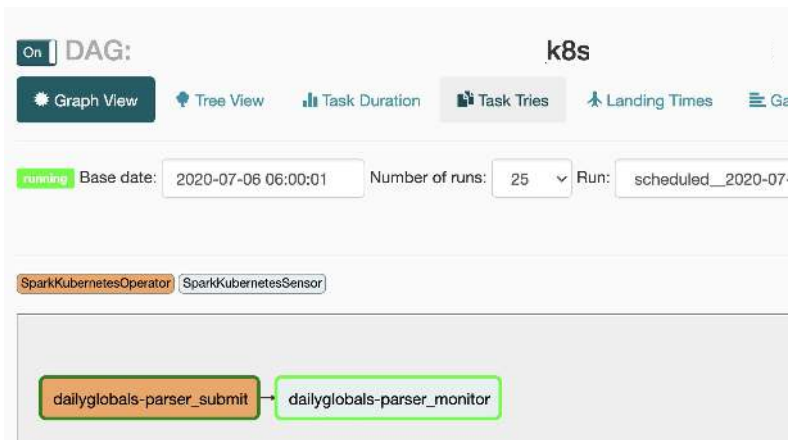
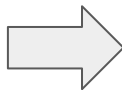
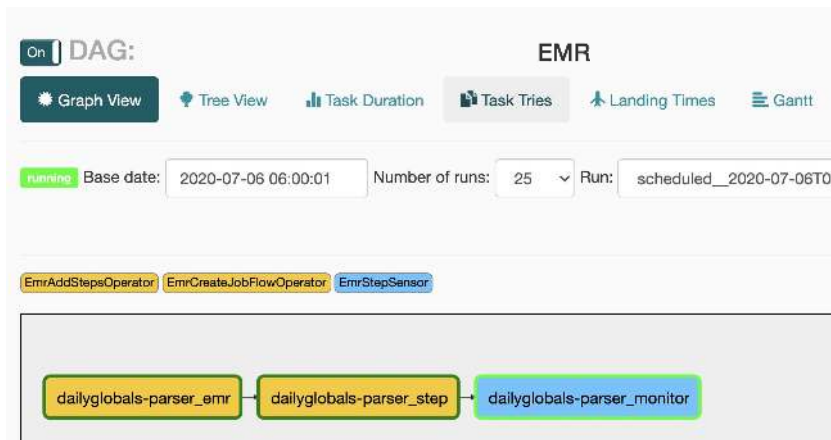


Airflow Summit 2020

July 6-17, 2020. Join from anywhere.

Join us!

Same-same...



... but different!



\$30,000/month Savings



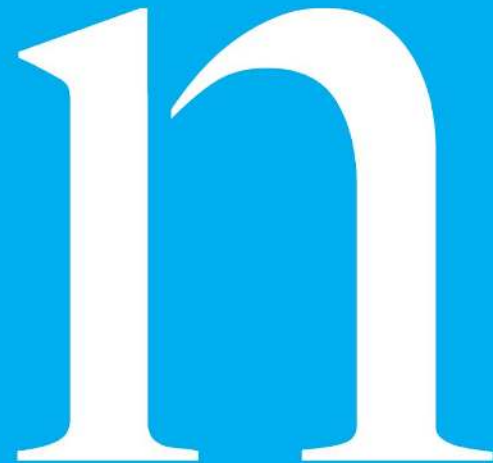
Open your eyes



Robust

Migrating Airflow-based Spark jobs to K8s the native way

Roi Teveth & Itai Yaffe
Nielsen



Introduction



Roi Teveth



Big Data developer



Kubernetes evangelist



Roi Teveth



@RTeveth



Itai Yaffe



Tech Lead, Big Data group



Dealing with Big Data challenges since 2012



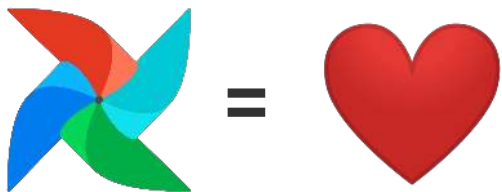
Itai Yaffe



@ItaiYaffe

What will you learn?

01.



02.

ETLs with
Airflow &



03.



-on- kubernetes



04.

Airflow Integration
& Contribution



What will you learn?

01.



02.

ETLs with
Airflow & Spark



03.



-on-kubernetes



04.

Airflow Integration
& Contribution



Nielsen Identity Engine

- eXelate was acquired by Nielsen on March 2015
- A Data company
- Machine learning models for insights
- Targeting
- Business decisions



Nielsen Identity Engine in numbers

Spark

~3000 nodes/day



~30TB ingested/day

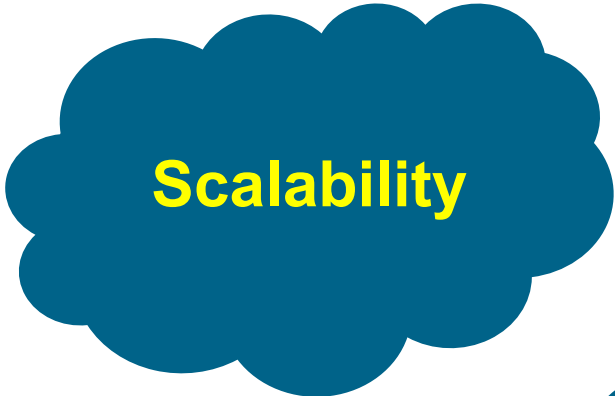
aws

\$100K's/month

druid

10's of TB
ingested/day

The challenges

A dark blue, cloud-like shape with a scalloped edge, containing the word "Scalability" in yellow text.

Scalability

A dark blue, cloud-like shape with a scalloped edge, containing the text "Fault-tolerance" in yellow text.

Fault-tolerance

A dark blue, cloud-like shape with a scalloped edge, containing the text "Cost Efficiency" in yellow text.

Cost Efficiency

Why did we need Airflow?

- Dozens of ETL workflows running around the clock
- Originally used AWS Data Pipeline for workflow management
- But we also wanted:
 - Better **visibility** of configuration and workflow
 - Better **monitoring** and **statistics**
 - Share **common configuration/code** between workflows



Why do we ❤️ Airflow?

**Met all
requirements &
more**

**~2 years in
production**

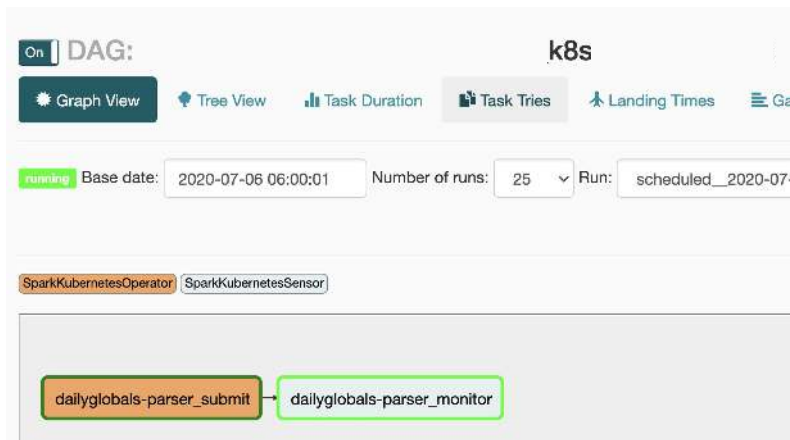
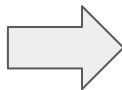
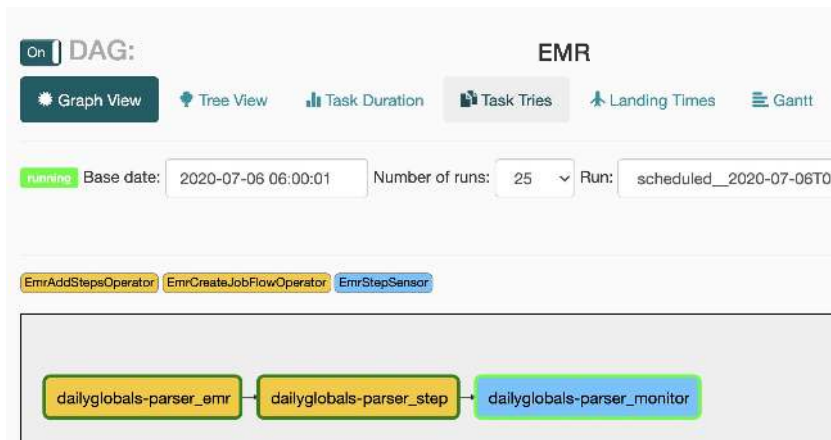
**~40 users across 4
groups**

**~1000 DAG
Runs/day**

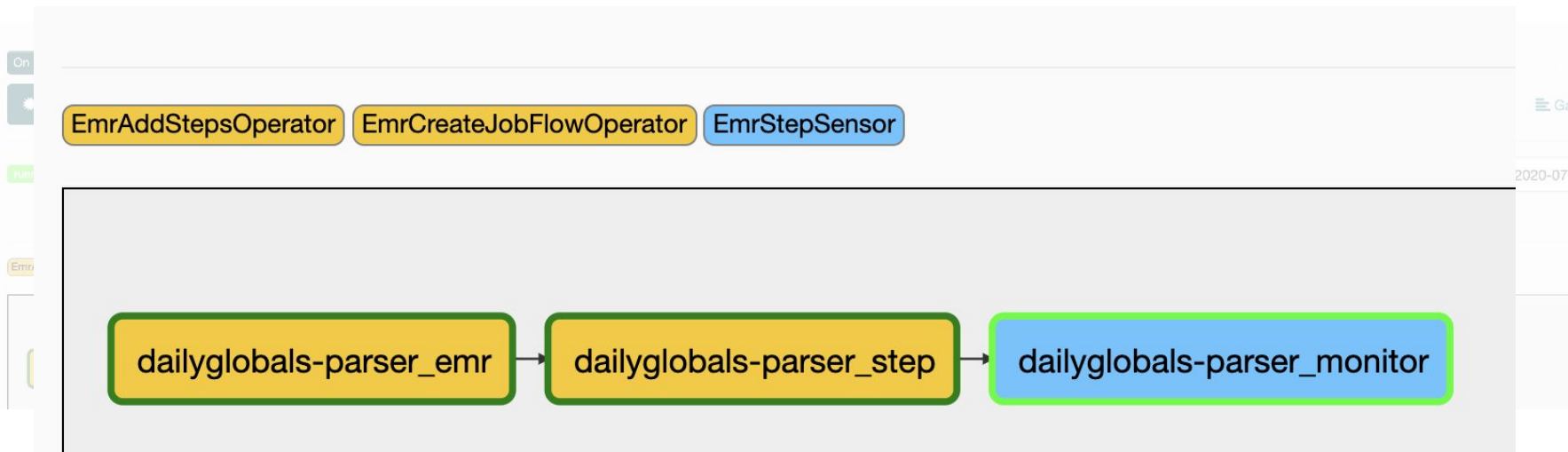
**~20 automatic DAG
deployments/day**

**6 contributions
to open-source**

Remember this slide?

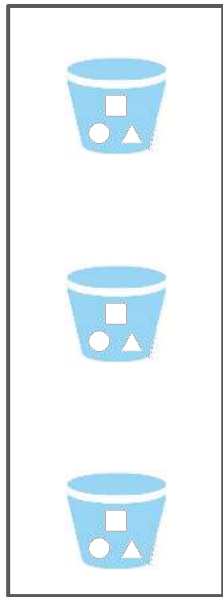


Let's take a closer look...



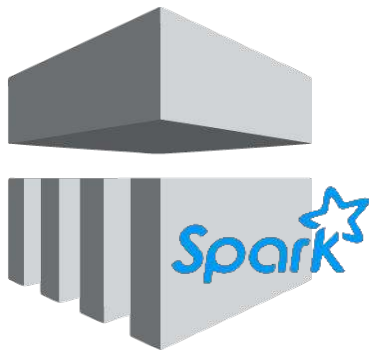
Common data pipeline pattern - high-level architecture

Data Lake



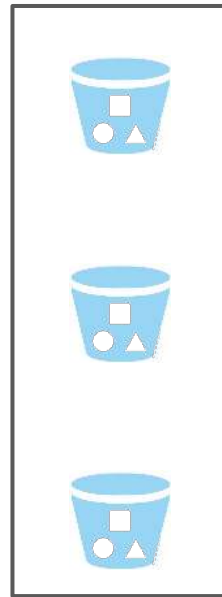
1.
Read input
files
➡➡

Data Processing



2.
Write output
files
➡➡

Intermediate Storage



3.
Ingest
to DB
➡➡



OLAP

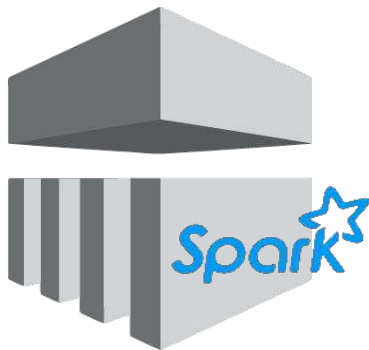
Common data pipeline pattern - high-level architecture

Data Lake



1.
Read input
files
➡➡

Data Processing



2.
Write output
files
➡➡

Intermediate Storage



3.
Ingest
to DB
➡➡

OLAP



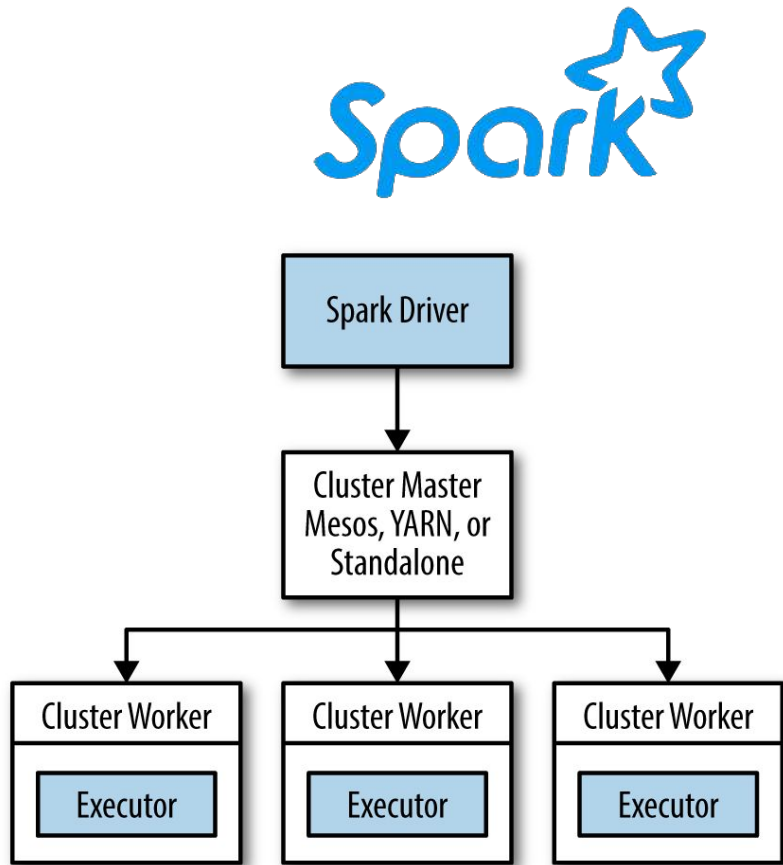
What is Spark?



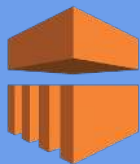
- An analytics engine for large-scale **data processing**
- **Distributed** and highly **scalable**
- A **unified framework** for batch, streaming, machine learning, etc.

Basic Spark terminology

- Driver
- Executor
- Cluster manager
 - Mesos, YARN or Standalone
- Managed Spark on public clouds
 - AWS EMR, GCP Dataproc, etc.



What is EMR?



EMR is an AWS managed service to run Hadoop & Spark clusters



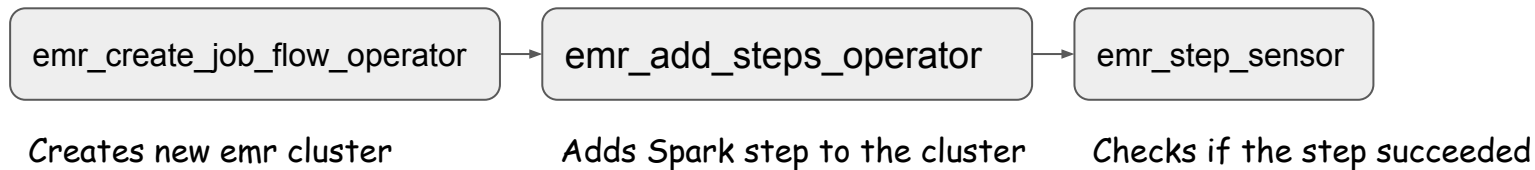
Allows you to reduce costs by using Spot instances



Charges management cost for each instance in a cluster

Running Airflow-based Spark jobs on EMR

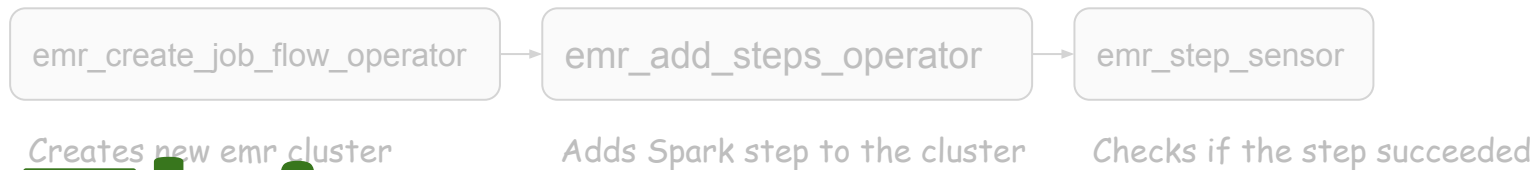
- EMR has official Airflow support



- Open-source, remember?
 - Allows us to **fix** existing components
 - EmrStepSensor fixes ([AIRFLOW-3297](#))
 - ... As well as add **new** components
 - AWS Athena Sensor ([AIRFLOW-3403](#))
 - OpenFaaS hook ([AIRFLOW-3411](#))

Running Airflow-based Spark jobs on EMR

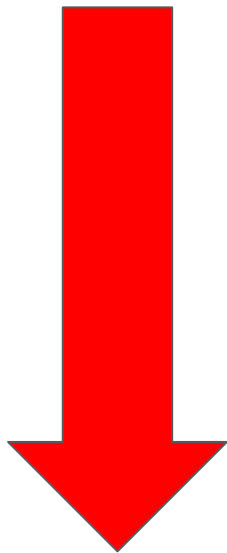
- EMR has official Airflow support



- **This was great...**
 - Open source, ~~remember?~~
 - Allows us to **fix** existing components
 - EmrStepSensor fixes ([AIRFLOW-3297](#))
 - ... As well as add **new** components
 - AWS Athena Sensor ([AIRFLOW-3403](#))
 - OpenFaaS hook ([AIRFLOW-3411](#))

But we wanted **MORE!**

\$\$\$



Visibility



Robustness



Introducing - Spark-on-Kubernetes

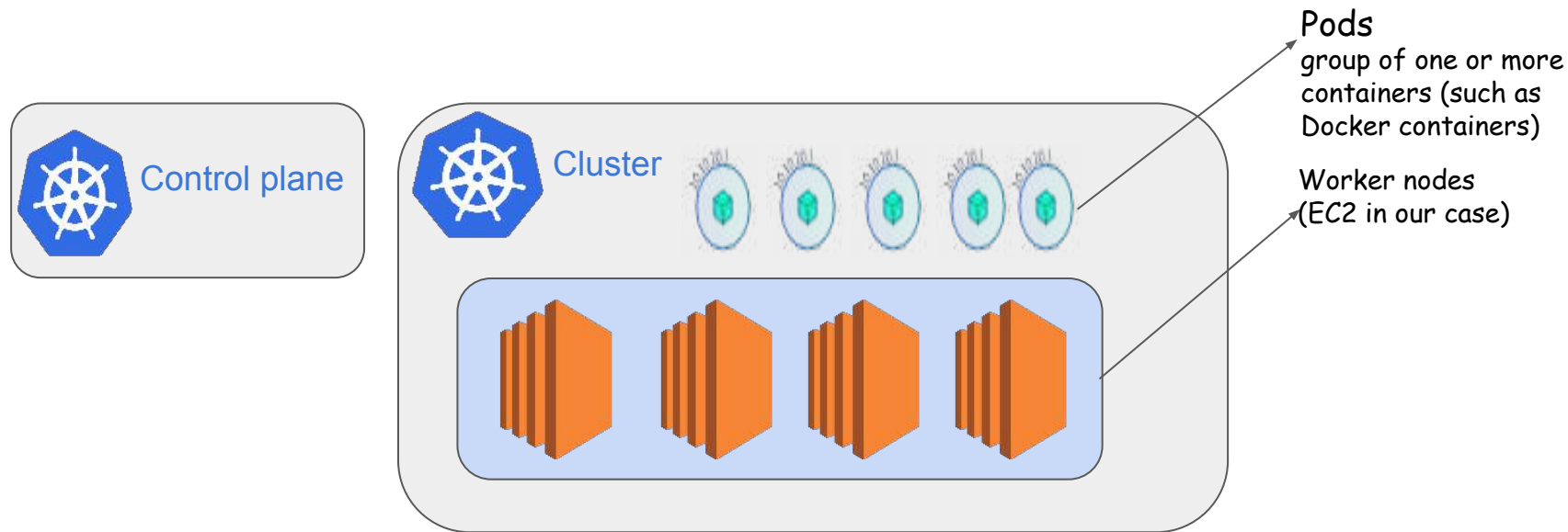


Let's explain what is Kubernetes (a.k.a K8s)

- Open source platform for running and managing **containerized workloads**
- Includes
 - **Built-in controllers** to support various workloads (e.g micro-services)
 - **Additional extensions** (called “**operators**”) to support custom workloads
- Highly **scalable**



Basic Kubernetes terminology



Basic Kubernetes terminology

- **kubectl** - K8s CLI

```
(base) → ~ kubectl get po
```

NAME	READY	STATUS	RESTARTS	AGE
app1-67d75d7f9-bj8fh	1/1	Running	0	11s

```
(base) → ~ kubectl run ubuntu --image ubuntu:18.06 --generator=run-pod/v1  
pod/ubuntu created
```

Basic Kubernetes terminology

- The term “operator” exists both in Airflow and in Kubernetes



Basic Kubernetes terminology

- The term “operator” exists both in Airflow and in Kubernetes
-  operator
 - Represents a **single task**
 - Operators determine what is actually executed when your DAG runs
 - Example:
 - **bash-operator** - executes a bash command

Basic Kubernetes terminology

- The term “operator” exists both in Airflow and in Kubernetes
-  operator
 - Additional extensions to Kubernetes
 - Holds the knowledge of how to manage a **specific application**
 - Example:
 - **postgres-operator** - defines and manages a PostgreSQL cluster

Basic Kubernetes terminology

- The term “operator” exists both in Airflow and in Kubernetes

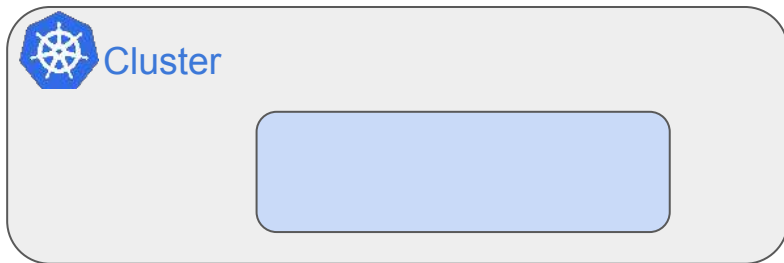
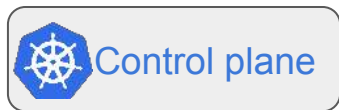
-  operator

 **Operator !=**  **Operator**

- A new Kubernetes controller
- Holds the knowledge of how to manage a **specific application**
- Example:
 - **postgres-operator** - defines and manages a PostgreSQL cluster

Kubernetes auto-scale

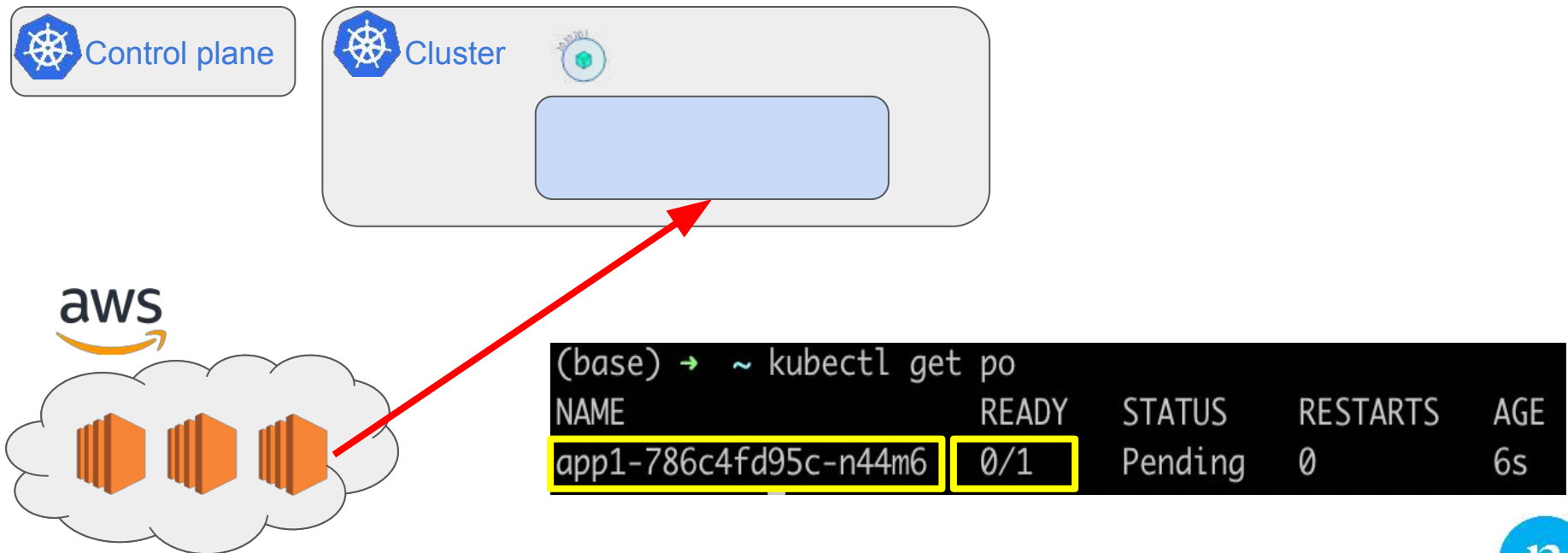
Phase 1: no applications are running on the cluster



```
(base) → ~ kubectl get pods  
No resources found in default namespace.
```

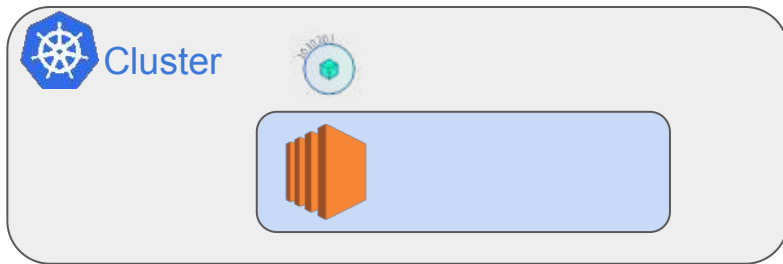
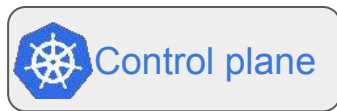
Kubernetes auto-scale

Phase 2: application #1 starts running



Kubernetes auto-scale

Phase 3: the cluster scales-up as needed

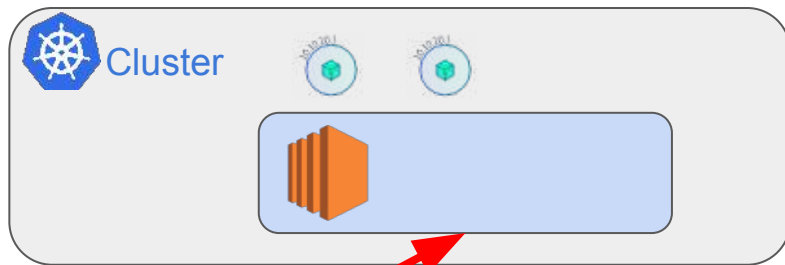
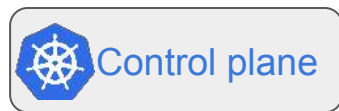


```
(base) → ~ kubectl get po
```

NAME	READY	STATUS	RESTARTS	AGE
app1-67d75d7f9-bj8fh	1/1	Running	0	11s

Kubernetes auto-scale

Phase 4: application #2 starts running

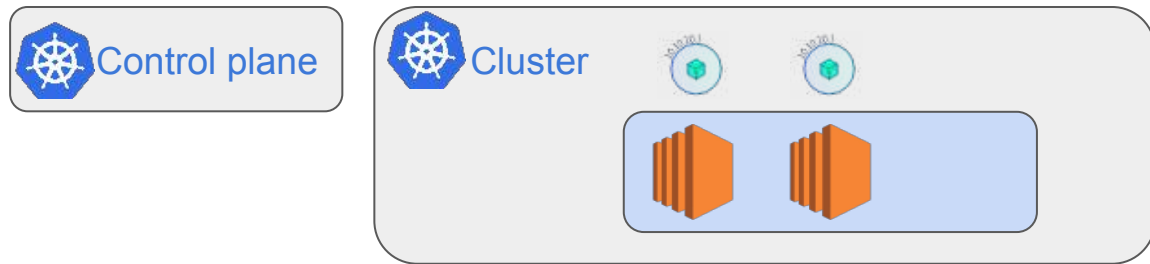


```
(base) → ~ kubectl get po
```

NAME	READY	STATUS	RESTARTS	AGE
app1-67d75d7f9-bj8fh	1/1	Running	0	22h
app2-65d4c7f97f-n8l9d	0/1	Pending	0	4s

Kubernetes auto-scale

Phase 5: the cluster scales-up as needed

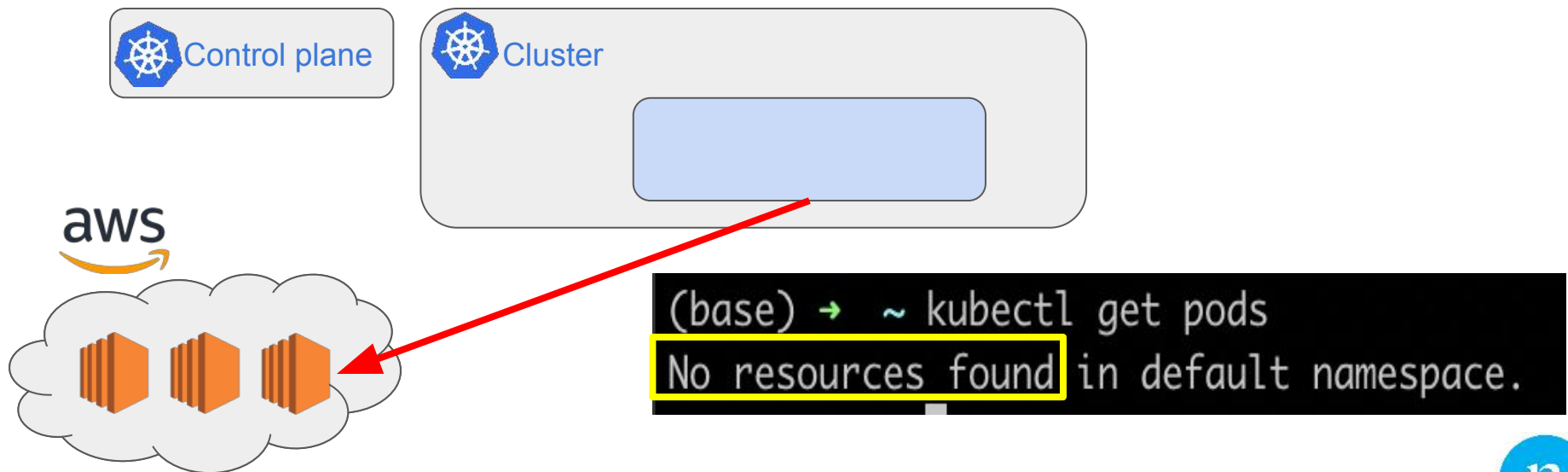


```
(base) → ~ kubectl get po
```

NAME	READY	STATUS	RESTARTS	AGE
app1-6589f85558-w8pdm	1/1	Running	0	12s
app2-5499955bb4-pplg1	1/1	Running	0	7s

Kubernetes auto-scale

Phase 6: applications finished running, cluster scales down



Kubernetes in a nutshell

- A platform for running and managing **containerized workloads**
- Each cluster has
 - 1 control plane
 - 0..X worker nodes
 - 0..Y pods
 - 0..Z applications running concurrently
- Kubernetes operator != Airflow operator
- Automatically scales out and in



Cool, so... Back to Spark-on-Kubernetes?



Spark-On-Kubernetes overview

- From Spark 2.3.0, K8s is supported as a **cluster manager**
- This is still **experimental**, and some features are missing
 - Better auto-scaling is expected in future Spark releases (e.g through dynamic allocation)



Submitting a Spark application to Kubernetes - alternatives

1. Using **spark-submit** script
2. Using Spark-On-Kubernetes **Operator**

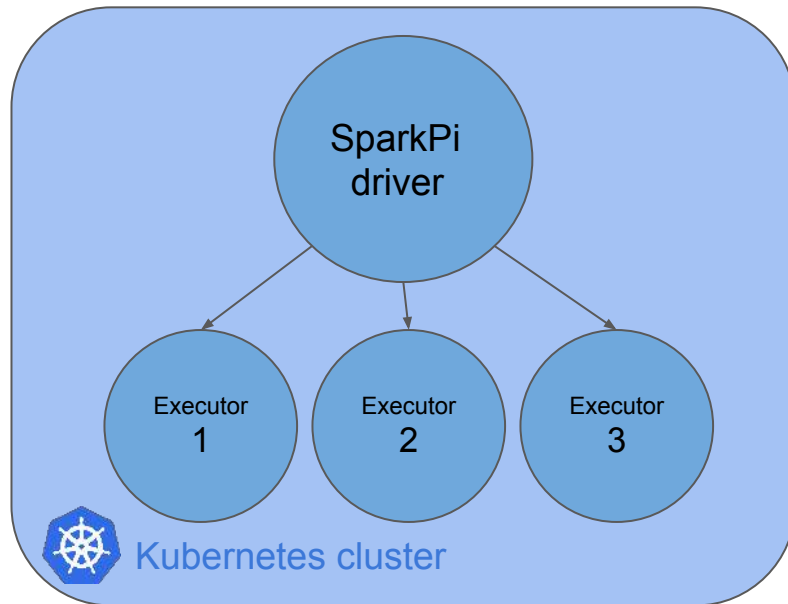


Spark-submit example - SparkPi

```
./bin/spark-submit \  
  --master  
k8s://https://<k8s-apiserver-host>:<k8s-apiserver-port> \  
  --deploy-mode cluster \  
  --name spark-pi \  
  --class org.apache.spark.examples.SparkPi \  
  --conf spark.executor.instances =3 \  
  --conf spark.kubernetes.container.image =<spark-image>  
  
local:///path/to/examples.jar
```



Kubernetes control plane



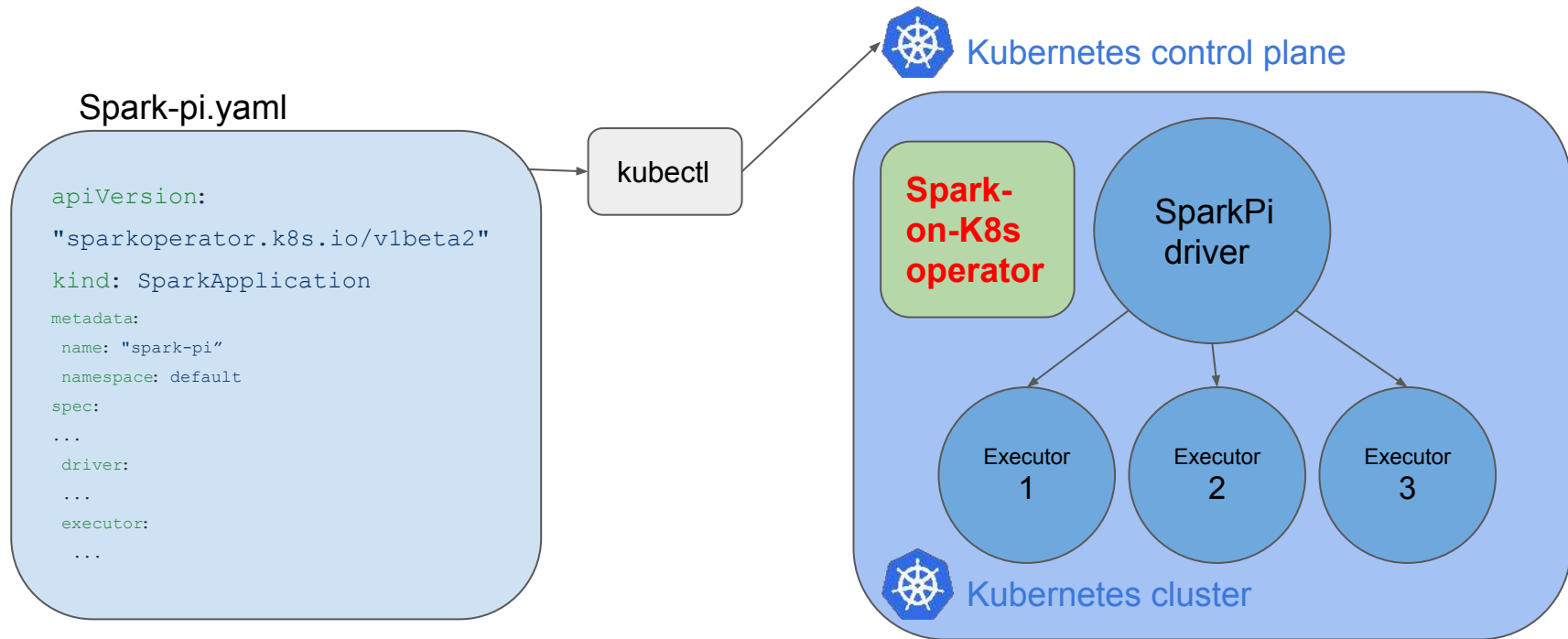
Spark-On-Kubernetes operator

- A Kubernetes operator
- Extends Kubernetes API to **support Spark applications**
- Built by GCP as an **open-source** project

<https://github.com/GoogleCloudPlatform/spark-on-k8s-operator>



Spark-On-Kubernetes operator example - SparkPi

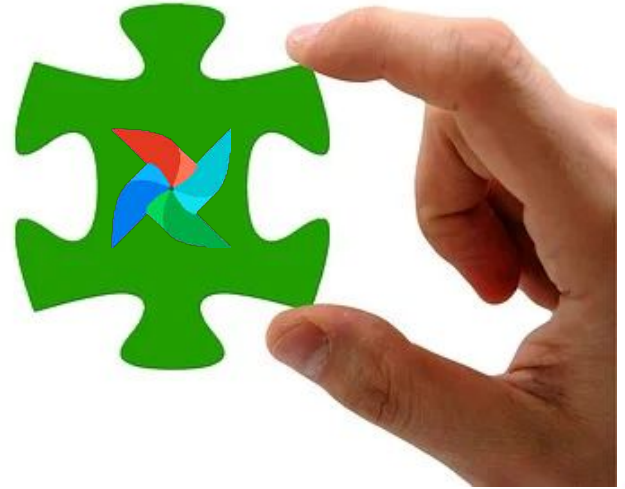
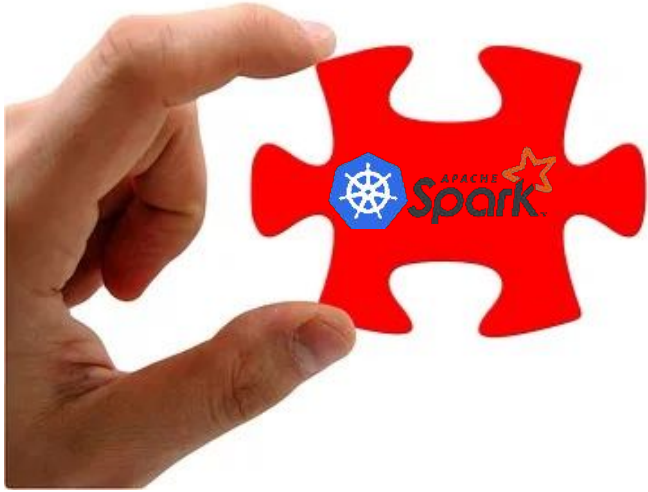


Submitting a Spark application to K8s

Topic	Spark-submit	Spark-On-K8s operator
Airflow built-in integration	V	X
Customize Spark-pods	X	V
Easy access to Spark UI	X	V
Submit and view application from kubectl	X	V

VS

Integrate it with Airflow



So... we decided to take the road less traveled



@ItaiYaffe, @RTeveth



So... we decided to take the road less traveled

[AIRFLOW-6542] add spark-on-k8s operator/hook/sensor #7163

Edit

Open with

Merged

kaxil merged 1 commit into apache:master from roitvt:master on Mar 10

Conversation 125

Commits 1

Checks 2

Files changed 24

+1,505 -5



roitvt commented on Jan 14 • edited -

Contributor

Add a operator and sensor for spark-on-k8s kubernetes operator by GCP <https://github.com/GoogleCloudPlatform/spark-on-k8s-operator> to send sparkApplication object to kubernetes cluster then check it's state with a sensor

Issue link: [AIRFLOW-6542](#)

Make sure to mark the boxes below before creating PR: [x]

Reviewers

kujon

alessioale

ashb

kaxil

dimberman

mik-laj

<https://github.com/apache/airflow/pull/7163>

A special thanks to Airflow committers

[AIRFLOW-6542] add spark-on-k8s operator/hook/sensor #7163

Merged kaxil merged 1 commit into apache:master from roitvt:master on Mar 10

Conversation 125

roitvt commented on Jan 14 • edited •

Add a operator and sensor for spark-on-k8s kubernetes operator by GCP <https://cloud.google.com/spark-on-k8s-operator> to send sparkApp to k8s cluster

Issue link: AIRFLOW-6542

Make sure to mark

- ☒ Description above provides context of the change
- ☒ Commit message/PR title starts with [AIRFLOW-XXXX]: AIRFLOW-NNNN - JIRA ID*
- ☒ Unit tests coverage for changes (not needed for documentation changes)
- ☒ Commits follow "Conventional Commits" style
- ☒ Relevant documentation is updated
- ☒ I will engage with the community

* For document-only changes commit message can start with [AIRFLOW-XXXX]

In case of fundamental code change, Airflow Improvement Proposal (AIP) is needed.
In case of a new dependency, check compliance with the ASF 3rd Party License Policy.
In case of backwards incompatible changes please leave a note in UPDATING.md.
Read the [Pull Request Guidelines](#) for more information.

5 1

Contributors

Reviewers

- kujan
- alexisale
- ashb
- kaxil
- dimberman
- mik-laj

Assignees

No one assigned

Labels

- area:webserver
- area:dev
- area:docs

Projects

None yet

Milestone

No milestone

Linked issues

Successfully merging this pull request may close these issues.

@CzerwonyElmo (Kamil Breguła)

@kaxil (Kaxil Naik)

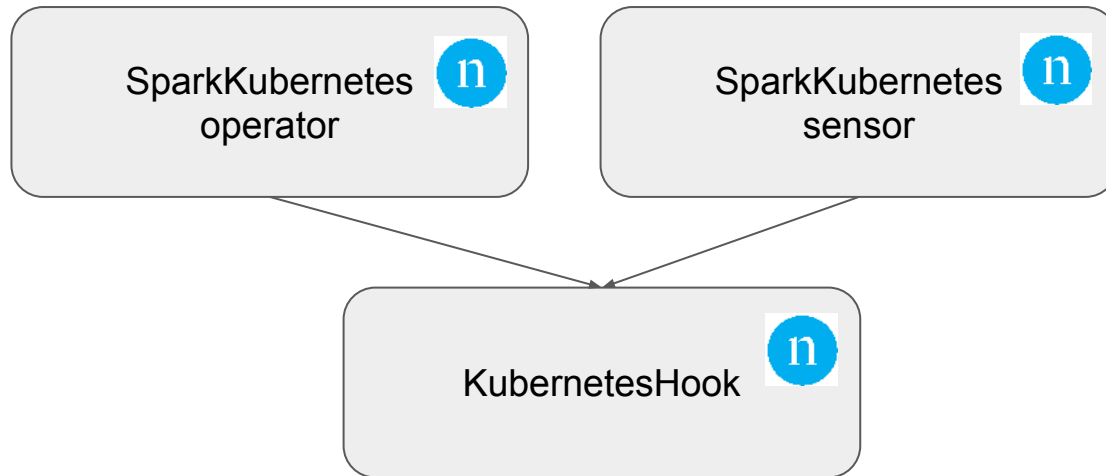
@AshBerlin (Ash Berlin-Taylor)

@higrys (Jarek Potiuk)

@ItaiYaffe, @RTeveth



Airflow SparkKubernetes integration



KubernetesHook

- Gets the **connection parameters** from Airflow's Kubernetes connection
 - E.g kubeconfig, namespace or in-cluster configuration
- Creates an **API client** and allows to create and get a Kubernetes `custom_resource_object`
 - *SparkApplication* is of type *customResource*



SparkKubernetes operator

- Gets the *SparkApplication* resource definition
- Templates it using Jinja
- Sends it to the Kubernetes cluster

```
apiVersion:  
"sparkoperator.k8s.io/v1beta2"  
  
kind: SparkApplication  
  
metadata:  
  name: "spark-pi-{{ ds }}-{{  
task_instance.try_number }}"  
  namespace: default  
  
spec:  
  ...  
  driver:  
    ...  
  executor:  
    ...
```

SparkKubernetes
operator



SparkKubernetes sensor

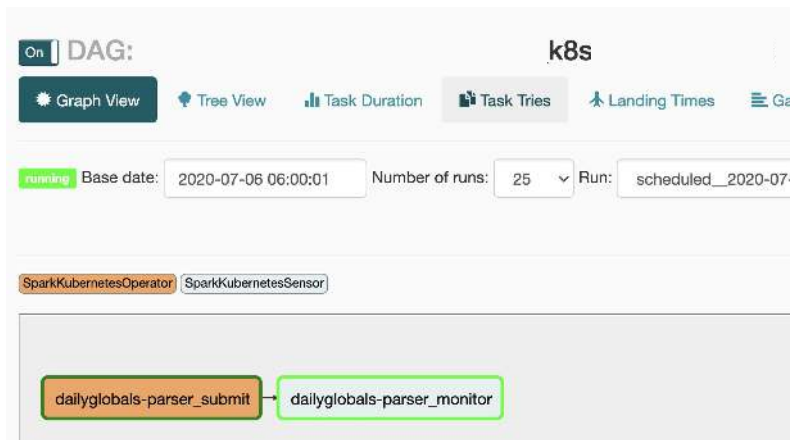
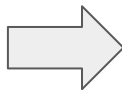
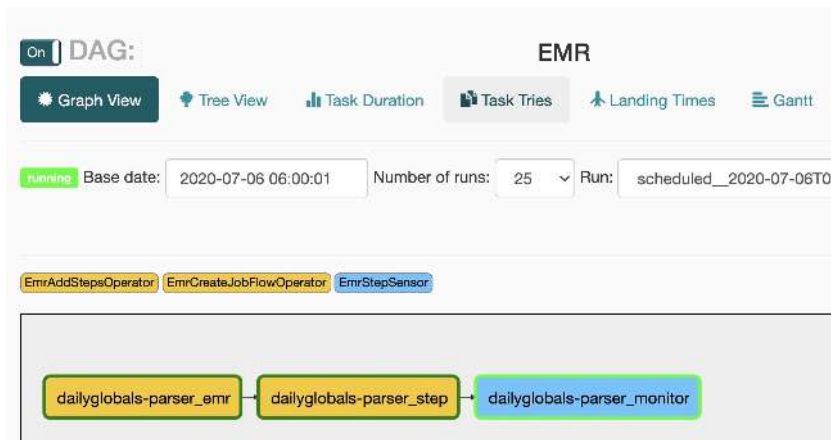
- Pokes the *SparkApplication* as long as the *applicationState* is SUBMITTED or RUNNING
- Completes successfully if the *applicationState* is SUCCESS, or raises an exception if the *applicationState* is FAILED



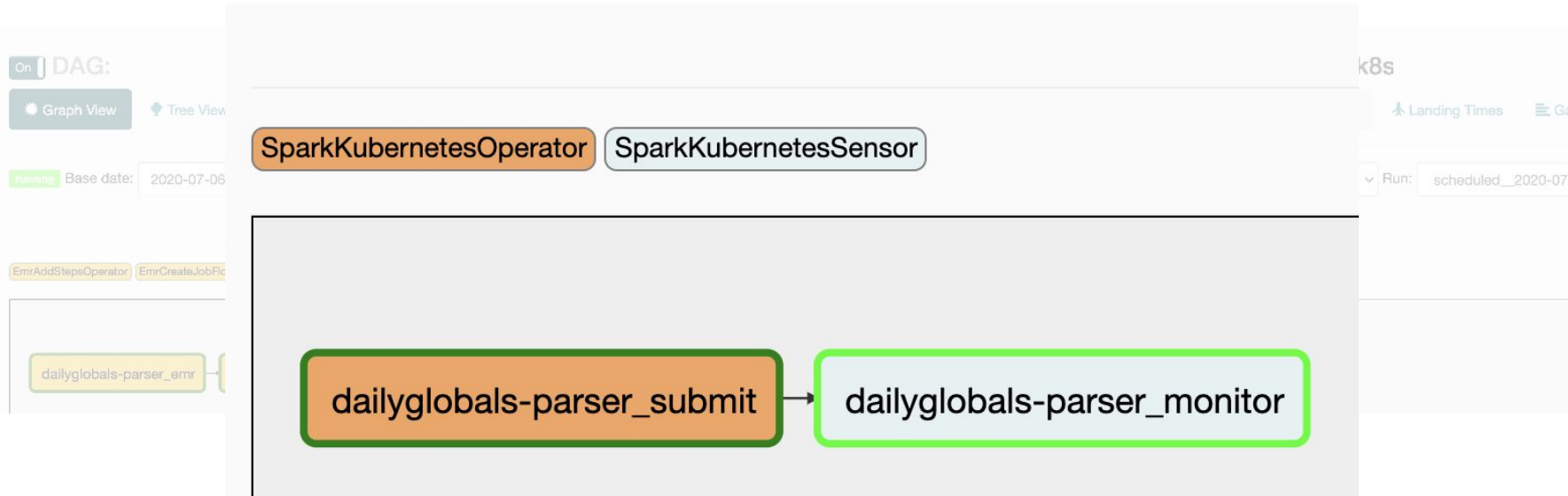
What have we gained by building this integration?

- **Official built-in Airflow support** 
- **Security**
 - Save Kubernetes credentials inside Airflow connection mechanism 
- **Portability**
 - Use templated Kubernetes object so the same app can be migrated easily to Airflow and also be run manually 
- **Kubernetes native**
 - Communicate directly with the Kubernetes API 

Remember this slide?



Let's take a closer look again...



Common data pipeline pattern - revised

Data Lake



1.
Read input
files



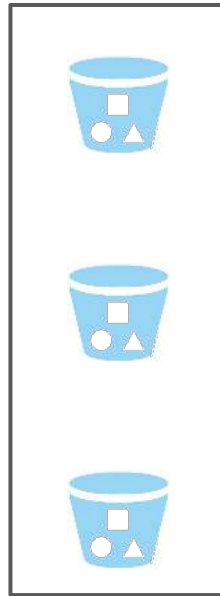
Data Processing



2.
Write output
files



Intermediate Storage



3.
Ingest
to DB



OLAP



Common data pipeline pattern - revised

Data Lake



1.
Read input
files



Data Processing



2.
Write output
files



Intermediate Storage



3.
Ingest
to DB



OLAP



Benefits from migrating to Kubernetes

- **~30%** cost reduction



- No additional cost per instance

- Better visibility

- E.g automatic Prometheus configuration using Spark-on-K8s operator



- Robustness

- E.g running a Spark job on multiple AZs
(can be beneficial when using Spot instances)



Current status and future plans

- Airflow integration merged to master
 - Will be available on Airflow 2.0
 - Planned to be included as a backport package on Airflow 1.10.11
- Extend the new KubernetesHook and possibly migrate `kubernetes_pod_operator` to work with it
- We're gradually migrating our DAGs



Airflow “pro” tips

- Use **Jinja templating**
 - Provides the DAG developer with a set of built-in parameters and macros
- Make Airflow more **secured** using K8s’ role-based access control (RBAC)



Airflow “pro” tips

- **Monitoring and alerting**

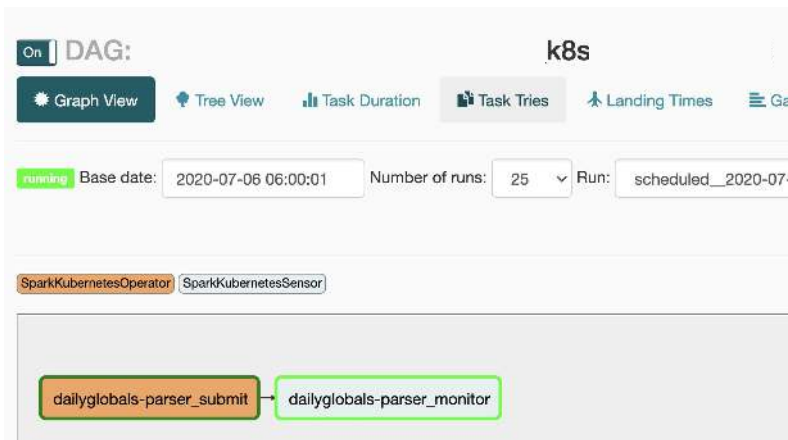
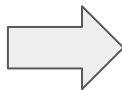
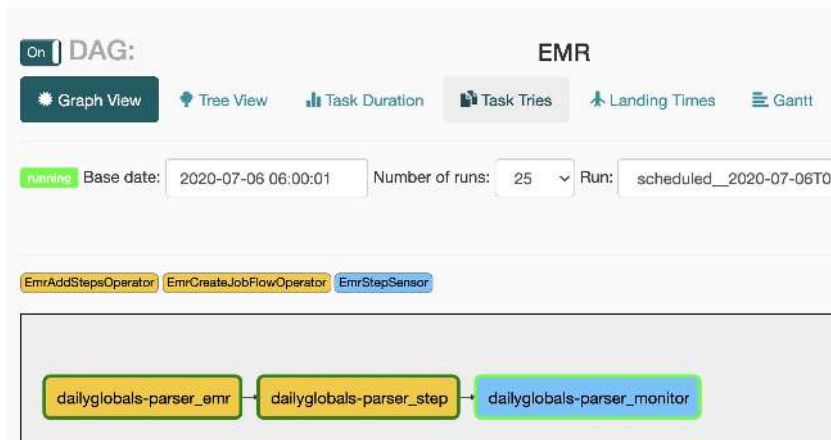
- Use the DAG's `on_success_callback` and `on_failure_callback` (in `default_args`) to **emit metrics** to your monitoring system and **trigger alerts** based on those metrics

- **Leverage Airflow's built-in components**

(Operator/Hook/Sensor)

- Couldn't find one? Build & **contribute** one 🤪

Same-same...



... but different - for you!



Reduce costs



Open your eyes



Robust

- Migrate **your** Spark jobs to Kubernetes
- Leverage the easy-to-use **native Airflow integration** we contributed

Want to know more?



- Women in Big Data
 - A world-wide program that aims :
 - To inspire, connect, grow, and champion success of women in the Big Data & analytics field
 - 30 chapters and 17,000+ members world-wide
 - Everyone can join (regardless of gender), so find a chapter near you - <https://www.womeninbigdata.org/wibd-structure/>
- Our Tech Blog - medium.com/nmc-techblog
 - Spark Dynamic Partition Inserts part 1 - <https://tinyurl.com/yd94ztz5>
 - Spark Dynamic Partition Inserts Part 2 - <https://tinyurl.com/y8uembml>



QUESTIONS



THANK YOU



[Roi Teveth](#)



[Roi Teveth](#)



[Itai Yaffe](#)



[Itai Yaffe](#)

