Apache Hadoop YARN: Present and Future 2017

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Hortonworks Inc

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POWERING THE FUTURE OF DATA™

About.html

- Apache Hadoop PMC, ASF Member
- Yahoo! -> Hortonworks
- 10 years of (only) Hadoop
  - Finally the job-adverts asking for “10 years of Hadoop experience” have validity
- ’Rewritten’ the Hadoop processing side – Became Apache Hadoop YARN
- Running compute platform teams at Hortonworks: YARN, MapReduce, Slider, container cloud on YARN

Agenda

- Introduction
- Past
- Present & Future

Hadoop Compute Platform – Today and Tomorrow

- It's all about data!
- Layers that enable applications and higher order frameworks that interact with data
- Multi-colored YARN
  - Apps
  - Long running services
- Admins and admin tools (Ambari) for cluster management and monitoring

https://www.flickr.com/photos/happyskrappy/15699919424

Why?

- Different asks from different actors
- On isolation, capacity allocations, scheduling

Faster!

More!

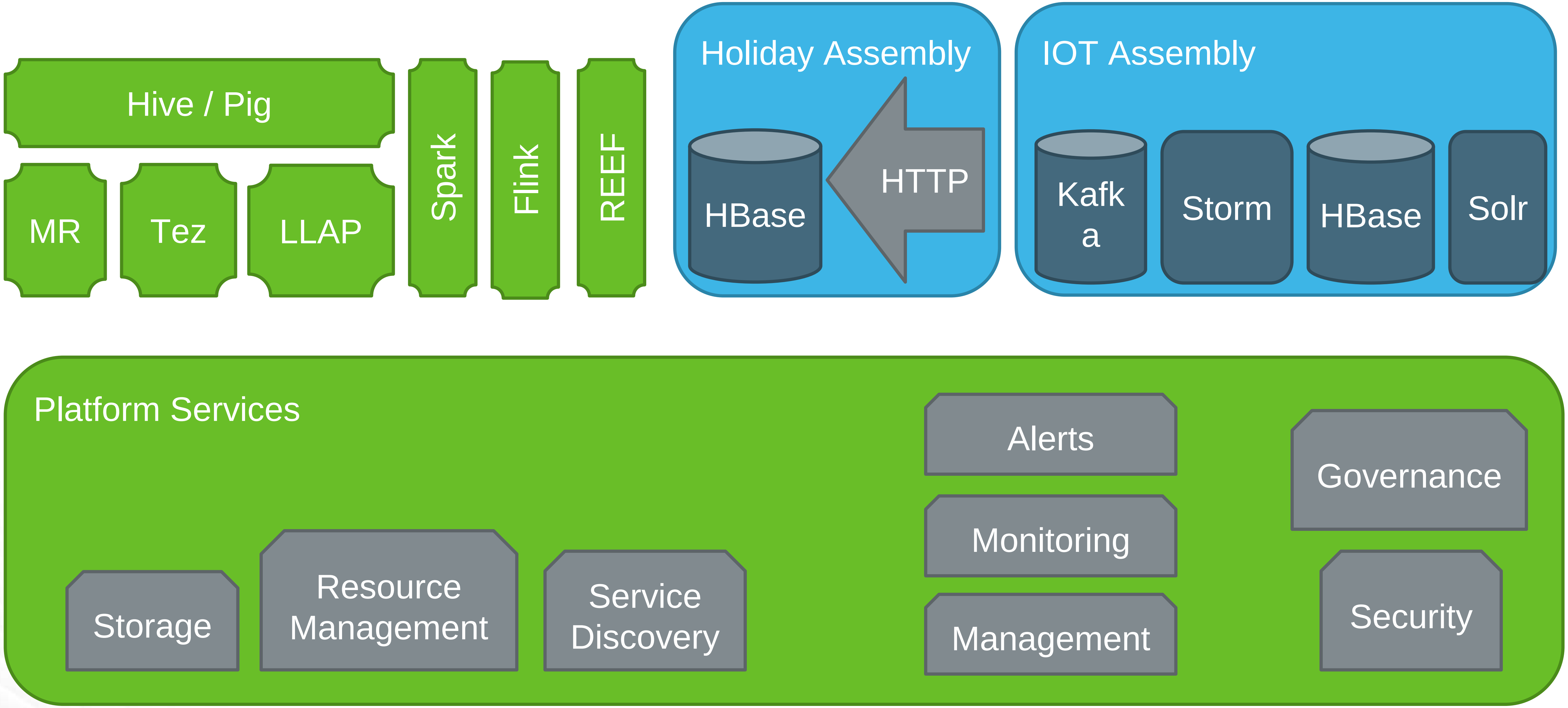
SLA!

Everything!

Right now!

Best for my cluster
Throughput
Utilization
Elasticity
Service uptime
Security
ROI

Hadoop Compute Platform – Today and Tomorrow



Past: A quick history

A brief Timeline: Pre GA

- **Sub-project of Apache Hadoop**
- **Releases tied to Hadoop releases**
- **Alphas and betas**
  - In production at several large sites for MapReduce already by that time

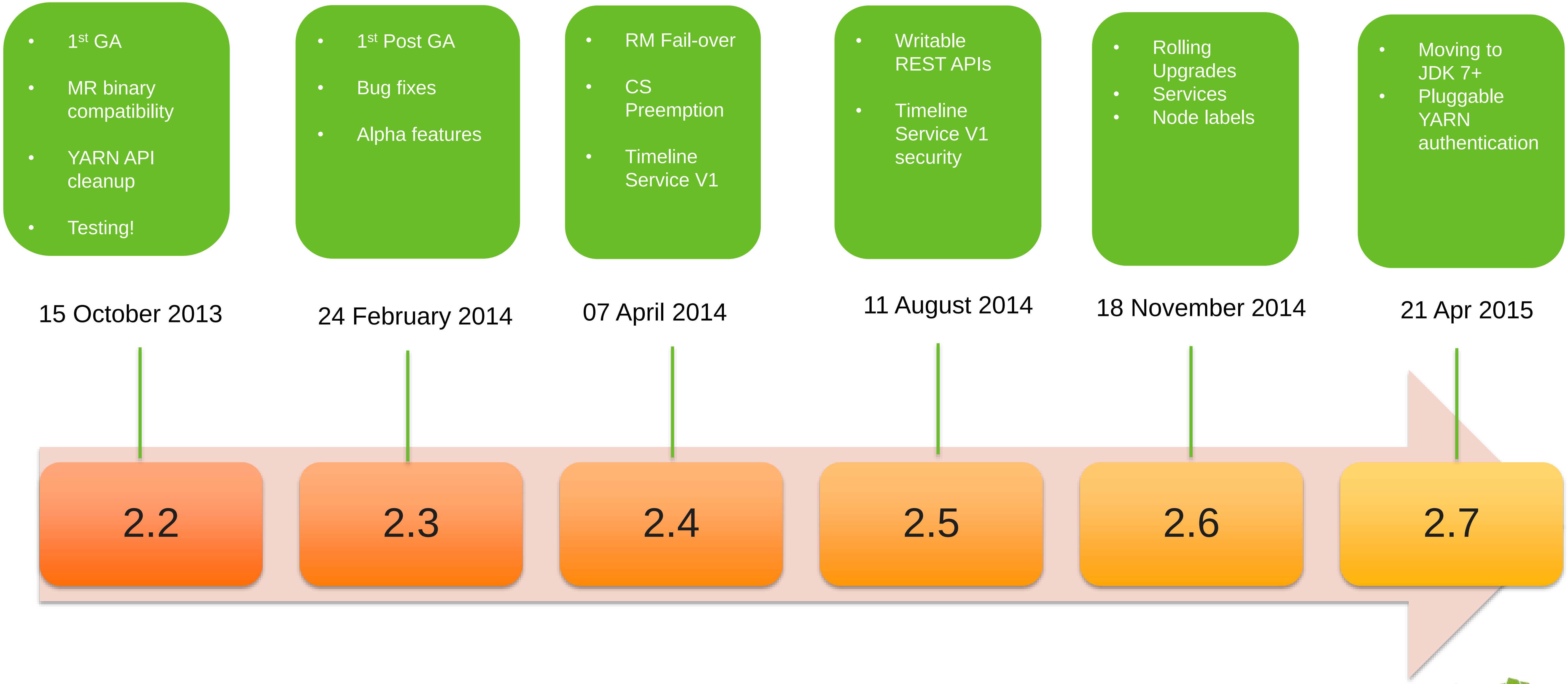
June-July 2010

August 2011

May 2012

August 2013

A brief Timeline: GA Releases 1/2



- 1st GA
- MR binary compatibility
- YARN API cleanup
- Testing!

15 October 2013

2.2

- 1st Post GA
- Bug fixes
- Alpha features

24 February 2014

2.3

- RM Fail-over
- CS Preemption
- Timeline Service V1

07 April 2014

2.4

- Writable REST APIs
- Timeline Service V1 security

11 August 2014

2.5

- Rolling Upgrades
- Services
- Node labels

18 November 2014

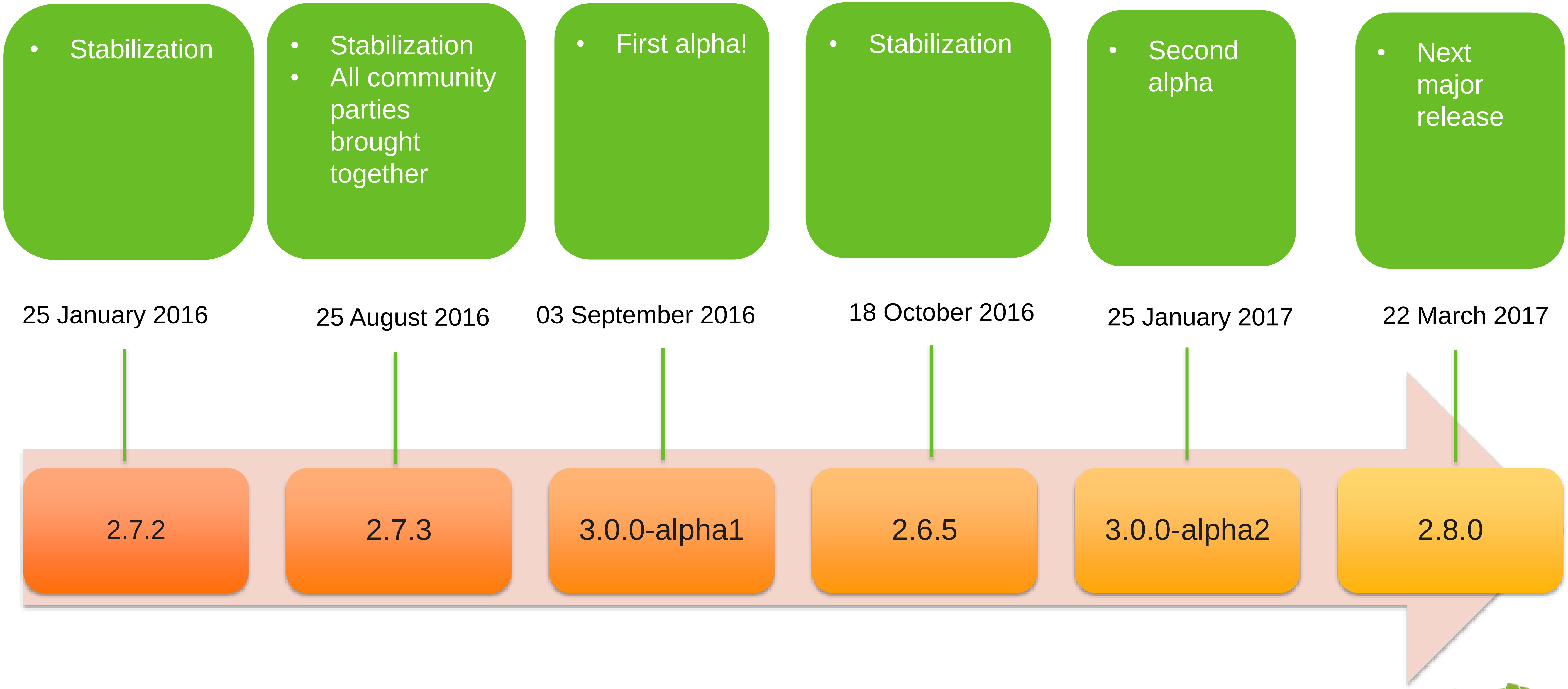
2.6

- Moving to JDK 7+
- Pluggable YARN authentication

21 Apr 2015

2.7

A brief Timeline: GA Releases 2/2



25 January 2016 – 2.7.2
- Stabilization

25 August 2016 – 2.7.3
- Stabilization
- All community parties brought together

03 September 2016 – 3.0.0-alpha1
- First alpha!

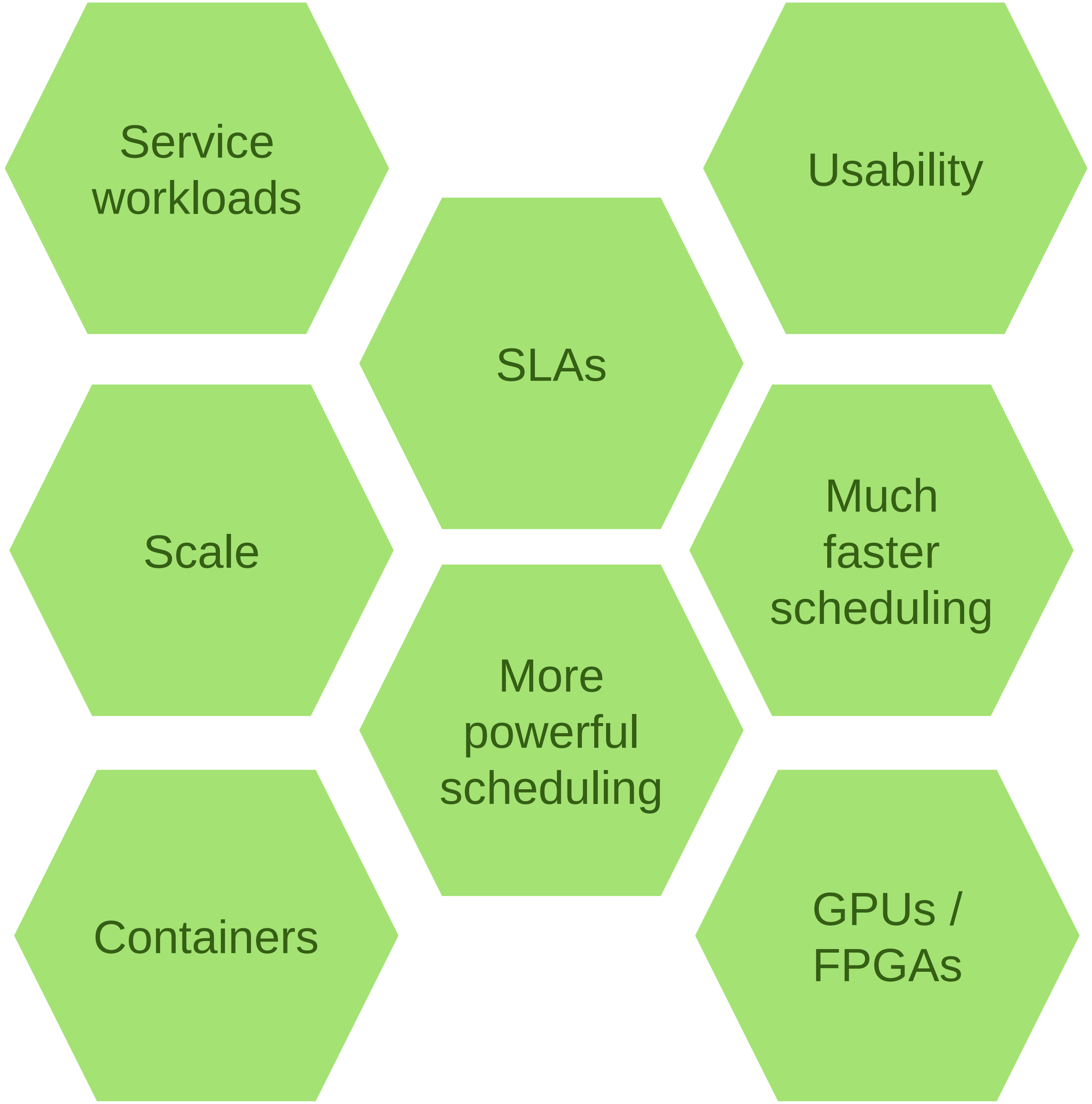
18 October 2016 – 2.6.5
- Stabilization

25 January 2017 – 3.0.0-alpha2
- Second alpha

22 March 2017 – 2.8.0
- Next major release

Hortonworks

Present & Future



Service workloads

Scale

Containers

SLAs

More powerful scheduling

Usability

Much faster scheduling

GPUs / FPGAs

Last few Hadoop releases

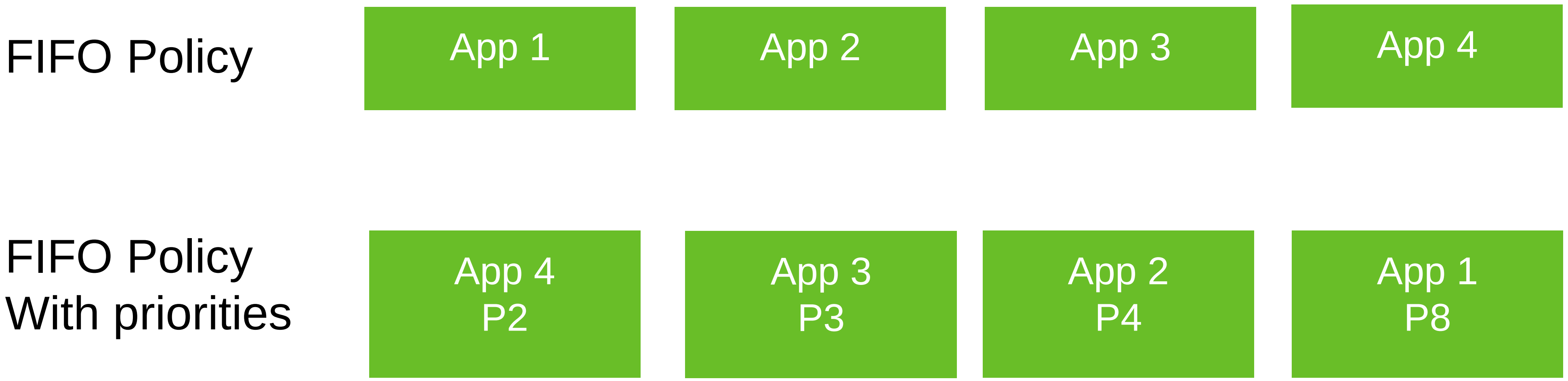
Apache Hadoop 2.8.0

Apache Hadoop 3.0.x

Apache Hadoop 2.8.0

Application priorities

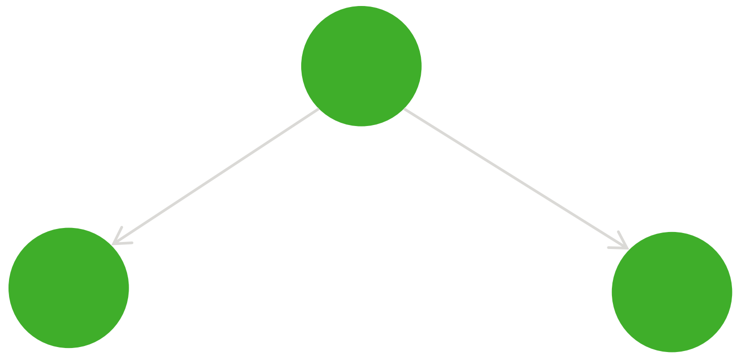
- YARN-1963
- Within a leaf-queue



FIFO Policy	App 1	App 2	App 3	App 4
FIFO Policy With priorities	App 4 P2	App 3 P3	App 2 P4	App 1 P8

Queue priorities

- Today
  - Give to the least satisfied queue first



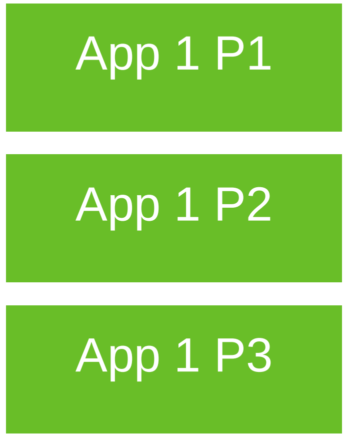
20% Configured Capacity
But 5% of used Capacity
Usage = 5/20 = 25%

80% Configured Capacity
But 8% of used Capaity
Usage 8/80 = 10%

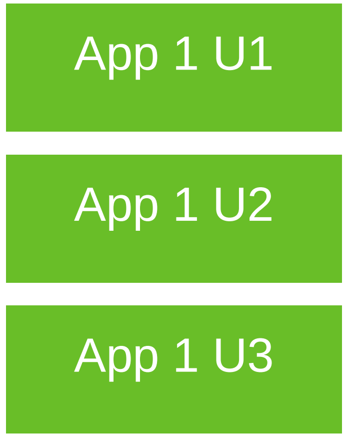
- With priorities
  - Give to the highest priority queue first

Preemption within a queue

- **Between apps of different priorities**

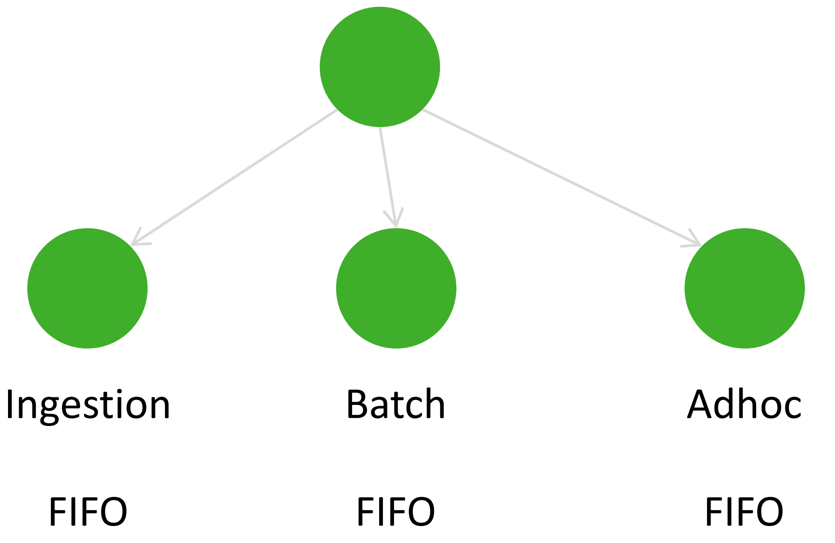


- **Between apps of different users**



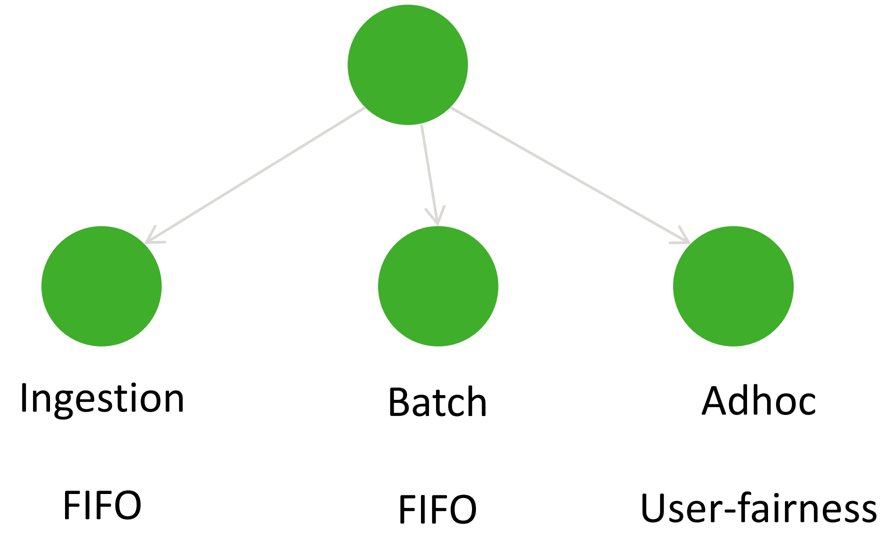
Per-queue Policy-driven scheduling

Previously



- Coarse policies
- One scheduling algorithm in the cluster
- Rigid
- Difficult to experiment

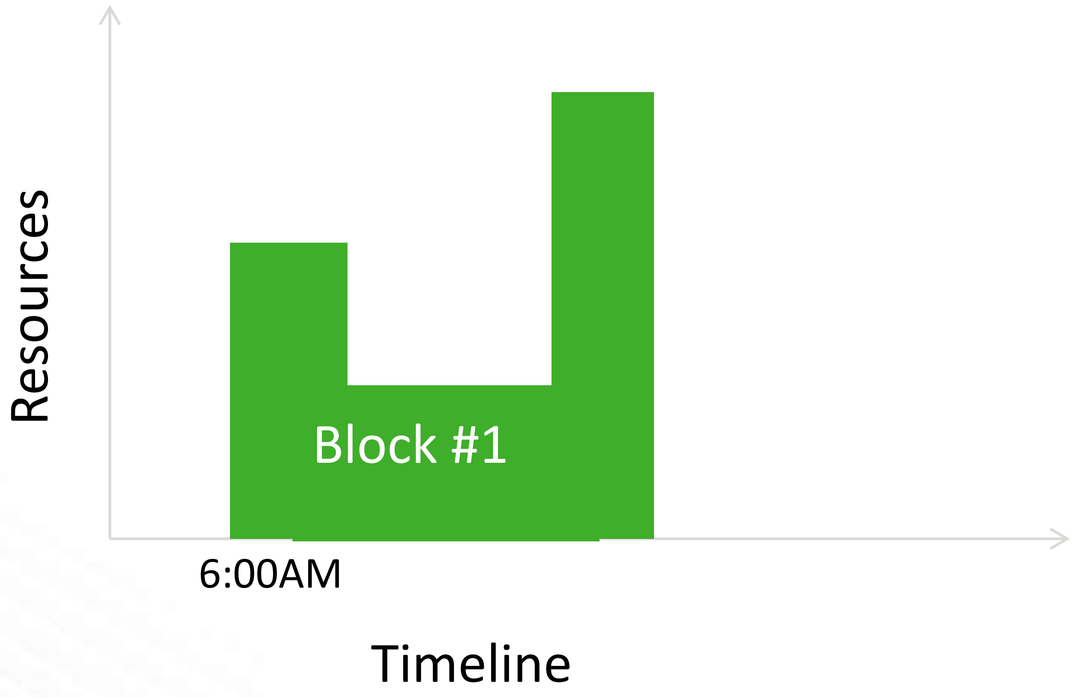
Now

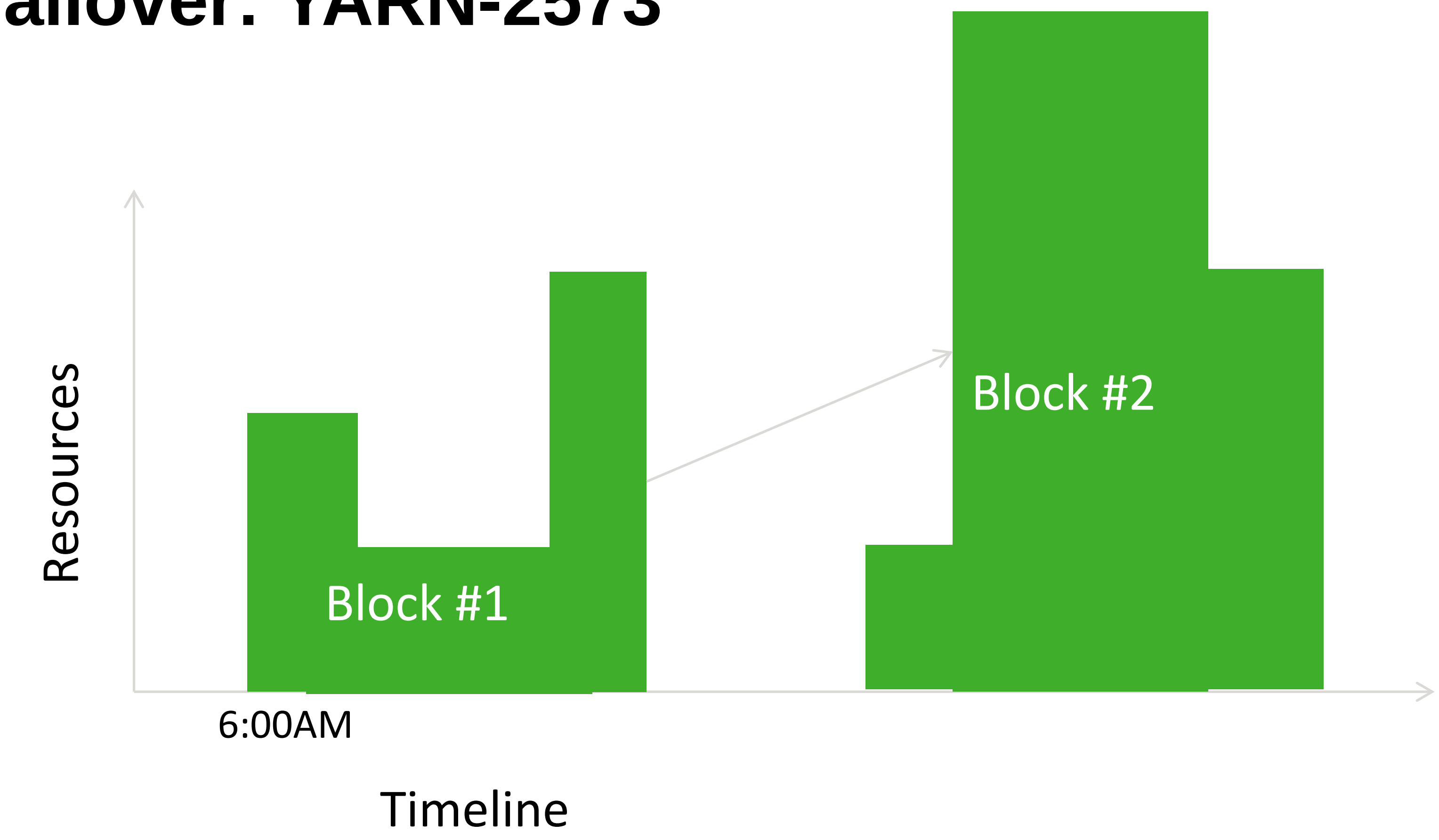


- Fine grained policies
- One scheduling algorithm per queue
- Flexible
- Very easy to experiment!

Reservations

- ***“Run my workload tomorrow at 6AM”***
- **Persistence of the plans with RM failover: YARN-2573**





-- Related Session --

Never late again! Job-Level deadline SLOs in YARN

Subru Krishnan
Microsoft

Carlo Curino
Microsoft

https://dataworkssummit.com/san-jose-2017/sessions/never-late-again-job-level-deadline-slos-in-yarn

Wednesday June 14th Room 230A

Apache Hadoop 3.x

-- Related Session --

Apache Hadoop 3.0

Junping Du
Hortonworks

Andrew Wang
Cloudera

https://dataworkssummit.com/san-jose-2017/sessions/apache-hadoop-3-0-community-update
Tuesday June 13th Room 210C

Scale!

- Only focusing on sizes of individual clusters
- Tons of sites with clusters made up of multiple thousands of nodes
  - Yahoo!, Twitter, LinkedIn, Microsoft
- Largest clusters the last couple of years
  - 6K-8K
- Roadmap: To 100K thousands and beyond
- Current progress: 40K nodes!

-- Related Session --

Lessons learned from scaling YARN to 40k machines in a multi tenancy environment

Hitesh Sharma
Microsoft

Roni Burd
Microsoft

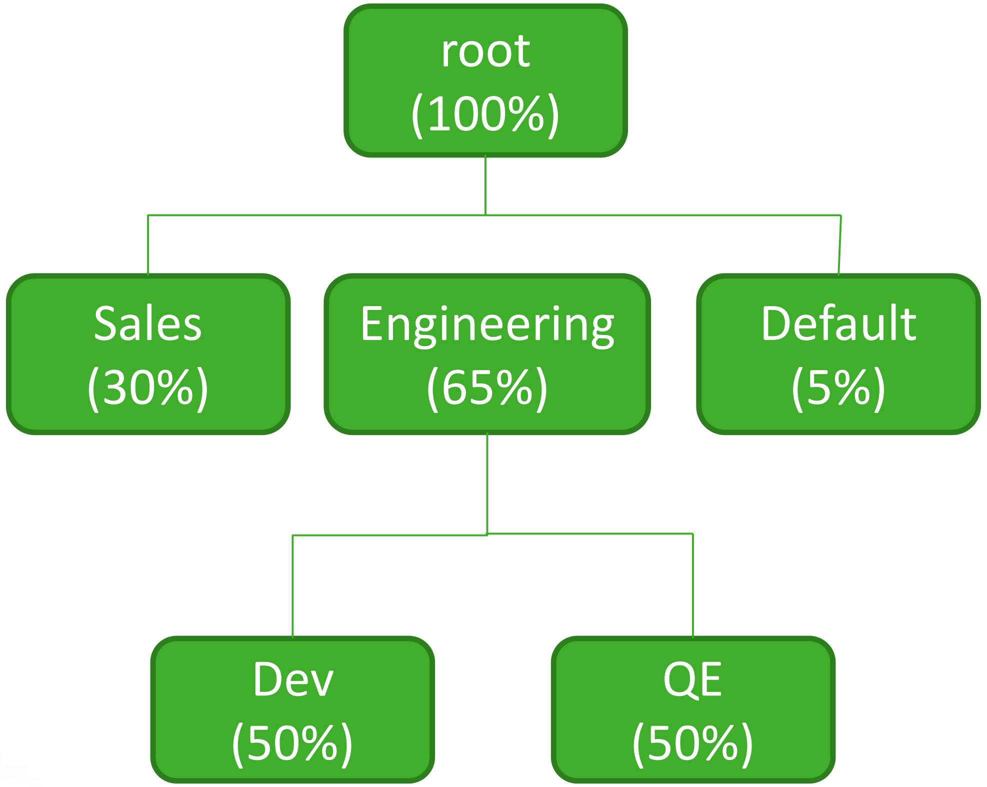
https://dataworkssummit.com/san-jose-2017/sessions/lessons-learned-from-scaling-yarn-to-40k-machines-in-a-multi-tenancy-environment

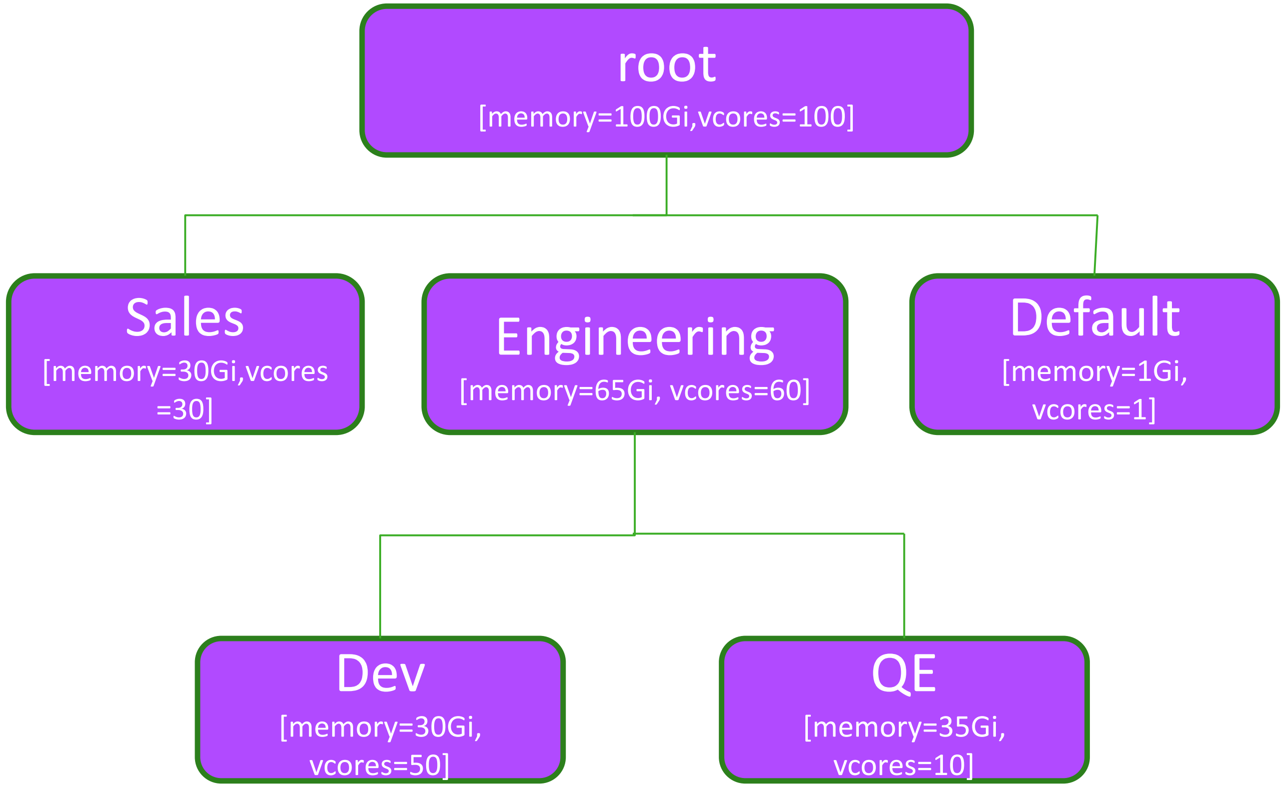
Wednesday June 14th Room 210A

Global & Fast Scheduling

- Effort led by Wangda Tan
- Problems
  - Current design of one-node-at-a-time allocation cycle can lead to suboptimal decisions.
  - Several coarse grained locks
- On trunk
  - Look at several nodes at a time
  - Fine grained locks
  - Multiple allocator threads
  - YARN scheduler can allocate 3k+ containers per second ≈ 10 mil allocations / hour!
  - 10X throughput gains with enhancement added recently
  - Opportunities for better placement

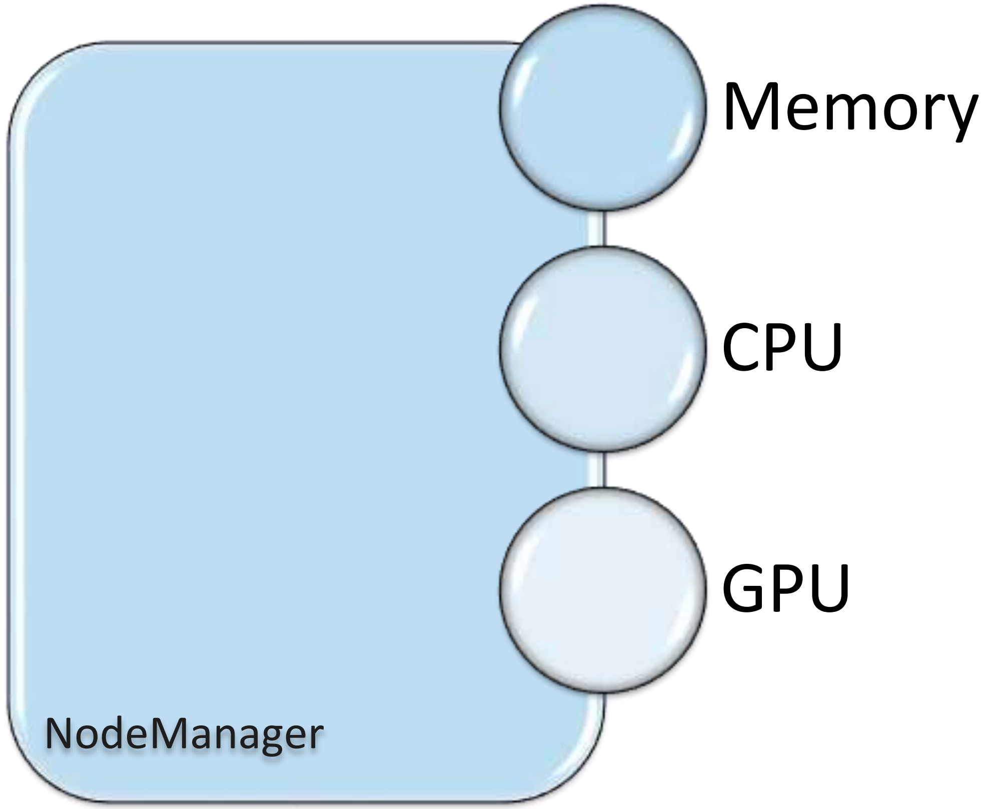
Capacities in numbers vs percentages





Resource vectors

- Till now
  - Hard coded resources
  - Memory and CPU
- Now
  - A generalized vector
  - Admins can create custom Resource Types!



GPUs on a YARN cluster!

- GPU can speed up compute-intensive applications 10x - 300x times
- Different levels of support
  - Take me to a machine where GPUs are available with Partitions / Node Labels
  - Take me to a machine where GPUs are available
    - give me a **full device** **only to me** for the **lifetime of my container**
    - give me **multiple full devices** **only to me** for the **lifetime of my container**
    - give me **full device(s)** **only to me** for a **portion of the lifetime of my container**
    - give me a **slice of device(s)** **to me** for a **full / portion of the lifetime of my container**
- More dimensions:
  - CPUs and memory and GPUs and on-GPU memory
  - Topology of multiple GPUs

-- Related Session --

Hadoop ecosystem boosts Tensorflow and machine learning technologies

Wangda Tan
Hortonworks

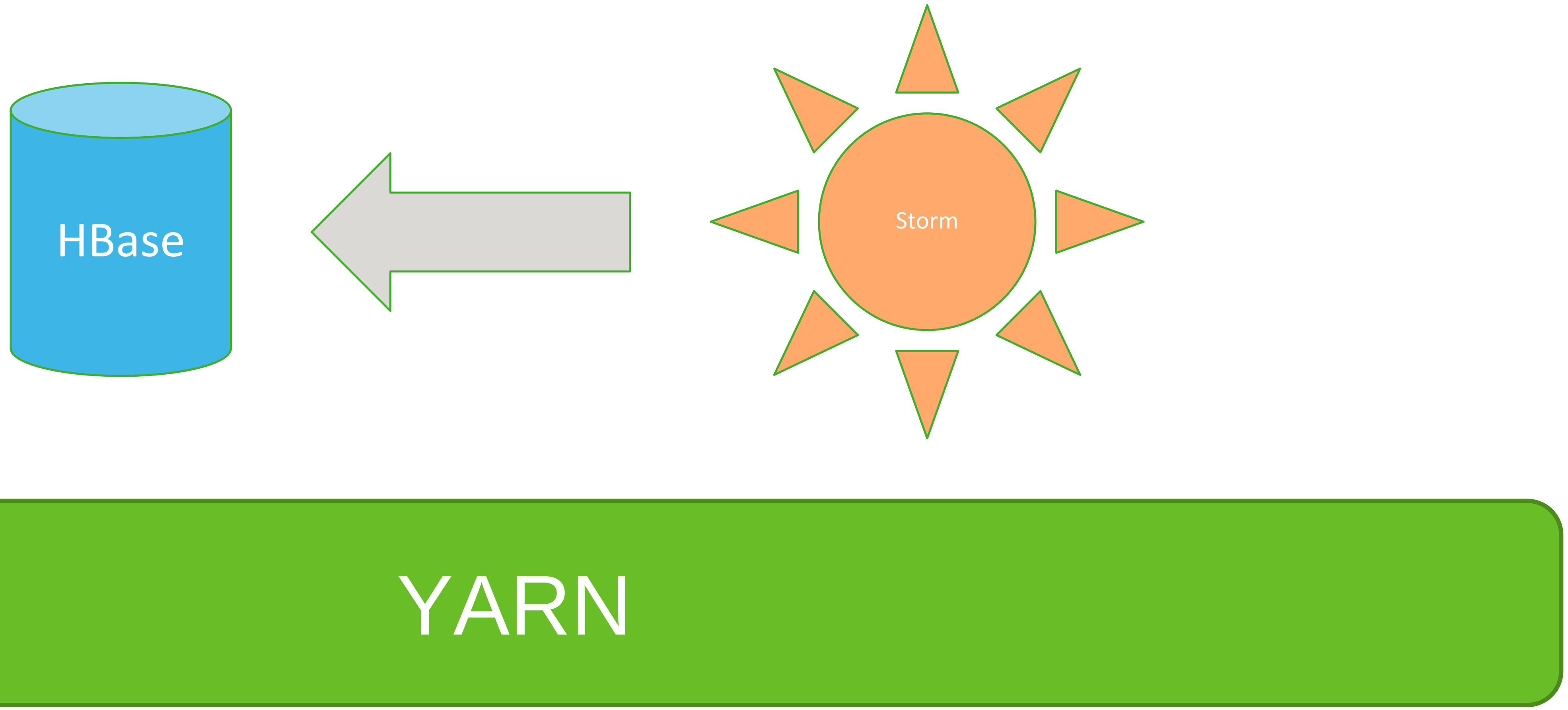
Yanbo Liang
Hortonworks

https://dataworkssummit.com/san-jose-2017/sessions/hadoop-ecosystem-boosts-tensorflow-and-machine-learning-technologies

Wednesday June 14th Ballroom B

Better placement strategies

- Affinity
- Anti-affinity



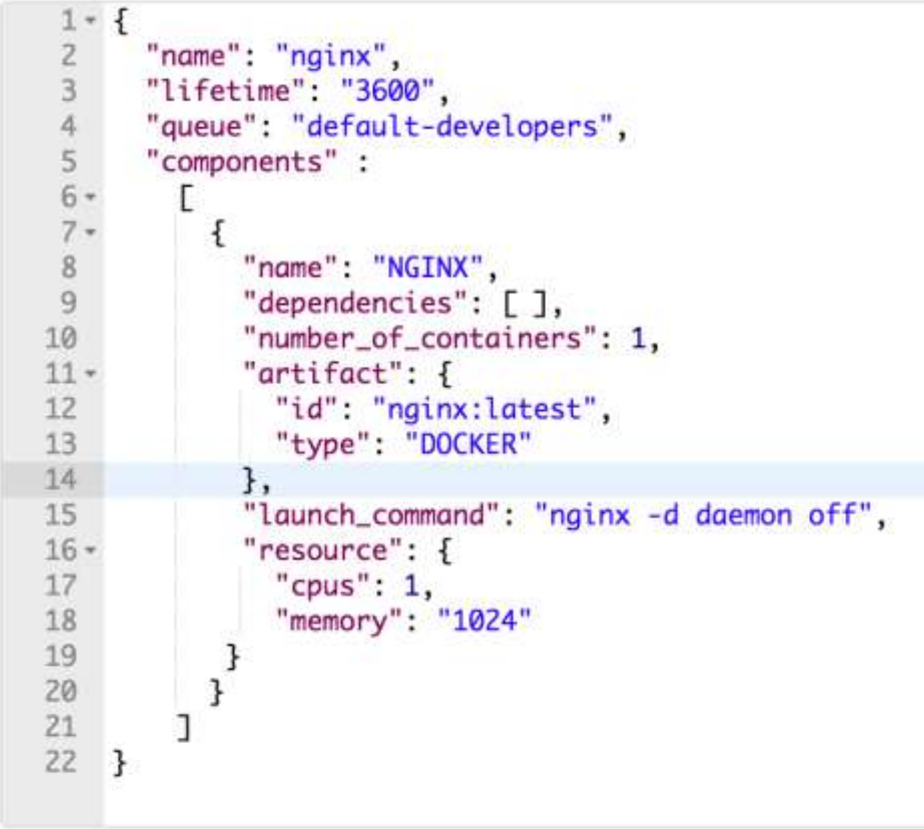
Packaging

- Containers
  - Lightweight mechanism for packaging and resource isolation
  - Popularized and made accessible by Docker
  - Can replace VMs in some cases
  - Or more accurately, VMs got used in places where they didn't need to be
- Native integration ++ in YARN
  - Support for "Container Runtimes" in LCE: YARN-3611
  - Process runtime
  - Docker runtime

Simplified APIs for service definitions

- Applications need simple APIs
- Need to be deployable "easily"

- Simple REST API layer fronting YARN
  - https://issues.apache.org/jira/browse/YARN-4793
  - [Umbrella] Simplified API layer for services and beyond
- Spawn services & Manage them



```
{
  "name": "nginx",
  "lifetime": "3600",
  "queue": "default-developers",
  "components" :
    [
      {
        "name": "NGINX",
        "dependencies": [ ],
        "number_of_containers": 1,
        "artifact": {
          "id": "nginx:latest",
          "type": "DOCKER"
        },
        "launch_command": "nginx -d daemon off",
        "resource": {
          "cpus": 1,
          "memory": "1024"
        }
      }
    ]
}
```

Services support

- Application & Services upgrades
  - ”Do an upgrade of my Spark / HBase apps with minimal impact to end-users”
  - YARN-4726
- Simplified discovery of services via DNS mechanisms: YARN-4757
  - ***regionserver30.hbase-app-3.0.vinodkv.yarn.site***

Services Framework

- Platform is only as good as the tools
- A native YARN services framework
  - https://issues.apache.org/jira/browse/YARN-4692
  - [Umbrella] Native YARN framework layer for services and beyond
- Assembly: Supporting a DAG of apps:
  - https://issues.apache.org/jira/browse/SLIDER-875

-- Related Session --

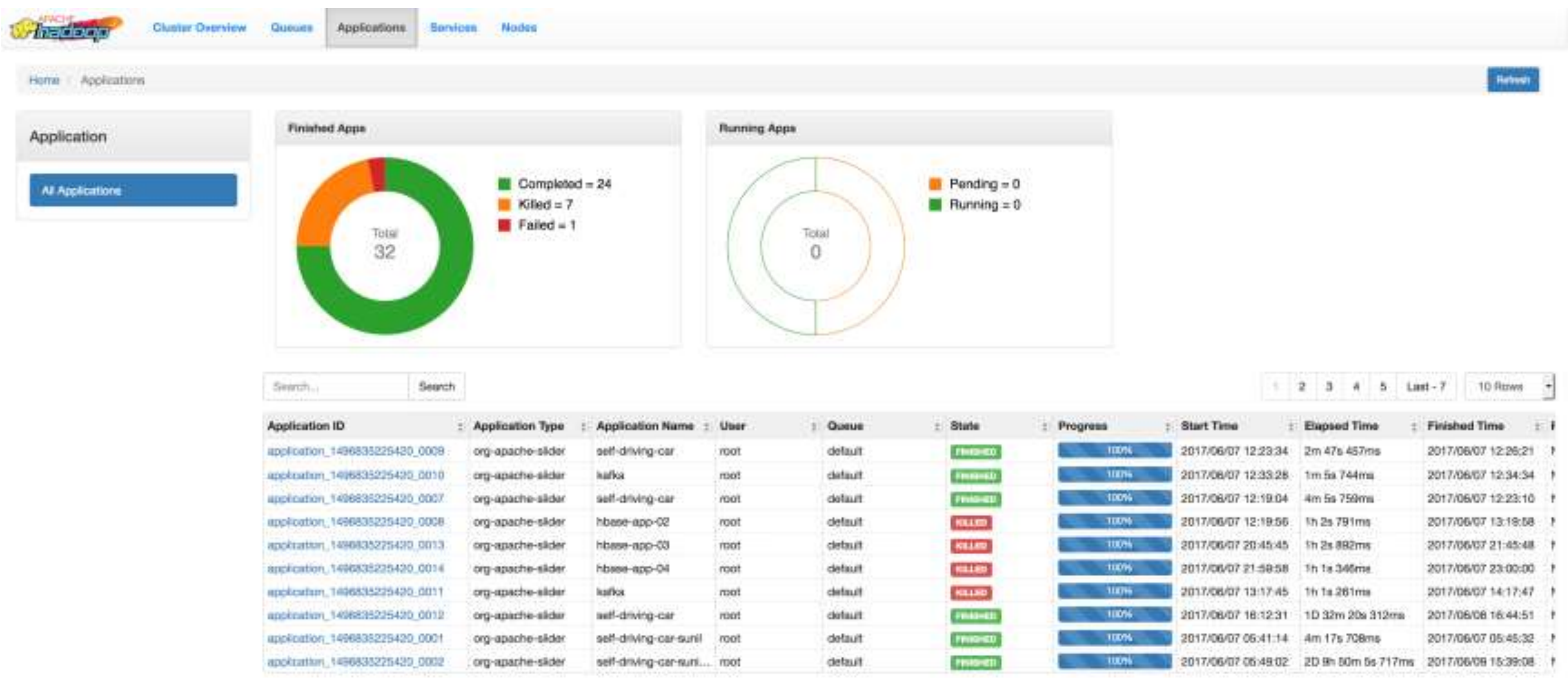
Running a container cloud on YARN

Shane Kumpf
Hortonworks

Jian He
Hortonworks

https://dataworkssummit.com/san-jose-2017/sessions/running-a-container-cloud-on-yarn
Thursday June 15th Room 210C

User experience



Application ID	Application Type	Application Name	User	Queue	State	Progress	Start Time	Elapsed Time	Finished Time
application_1496835225420_0009	org-apache-slider	self-driving-car	root	default	FINISHED	100%	2017/06/07 12:23:34	2m 47s 457ms	2017/06/07 12:26:21
application_1496835225420_0010	org-apache-slider	kafka	root	default	FINISHED	100%	2017/06/07 12:33:28	1m 5s 744ms	2017/06/07 12:34:34
application_1496835225420_0007	org-apache-slider	self-driving-car	root	default	FINISHED	100%	2017/06/07 12:19:04	4m 5s 759ms	2017/06/07 12:23:10
application_1496835225420_0008	org-apache-slider	hbase-app-02	root	default	KILLED	100%	2017/06/07 12:19:56	1h 2s 791ms	2017/06/07 13:19:58
application_1496835225420_0013	org-apache-slider	hbase-app-03	root	default	KILLED	100%	2017/06/07 20:45:45	1h 2s 892ms	2017/06/07 21:45:48
application_1496835225420_0014	org-apache-slider	hbase-app-04	root	default	KILLED	100%	2017/06/07 21:59:58	1h 1s 346ms	2017/06/07 23:00:00
application_1496835225420_0011	org-apache-slider	kafka	root	default	KILLED	100%	2017/06/07 13:17:45	1h 1s 261ms	2017/06/07 14:17:47
application_1496835225420_0012	org-apache-slider	self-driving-car	root	default	FINISHED	100%	2017/06/07 16:12:31	1D 32m 20s 312ms	2017/06/08 16:44:51
application_1496835225420_0001	org-apache-slider	self-driving-car-sunil	root	default	FINISHED	100%	2017/06/07 05:41:14	4m 17s 708ms	2017/06/07 05:45:32
application_1496835225420_0002	org-apache-slider	self-driving-car-suni...	root	default	FINISHED	100%	2017/06/07 05:49:02	2D 9h 50m 5s 717ms	2017/06/09 15:39:08

API based queue management

Decentralized

New web UI

Improved logs management

Live application logs

Timeline Service

- Application History
  - “Where did my containers run?”
  - “Why is my application slow?”
  - “Is it really slow?”
  - “Why is my application failing?”
  - “What happened with my application? Succeeded?”

- Cluster History
  - Run analytics on historical apps!
  - “User with most resource utilization”
  - “Largest application run”
  - “Why is my cluster slow?”
  - “Why is my cluster down?”
  - “What happened in my clusters?”
- Collect and use past data
  - To schedule “my application” better
  - To do better capacity planning

Timeline Service 2.0

- **Next generation**
  - Today’s solution helped us understand the space
  - Limited scalability and availability

- ***“Analyzing Hadoop Clusters is becoming a big-data problem”***
  - Don’t want to throw away the Hadoop application metadata
  - Large scale
  - Enable near real-time analysis: *“Find me the user who is hammering the FileSystem with rouge applications. Now.”*

- **Timeline data stored in HBase and accessible to queries**

Building a modern end-to-end open source Big Data reference application

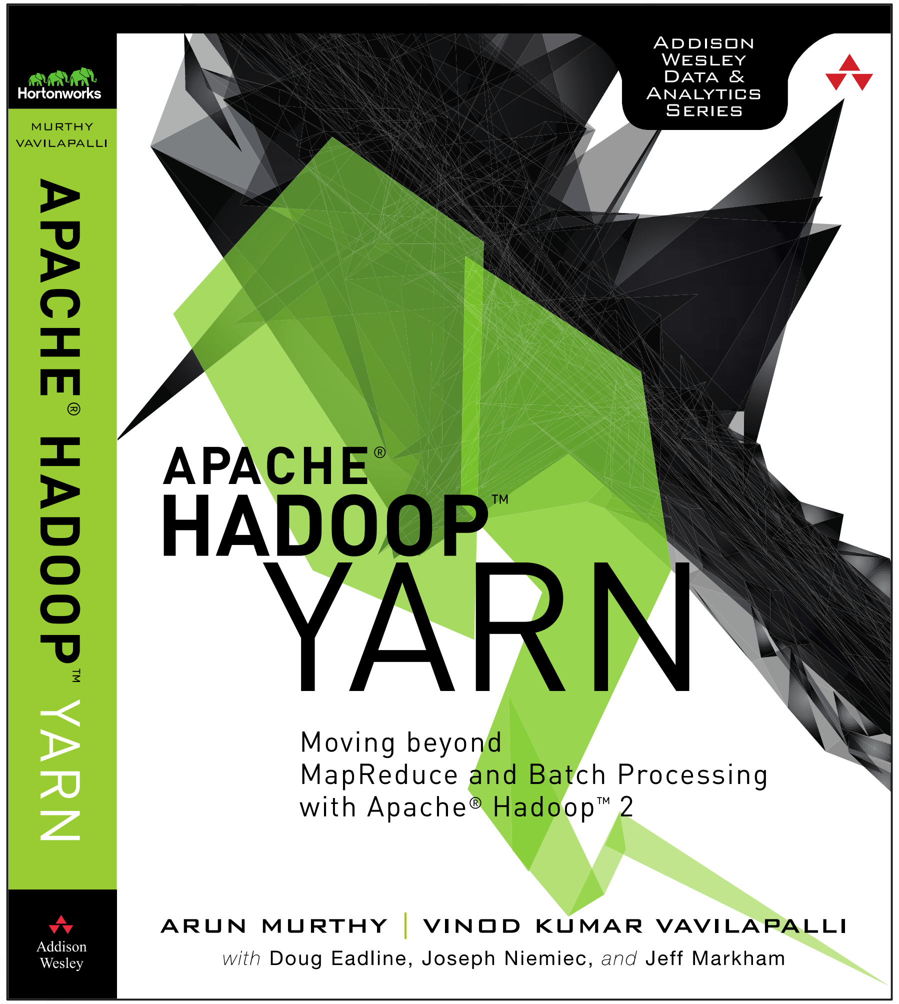
Edgar Orendain

UC Berkeley / Hortonworks

https://dataworkssummit.com/san-jose-2017/sessions/building-a-modern-end-to-end-open-source-big-data-reference-application

Wednesday June 14th Ballroom C

Thank you!



APACHE® HADOOP™ YARN

Moving beyond
MapReduce and Batch Processing
with Apache® Hadoop™ 2

ARUN MURTHY | VINOD KUMAR VAVILAPALLI

with Doug Eadline, Joseph Niemiec, *and* Jeff Markham

Hortonworks Sandbox

VERSION 2.0

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Sandbox is a personal, portable Hadoop environment that comes with a dozen interactive Hadoop tutorials. Sandbox includes many of the most exciting developments from the latest HDP distribution, packaged up in a virtual environment that you can get up and running in 15 minutes!

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