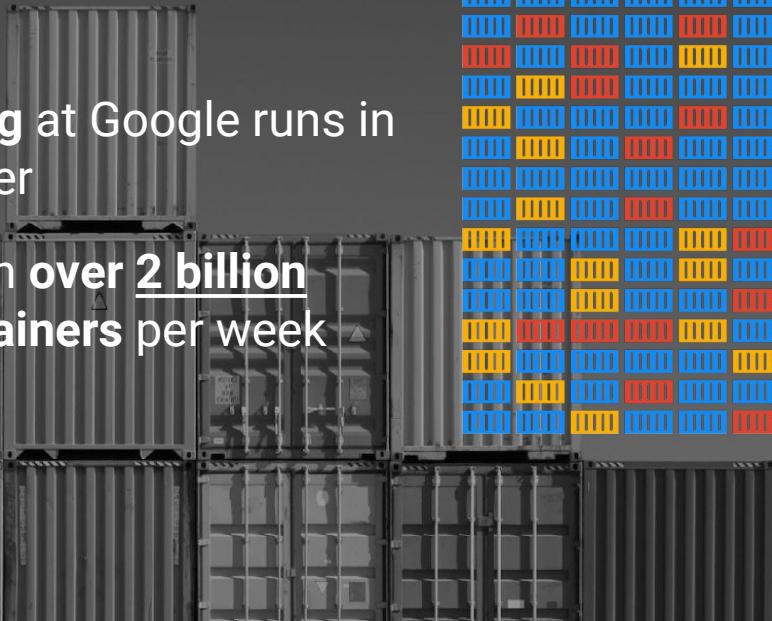
Google is using container technology for more than 10 years

Everything at Google runs in a container



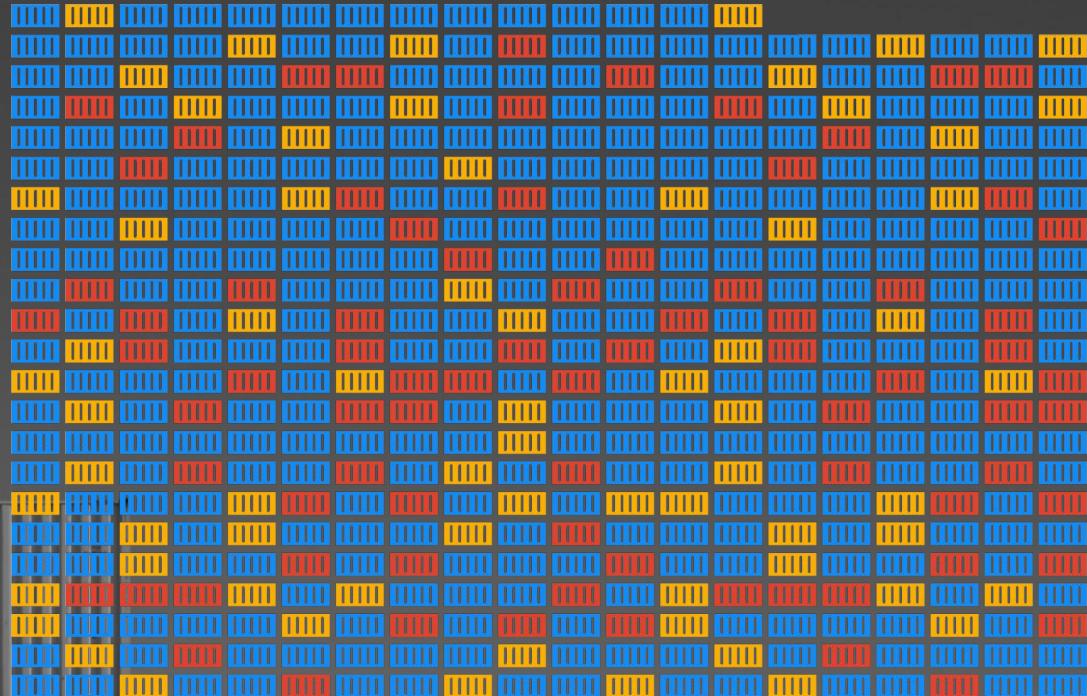
Containers at Google

Google is using container technology for more than 10 years

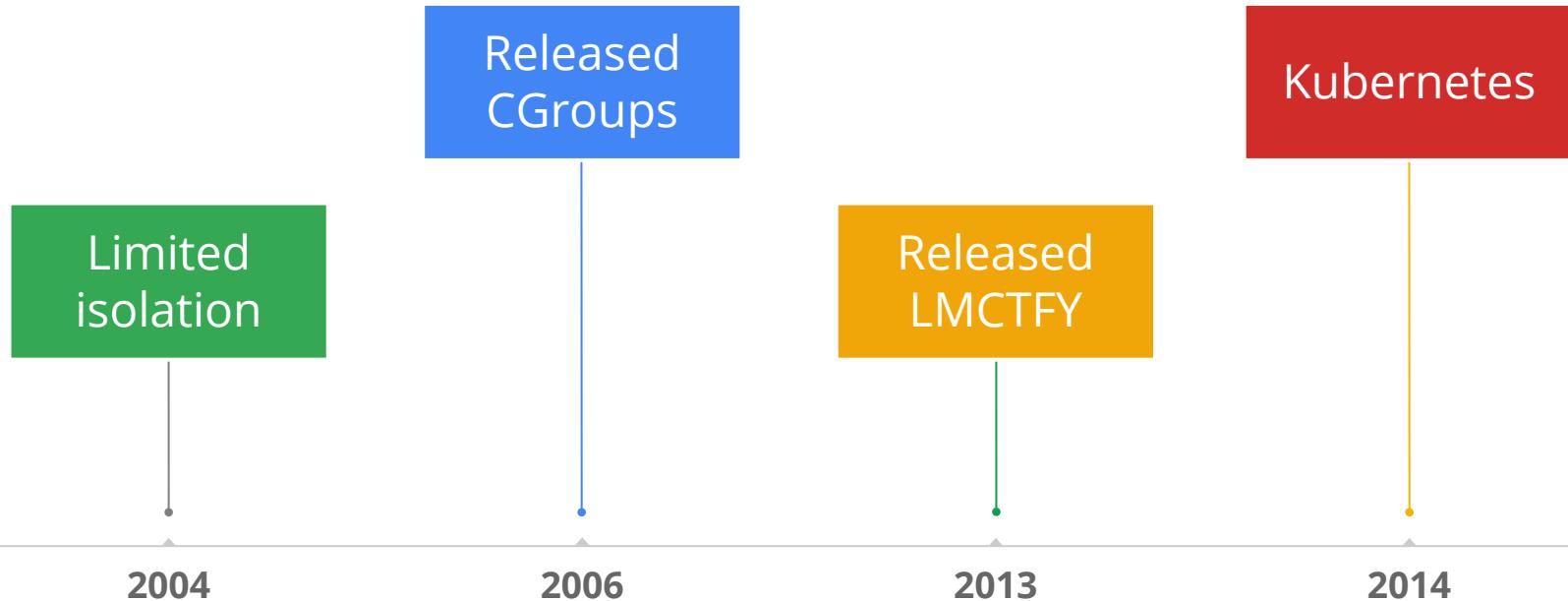


Everything at Google runs in a container

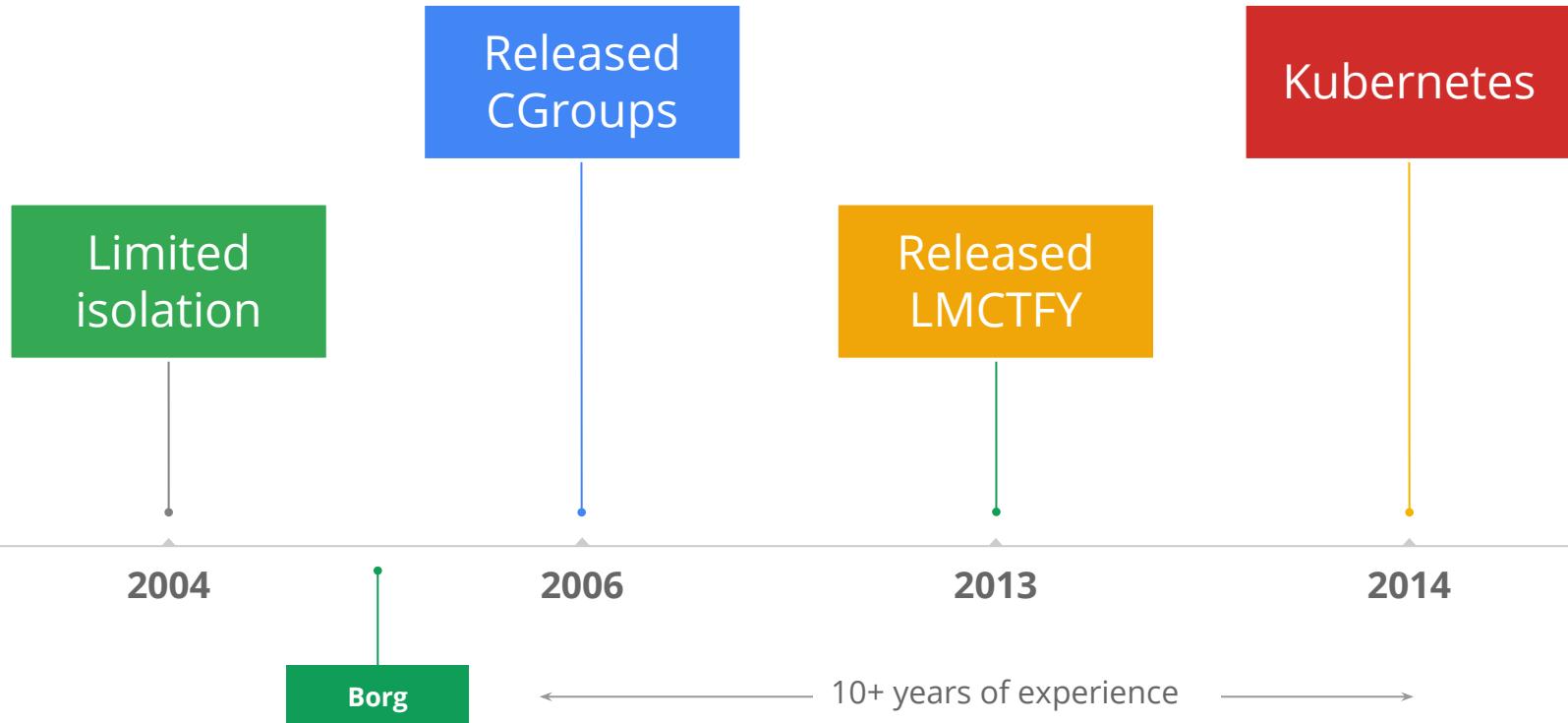
We launch **over 2 billion** new containers per week

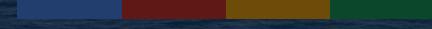


Google and container technology



Google and container technology





So why Kubernetes?

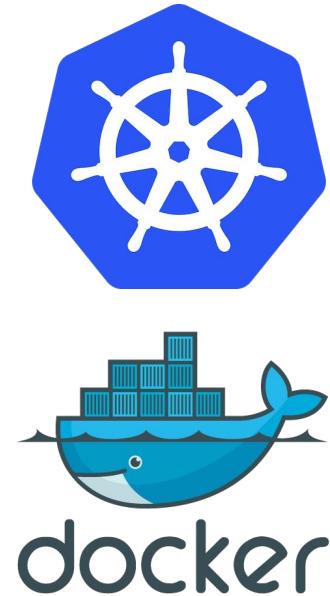


https://en.wikipedia.org/wiki/MV_Rena

Kubernetes

- Container **orchestrator**
- Builds on **containers** (Docker, Rocket)
- Handles **container and node failure**
- Multiple **cloud and bare-metal environments**
- **100% Open Source**, written in Go

Let users manage **applications**, not machines



Open Source

5k Commits
in 1.2

+50% Unique
Contributors

Top 0.01% of all
Github Projects

1200+ External
Projects Based on
K8s

Companies
Contributing



Companies
Using



Kubernetes

Greek for “*Helmsman*”; also the root of the words “*governor*” and “*cybernetic*”

- Runs and manages containers
- Inspired and informed by Google’s experiences and internal systems
- Supports multiple cloud and bare-metal environments
- Supports multiple container runtimes
- **100% Open source**, written in Go

Manage applications, not machines



Concepts Intro

Container



Pod



Service



Volume



Label



Replication
Controller

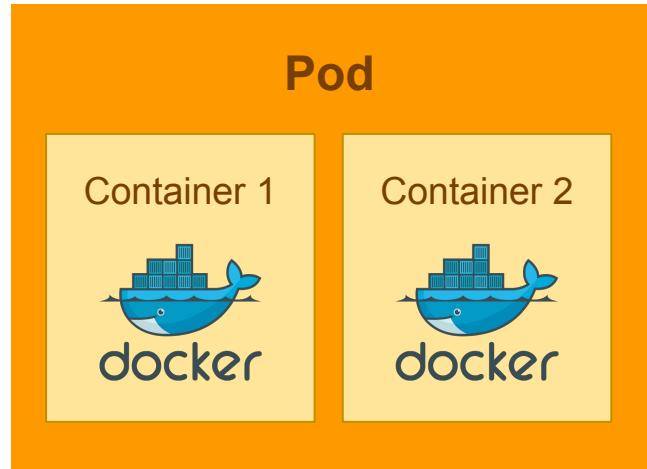


Node

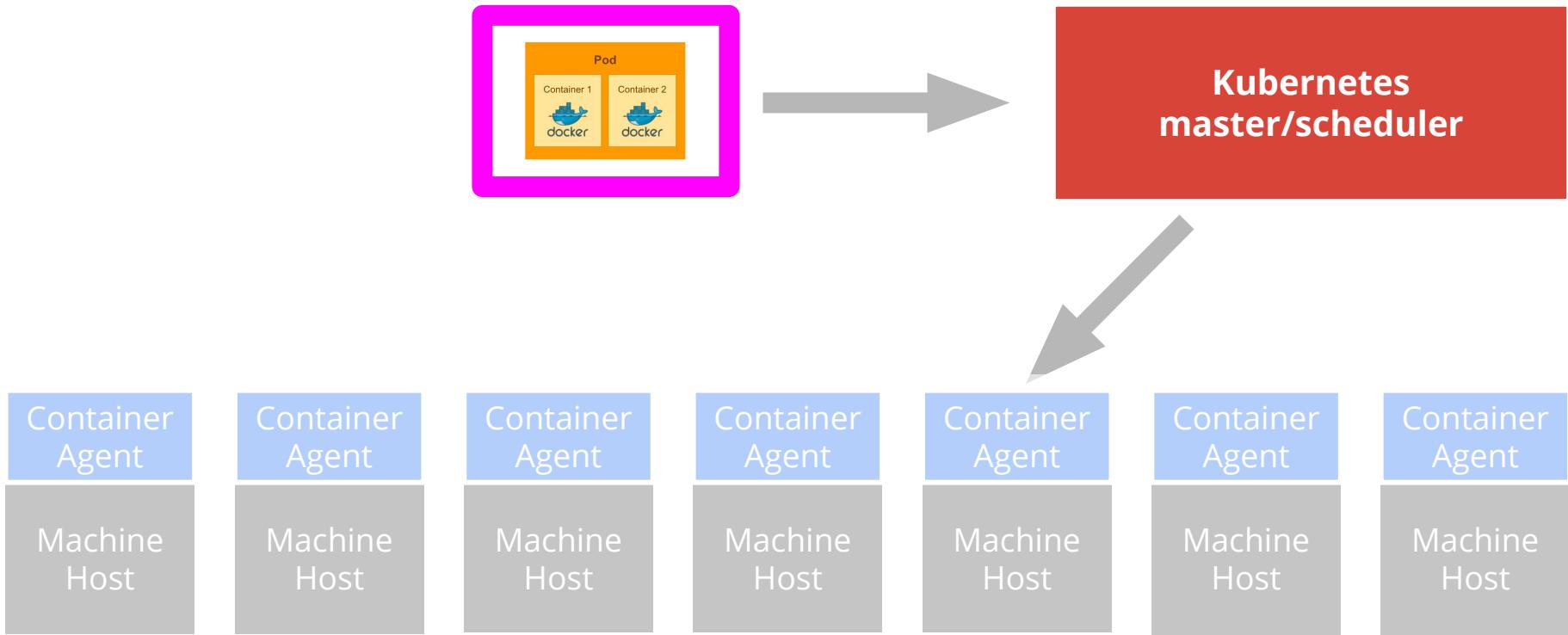


Pods

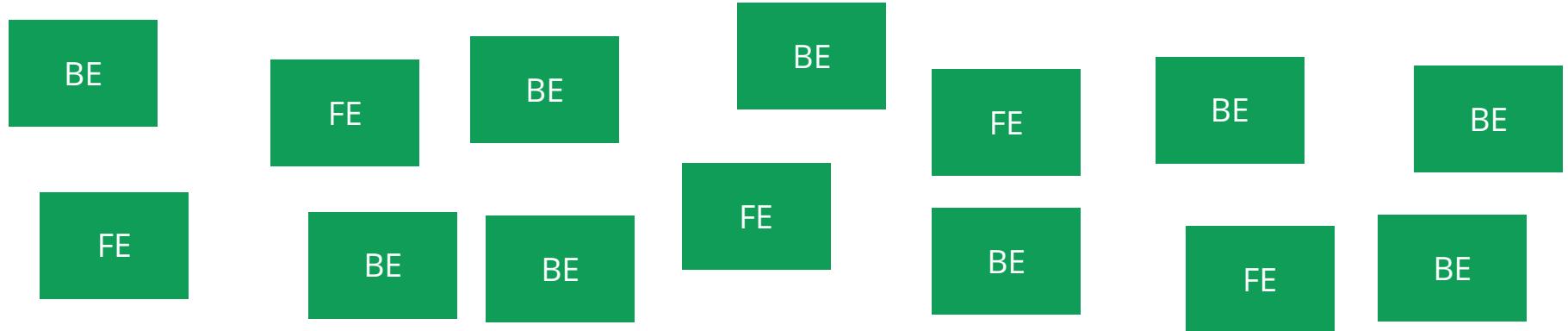
- A group of one or more containers sharing fate
- Containers in a pod run in a shared context (tcp/ip, sockets)
 - Can communicate via `localhost`
- Considered to be relatively ephemeral (rather than durable) entities



Pods



Labels

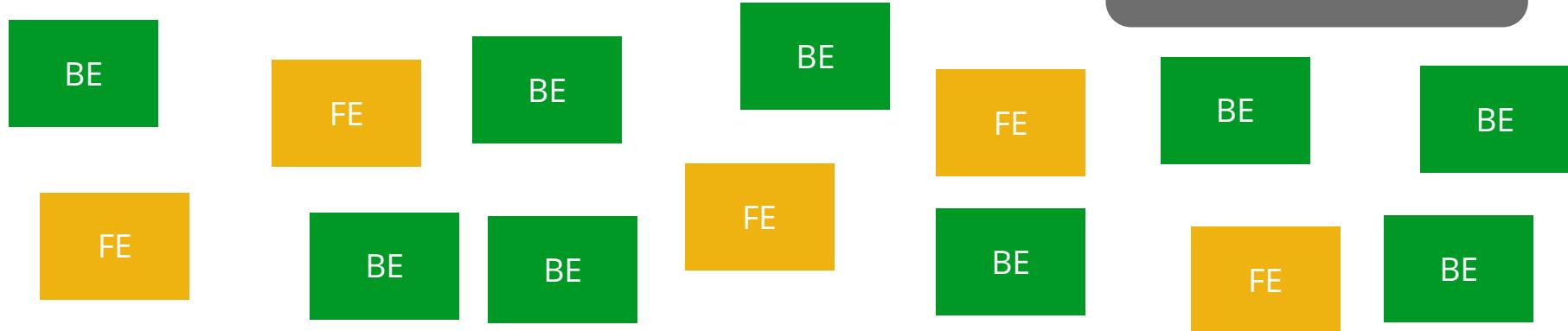


Kubernetes master/scheduler



Label selectors

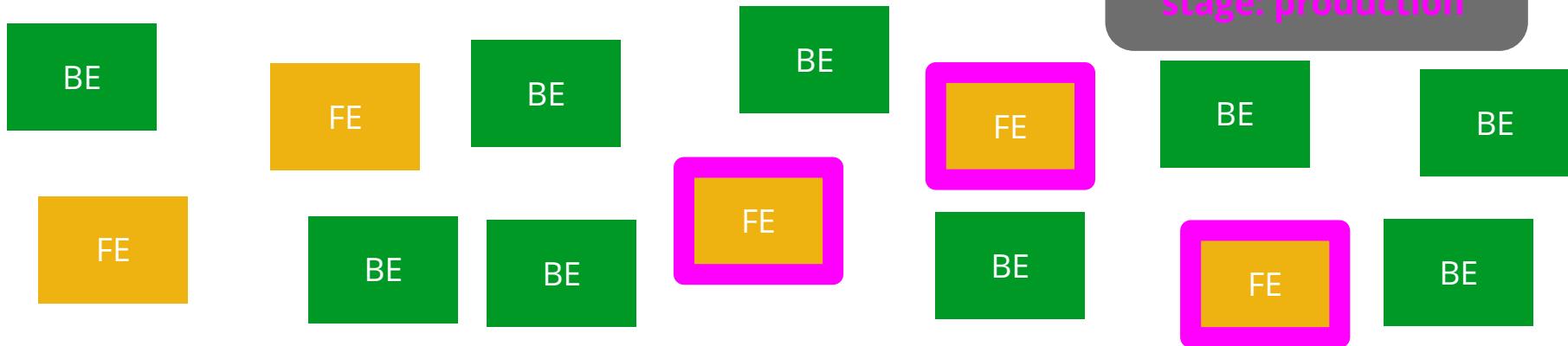
labels:
role: frontend



Kubernetes master/scheduler



Label selectors



Kubernetes master/scheduler



Replica controller



Kubernetes - Master/Scheduler



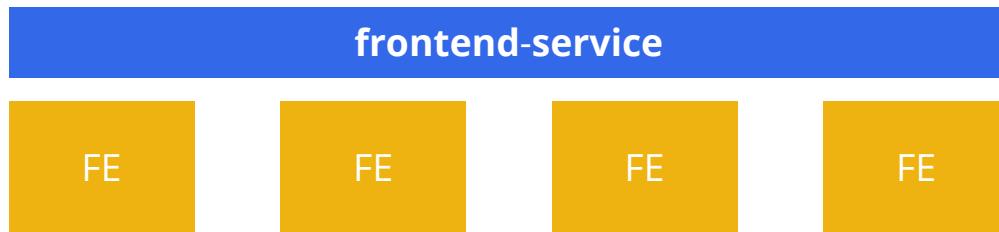
Replica controller



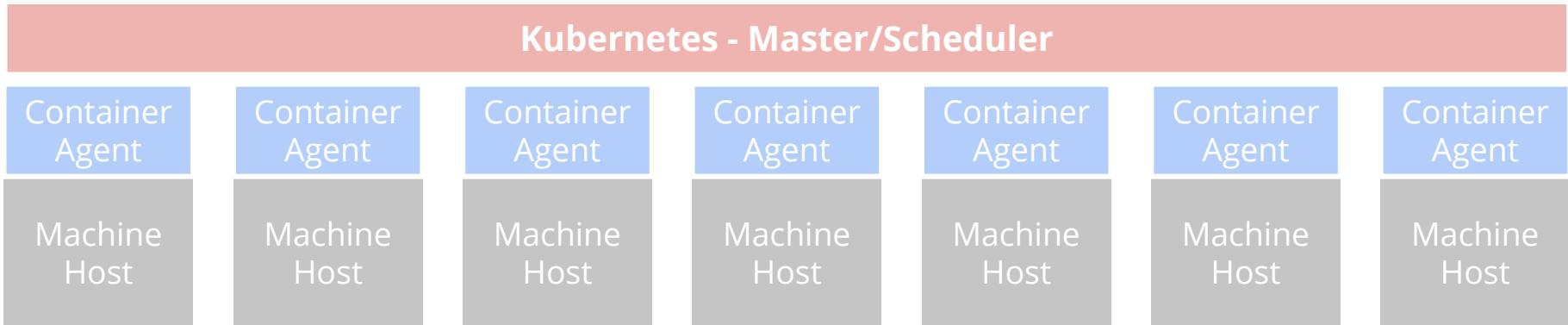
Kubernetes - Master/Scheduler



Service



id: frontend-service
port: 9000
labels:
role: frontend



Pod example

```
apiVersion: v1
kind: Pod
metadata:
  name: wordpress
spec:
  containers:
    - image: wordpress
      name: wordpress
      env:
        - name: WORDPRESS_USER
          value: wp_user
```



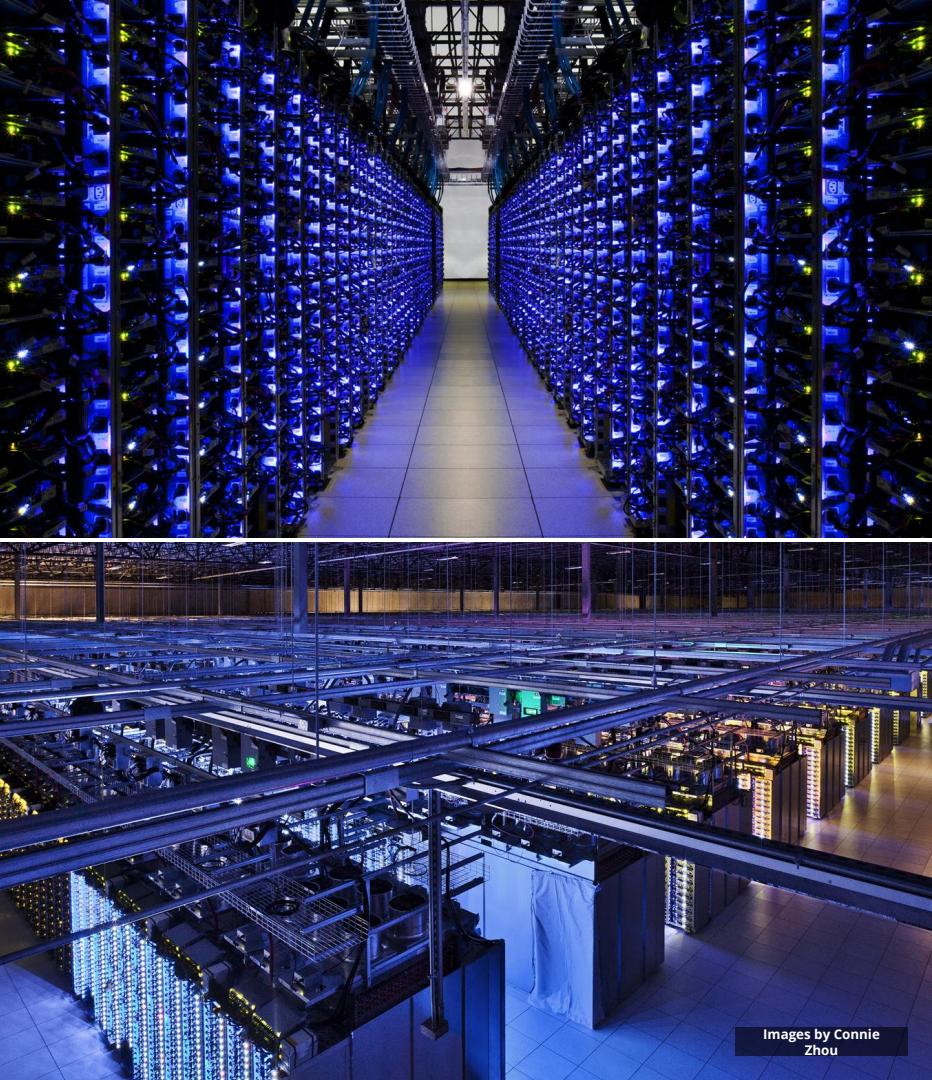
Public image from [Docker Hub](#).
Private images have the form
gcr.io/<your-project>/<your-image>



Why containers?

- Performance
- Repeatability
- Quality of service
- Accounting
- Portability

A **fundamentally different** way of managing **applications**





Host it in the cloud
or on premise

Google Container Engine

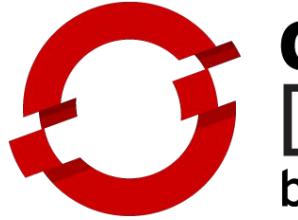


- The easiest way of getting started with Kubernetes
- Managed by Google
- Cloud Logging and Monitoring integrated out-of-the-box
- Once connected, it's just Kubernetes

```
# Create cluster  
gcloud container clusters create hello-world --num-nodes 3
```

```
# Connect Kubernetes  
gcloud container clusters get-credentials hello-world
```

```
# Use Kubernetes  
kubectl get pods
```



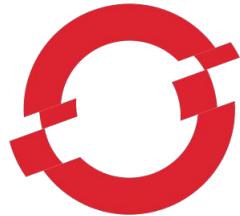
OPENSHIFT DEDICATED

by Red Hat®

(Coming soon)

- A collaboration between **Google** and **Red Hat**
- Deploy your Docker containers in a **IaaS platform managed by Red Hat**
- **Migrate your application seamlessly** between Google Cloud and your own premises
- **Portable:** move your application to your own Data Center using **Open Shift Online or Open Shift Enterprise.**

Hosting Kubernetes



OPENSIFT

**Hosting for Kubernetes in the hybrid cloud
Online, Enterprise or Dedicated
Managed by Red Hat or hosted yourself**



**Hosting for Kubernetes in Google Cloud Platform
Managed by Google
Scale with a click**

A wide-angle photograph of a massive server room. The space is filled with floor-to-ceiling server racks, their front panels glowing with various colors like blue, green, and yellow. A complex network of steel beams and pipes forms a grid-like ceiling structure. The floor is made of large, light-colored tiles. In the background, there are more server racks and some bright lights. The overall atmosphere is dark and industrial.

Questions?

<http://kubernetes.io>