

Improving the Airflow User Experience



Speakers



Ry Walker

Founder/CTO at Astronomer



@rywalker



Viraj Parekh

Head of Field Engineering
at Astronomer



@vmpvmp94



Maxime Beauchemin

Founder/CEO of Preset, Creator of
Apache Airflow and Apache Superset



@mistercrunch

About Astronomer



Astronomer is focused on helping organizations adopt Apache Airflow, the open-source standard for data pipeline orchestration.

Products



Astronomer
Enterprise



Astronomer
Cloud

Locations

San Francisco

London

New York

Cincinnati

Hyderabad

100+

Enterprise customers around the world

4 of top 7

Airflow committers are Astronomer advisors or employees

Investors



Frontline

Wireframe
VENTURES

7 Stages of Airflow User Experience





Current

LDAP authentication

Kerberos (w/ some operators)

Fernet key encryption

External secrets backend

CVE Mitigations

RBAC

- Astronomer has multi-tenant RBAC solution built in



Data Science

← Users

User Details

Name

Email

Joined

07/08/20

Workspace Role

Viewer

Editor

Admin

Update User

Cancel

Remove User

[REDACTED] will be removed from the workspace.

Remove User

astronomer-fab-securitymanager

A custom Flask-AppBuilder security manager for use with [Apache Airflow](#) inside the [Astronomer Platform](#).



Current

LDAP authentication

Kerberos (w/ some operators)

Fernet key encryption

External secrets backend

CVE Mitigations

RBAC

- Astronomer has multi-tenant RBAC solution built in

Future

Data lineage

Audit logs

Integration with external identity providers (Auth0, Okta, Ping, SAML)





Current

Your Text Editor + Python environment

Astronomer CLI

Community Projects

- [DagFactory](#) (DevotedHealth)
- [Airflow DAG Creation Manager](#)
- [Plugin](#)
- [Kedro](#)

git pull

code .

```
with DAG('covid_data_to_s3',
         start_date=datetime(2020, 3, 1),
         max_active_runs=1,
         schedule_interval='@daily',
         default_args=default_args,
         catchup=False # enable if you don't want historical data to be re-run
        ) as dag:

    t0 = DummyOperator(task_id='start')

    for endpoint in endpoints:
        generate_files = PythonOperator(
            task_id='generate_file_{0}'.format(endpoint),
            python_callable=upload_to_s3,
            op_kwargs={'endpoint': endpoint, 'date': date}
        )

    t0 >> generate_files
```

virajparekh@orbiter:~/Code/Astronomer/airflow-covid-data\$

█



dag-factory



dag-factory is a library for dynamically generating [Apache Airflow](#) DAGs from YAML configuration files.

<https://github.com/ajbosco/dag-factory>

dag-factory



dag-factory is a library for dynamically generating [Apache Airflow](#) DAGs from YAML configuration files.

Define a DAG with YAML

```
example_dag1:  
    default_args:  
        owner: 'example_owner'  
        start_date: 2018-01-01 # or '2 days'  
        end_date: 2018-01-05  
        retries: 1  
        retry_delay_sec: 300  
        schedule_interval: '0 3 * * *'  
        concurrency: 1  
        max_active_runs: 1  
        dagrun_timeout_sec: 60  
        default_view: 'tree' # or 'graph', 'duration', 'gantt', 'landing_times'  
        orientation: 'LR' # or 'TB', 'RL', 'BT'  
        description: 'this is an example dag!'  
        on_success_callback_name: print_hello  
        on_success_callback_file: /usr/local/airflow/dags/print_hello.py  
        on_failure_callback_name: print_hello  
        on_failure_callback_file: /usr/local/airflow/dags/print_hello.py  
    tasks:
```

dag-factory

 build passing  codecov 91%  pypi v0.4.5
 code style black  downloads 44k

dag-factory is a library for dynamically generating [Apache Airflow](#) DAGs from YAML configuration files.

Parse the YAML

```
from airflow import DAG
import dagfactory

dag_factory = dagfactory.DagFactory("/path/to/dags/config_file.yml")

dag_factory.clean_dags(globals())
dag_factory.generate_dags(globals())
```

Define a DAG with YAML

```
example_dag1:
    default_args:
        owner: 'example_owner'
        start_date: 2018-01-01 # or '2 days'
        end_date: 2018-01-05
        retries: 1
        retry_delay_sec: 300
        schedule_interval: '0 3 * * *'
        concurrency: 1
        max_active_runs: 1
        dagrun_timeout_sec: 60
        default_view: 'tree' # or 'graph', 'duration', 'gantt', 'landing_times'
        orientation: 'LR' # or 'TB', 'RL', 'BT'
        description: 'this is an example dag!'
        on_success_callback_name: print_hello
        on_success_callback_file: /usr/local/airflow/dags/print_hello.py
        on_failure_callback_name: print_hello
        on_failure_callback_file: /usr/local/airflow/dags/print_hello.py
```

....and you have a DAG!

Off DAG: example_dag this is an example dag

Graph View Tree View Task Duration Task Tries Landing Times Gantt Details Code Refresh

None Base date: 2018-11-20 02:03:56 Number of runs: 25 Run: Layout: Left->Right Go

BashOperator

```
graph LR; task_1[task_1] --> task_2[task_2]; task_1 --> task_3[task_3]
```



Airflow DAG Creation Manager Plugin

Description

A plugin for [Apache Airflow](#) that create and manage your DAG with web UI.

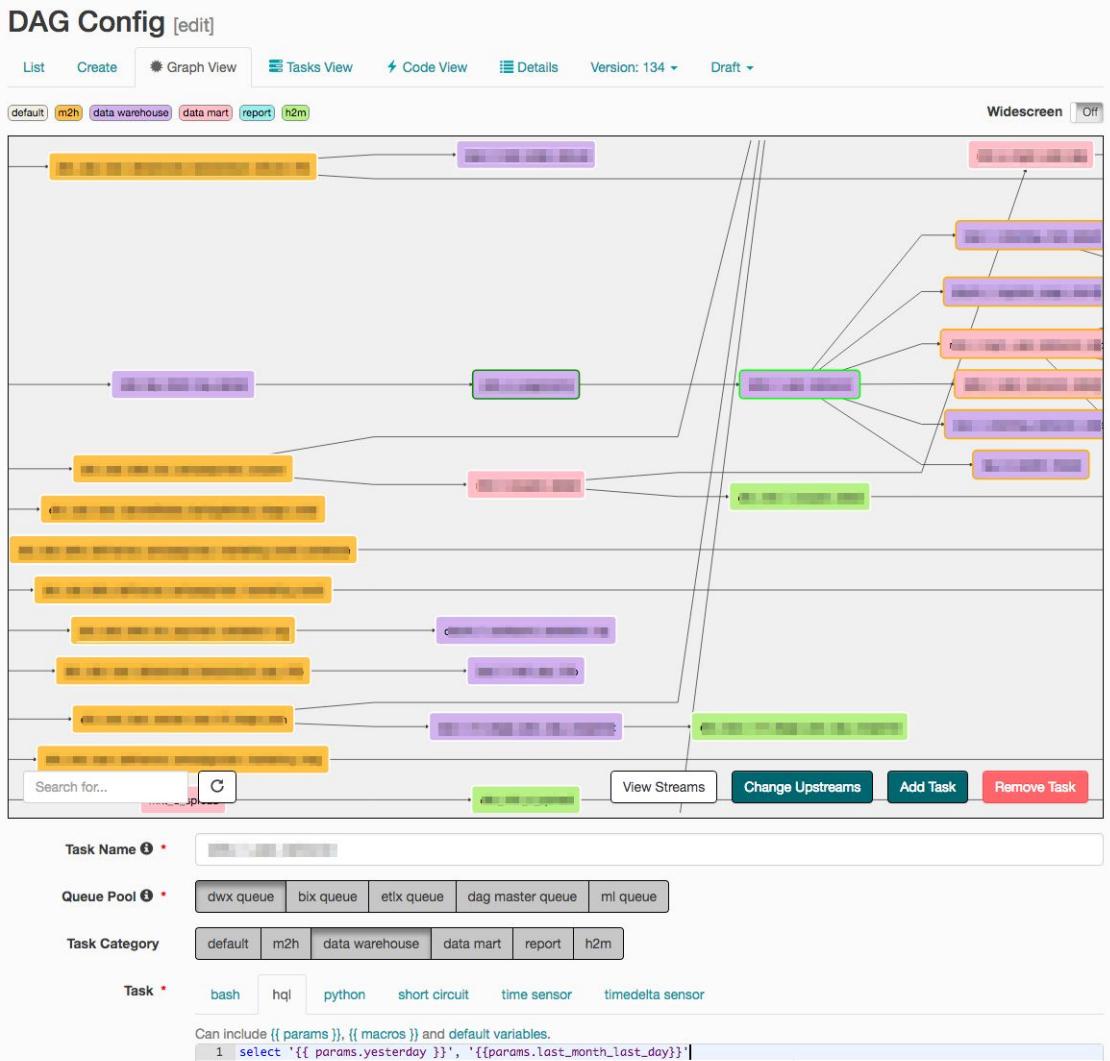
<https://github.com/lattebank/airflow-dag-creation-manager-plugin>

Airflow DAG Creation Manager Plugin

Description

A plugin for [Apache Airflow](#) that create and manage your DAG with web UI.

Create and manage DAGS directly from the UI





Current

Your Text Editor + Python environment

Astronomer CLI

Community Projects

- [DagFactory](#) (DevotedHealth)
- [Airflow DAG Creation Manager](#)
- [Plugin](#)
- [Kedro](#)

Future

DAGs from Notebooks

Scheduling SQL query from UI

DAG Generator from standard templates





Current

Most users git-sync DAGs, add prod dependencies manually

Official Community Docker Image

Astronomer is Docker-centric

- Define dependencies (both Python packages + system-level packages) directly in your code project
- Run the image locally with Docker
- Reduces devOps workload, since data engineers trial and error dependencies locally
- Can run the whole image through CVE testing

virajparekh@orbiter:~/Code/Astronomer/airflow-covid-data\$





Current

No standardization around DAG unit testing

Adhoc testing for different data scenarios

Community Projects:

- [Raybeam Status Plugin](#)
- [Great Expectations Pipeline Tutorial](#)



Data confidence plugin for Airflow.

The Status Airflow plugin makes it easy to communicate confidence about your data system to manager, executives and other stakeholders in your organization. It improves trust in underlying data by increasing transparency.

https://github.com/Raybeam/rb_status_plugin



Is the data ready?



Airflow

DAGs

Security

Browse

Admin

Docs

About

Status

2020-05-29, 22:52:19 UTC

admin user

No reports have run yet!

Don't worry, here's some steps for creating a new report:

- Create a new report.
- Turn on the new report on the reports page.
- Run the new report manually or let it run naturally on the schedule you provided.
- Wait for the report to finish running.
- This status page will now be populated with a new report.

Schedule data quality tasks as reports

Airflow DAGs Security Browse Admin Docs About Status 2020-05-29, 22:53:30 UTC admin user

New Report

General

| | |
|--|--|
| Title * | Social channels |
| Title will be used as the report's name | |
| Description * | Data status for social dashboards and marketing optimization model |
| Owner Name * | Anne A. List |
| Owner Email * | analyst@example.com |
| Owner email will be added to the subscribers list | |
| Subscribers | manager@example.com |
| List of comma separated emails that should receive email notifications. Automatically adds owner email to this list. | |

Airflow DAGs Security Browse Admin Docs About Status 2020-06-04, 17:17:32 UTC admin user

Reports

[Create New Report](#)

| | | Report | Schedule | Tests | Owner | Subscribers | Links |
|-------------------------------------|--|---------------------|----------|--|--------------|------------------------------|-------|
| <input checked="" type="checkbox"/> | | Data loading report | None | social_channels_dag.load_facebook, social_channels_dag.load_pinterest, social_channels_dag.load_twitter | Data | data@starship-enterprise.com | |
| <input checked="" type="checkbox"/> | | Social channels | None | social_channels_dag.test_correlations, social_channels_dag.test_model_boundaries, social_channels_dag.test_new_records | Anne A. List | bbrischi@raybeam.com | |



Some Tests Are Failing

Updated Jun 04 at 17:27

Reports



Failed / Updated Jun 04 at 17:27
Data loading report

Details ^

Report Owner: Data bbriscki@raybeam.com

Description: Status of all data loads from external partners

Subscribers: bbriscki@raybeam.com

Failed:

- test_social_channels_dag.load_facebook



Passed / Updated May 29 at 23:08
Social channels

Details ▾

Keep stakeholders aware of data quality

**Some Tests Are Failing**

Updated Jun 04 at 17:27

Reports

● Failed / Updated Jun 04 at 17:27
Data loading report

Details ^

Report Owner: Data bbriscki@raybeam.com

Description: Status of all data loads from external partners

Subscribers: bbriscki@raybeam.com

Failed:

- test_social_channels_dag.load_facebook

● Passed / Updated May 29 at 23:08
Social channels

Details ▾

Keep stakeholders aware of data quality

Hooks into existing Airflow functionality

[Failed] Data loading report ➔ [Inbox](#) via sendgrid.net
to me ▾

10:27 AM (0 minutes ago)

New status update on the "Data loading report" report you subscribed to

● Failed / Updated Jun 04 at 17:27
Data loading report[Details](#)This report was generated by rb status
© 1997 - 2020 Raybeam, Inc. All Rights Reserved[Reply](#)[Forward](#)



Current

No standardization around DAG unit testing

Adhoc testing for different data scenarios

Community Projects:

- [Raybeam Status Plugin](#)
- [Great Expectations Pipeline Tutorial](#)

Future

Data awareness?

Standardized best practices for DAG unit testing

Additional automated testing of Hooks and Operators



Current

Most Airflow deployments are pets,
not cattle — manually deployed

“Guess and check” for configurations

The Astronomer Way

- Use Kubernetes!
- Airflow now has an official Helm chart
- Astronomer platform makes it easy to CRUD Airflow deployments

github.com/apache/airflow/tree/master/chart



Official Helm Chart for Apache Airflow

This chart will bootstrap an [Airflow](#) deployment on a [Kubernetes](#) cluster using the [Helm](#) package manager.

Prerequisites

- Kubernetes 1.12+ cluster
- Helm 2.11+ or Helm 3.0+
- PV provisioner support in the underlying infrastructure

```
## from the chart directory of the airflow repo
kubectl create namespace airflow
helm repo add stable https://kubernetes-charts.storage.googleapis.com
helm dep update
helm install airflow . --namespace airflow
```



| | | |
|----------------------------|--------------------------------------|---|
| uid | | |
| gid | | |
| nodeSelector | | |
| affinity | | |
| tolerations | | |
| labels | | |
| privateRegistry.enabled | images.redis.pullPolicy | workers.terminationGracePeriodSeconds |
| privateRegistry.repository | images.pgbouncer.repository | workers.safeToEvict |
| networkPolicies.enabled | images.pgbouncer.tag | scheduler.podDisruptionBudget.enabled |
| airflowHome | images.pgbouncer.pullPolicy | scheduler.podDisruptionBudget.config.maxUnavailable |
| rbacEnabled | images.pgbouncerExporter.repository | scheduler.resources.limits.cpu |
| executor | images.pgbouncerExporter.tag | scheduler.resources.limits.memory |
| allowPodLaunching | images.pgbouncerExporter.pullPolicy | scheduler.resources.requests.cpu |
| defaultAirflowRepository | env | scheduler.resources.requests.memory |
| defaultAirflowTag | secret | scheduler.airflowLocalSettings |
| images.airflow.repository | data.metadataSecretName | scheduler.safeToEvict |
| images.airflow.tag | data.resultBackendSecretName | webserver.livenessProbe.initialDelaySeconds |
| images.airflow.pullPolicy | data.metadataConection | webserver.livenessProbe.timeoutSeconds |
| images.flower.repository | data.resultBackendConnection | webserver.livenessProbe.failureThreshold |
| images.flower.tag | fernetKey | webserver.livenessProbe.periodSeconds |
| images.flower.pullPolicy | fernetKeySecretName | webserver.readinessProbe.initialDelaySeconds |
| images.statsd.repository | workers.replicas | webserver.readinessProbe.timeoutSeconds |
| images.statsd.tag | workers.keda.enabled | webserver.readinessProbe.failureThreshold |
| images.statsd.pullPolicy | workers.keda.pollingInveral | webserver.readinessProbe.periodSeconds |
| images.redis.repository | workers.keda.cooldownPeriod | webserver.replicas |
| images.redis.tag | workers.keda.maxReplicaCount | webserver.resources.limits.cpu |
| | workers.persistence.enabled | webserver.resources.limits.memory |
| | workers.persistence.size | webserver.resources.requests.cpu |
| | workers.persistence.storageClassName | webserver.resources.requests.memory |
| | workers.resources.limits.cpu | webserver.defaultUser |
| | workers.resources.limits.memory | dags.persistence.* |
| | workers.resources.requests.cpu | dags.gitSync.* |
| | workers.resources.requests.memory | |

```
helm install airflow-ry . --namespace airflow-ry
```

```
NAME: airflow-ry
LAST DEPLOYED: Wed Jul  8 20:10:29 2020
NAMESPACE: airflow-ry
STATUS: deployed
REVISION: 1
```

You can now access your dashboard(s) by executing the following command(s) and visiting the corresponding port at localhost in your browser:

```
Airflow dashboard:      kubectl port-forward svc/airflow-ry-webserver 8080:8080 --namespace airflow
```

```
kubectl get pods --namespace airflow-ry
```

| NAME | READY | STATUS | RESTARTS | AGE |
|---------------------------------------|-------|---------|----------|-------|
| airflow-ry-postgresql-0 | 1/1 | Running | 0 | 6m45s |
| airflow-ry-scheduler-78757cd557-t8zdn | 2/2 | Running | 0 | 6m45s |
| airflow-ry-statsd-5c889cc6b6-jxhzw | 1/1 | Running | 0 | 6m45s |
| airflow-ry-webserver-59d79b9955-7sgp5 | 1/1 | Running | 0 | 6m45s |



```
astro deployment create test-deployment --executor celery
```

| NAME | DEPLOYMENT NAME | ASTRO | DEPLOYMENT ID |
|-----------------|--------------------------|--------|---------------------------|
| test-deployment | theoretical-element-5806 | 0.15.2 | ckce1ssco4uf90j16a5adke17 |

Successfully created deployment with Celery executor. Deployment can be accessed at the following URLs

Airflow Dashboard: <https://deployments.astronomer.io/theoretical-element-5806/airflow>

Flower Dashboard: <https://deployments.astronomer.io/theoretical-element-5806/flower>

```
astro deployment delete ckce1ssco4uf90j16a5adke17
```

Successfully deleted deployment

Execution Environment

Executor ⓘ

Kubernetes

Celery

Local

Worker Count ⓘ

1



Worker Resources ⓘ

20

AU

2 CPU

7.5 GB memory

\$200/mo

Worker Termination Grace Period ⓘ

10

min



Extra Capacity ⓘ

0

AU

0 CPU

0 memory

Only necessary to run the KubernetesPodOperator (minimum 10AU).

Core Resources

Webserver ⓘ

9

AU

0.9 CPU

3.38 GB memory

\$90/mo

Scheduler ⓘ

9

AU

0.9 CPU

3.38 GB memory

\$90/mo

www.astronomer.io/guides/airflow-scaling-workers

| airflow.cfg name | Environment Variable | Default Value |
|--------------------|-----------------------------------|---------------|
| parallelism | AIRFLOW_CORE_PARALLELISM | 32 |
| dag_concurrency | AIRFLOW_CORE_DAG_CONCURRENCY | 16 |
| worker_concurrency | AIRFLOW_CELERY_WORKER_CONCURRENCY | 16 |
| max_threads | AIRFLOW_SCHEDULER_MAX_THREADS | 2 |

parallelism is the max number of task instances that can run concurrently on airflow. This means that across all running DAGs, no more than 32 tasks will run at one time.

dag_concurrency is the number of task instances allowed to run concurrently within a *specific dag*. In other words, you could have 2 DAGs running 16 tasks each in parallel, but a single DAG with 50 tasks would also only run 16 tasks - not 32

These are the main two settings that can be tweaked to fix the common "Why are more tasks not running even after I add workers?"

worker_concurrency is related, but it determines how many tasks a single worker can process. So, if you have 4 workers running at a worker concurrency of 16, you could process up to 64 tasks at once. Configured with the defaults above, however, only 32 would actually run in parallel. (and only 16 if all tasks are in the same DAG)

Pro tip: If you increase worker_concurrency, make sure your worker has enough resources to handle the load. You may need to increase CPU and/or memory on your workers. Note: This setting only impacts the CeleryExecutor



Current

Most Airflow deployments are pets,
not cattle — manually deployed
“Guess and check” for configurations

The Astronomer Way

- Use Kubernetes!
- Airflow now has an official Helm chart
- Astronomer platform makes it easy to CRUD Airflow deployments

Future

Infrastructure and configuration
recommendations to optimize
performance and identify bottlenecks



Current

Most Airflow deployments running on virtual machines

Running in K8s enhances stability, observability, and ability to scale

Deployments 205

Users 1512

← on a single k8s cluster!

 Filter by deployment, workspace, or user

| | | | |
|------------|--|---|---|
| ● REDACTED | Tag: deploy-28 Celery executor | Last updated 06/09/20 Created 09/25/19 | > |
| ● REDACTED | Tag: ci-fa3b117570ffadca4f07963a6ac96b0890001d3c Local executor | Last updated 06/09/20 Created 10/15/19 | > |
| ● REDACTED | Tag: ci-0.1.949 Celery executor | Last updated 07/08/20 Created 10/16/19 | > |
| ● REDACTED | Tag: deploy-21 Celery executor | Last updated 07/06/20 Created 10/21/19 | > |
| ● REDACTED | Tag: ci-6b00ab4 Celery executor | Last updated 06/19/20 Created 10/21/19 | > |
| ● REDACTED | Tag: ci-6b00ab4 Celery executor | Last updated 06/22/20 Created 10/21/19 | > |

Settings Variables 11 Metrics Logs Service Accounts 4

Core Container Status ⓘ

| | | |
|------------------|--|---------|
| flower | celestial-wormhole-4369-flower-dbfd99bb4-8svl5 | HEALTHY |
| metrics-exporter | celestial-wormhole-4369-pgbouncer-5bb5f8b799-khh4l | HEALTHY |
| pgbouncer | celestial-wormhole-4369-pgbouncer-5bb5f8b799-khh4l | HEALTHY |
| redis | celestial-wormhole-4369-redis-0 | HEALTHY |
| scheduler | celestial-wormhole-4369-scheduler-697c95478d-4j6d2 | HEALTHY |
| scheduler-gc | celestial-wormhole-4369-scheduler-697c95478d-4j6d2 | HEALTHY |
| statsd | celestial-wormhole-4369-statsd-666dd67fb-d2ljx | HEALTHY |
| webserver | celestial-wormhole-4369-webserver-855995c54c-fhzfw | HEALTHY |
| worker | celestial-wormhole-4369-worker-cf77888ff-tbkf9 | HEALTHY |

← All this for one celery worker. But it's ready to scale.

Usage Quotas

Pods Usage ⓘ



Using 50% of 14 pods

CPU Usage ⓘ



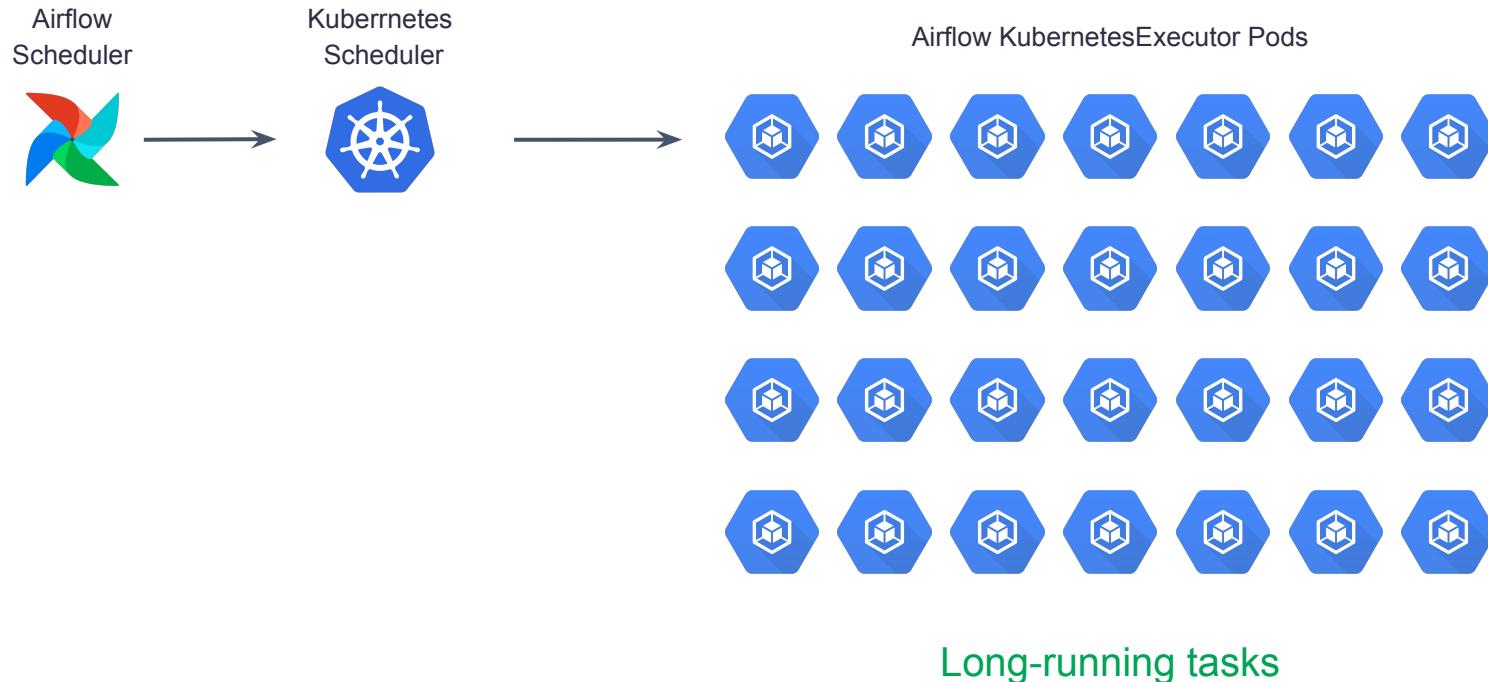
Using 50% of 15.2 cores

Memory Usage ⓘ

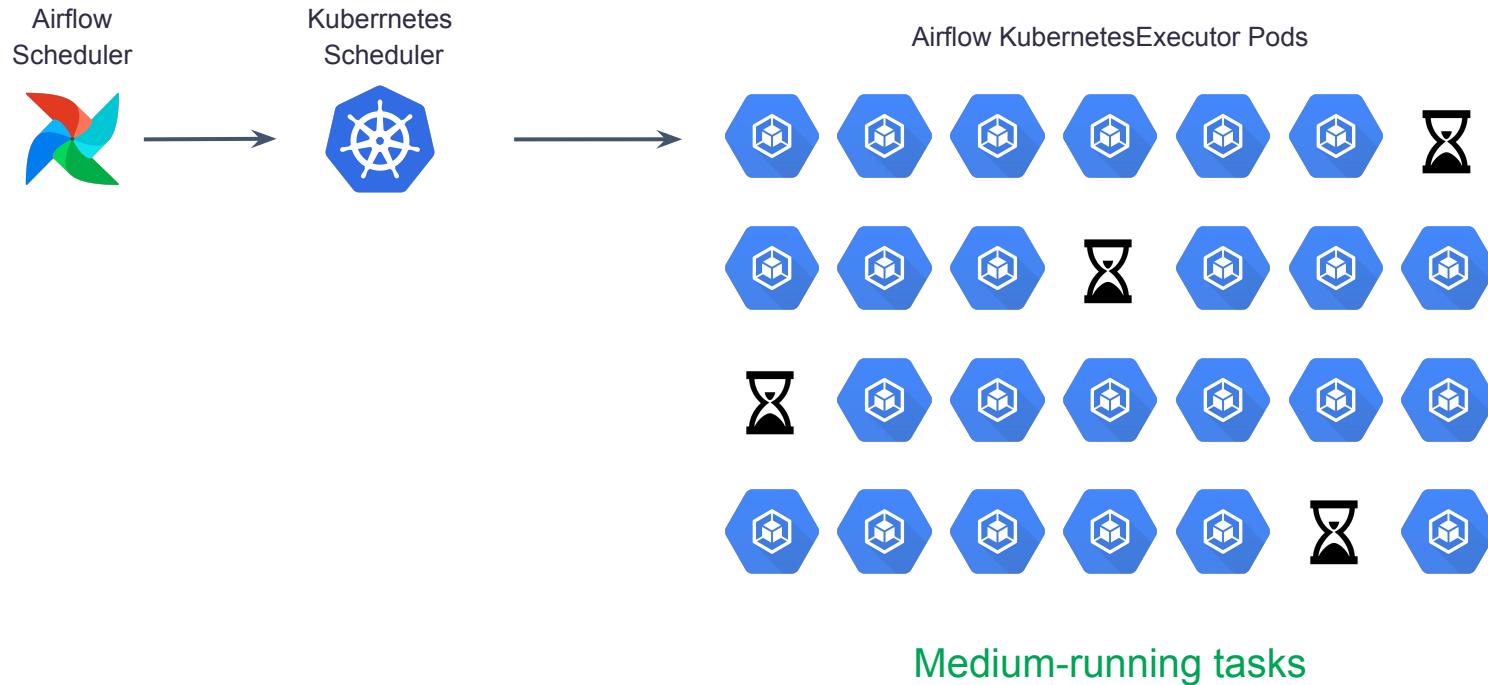


Using 50% of 39.39 GB

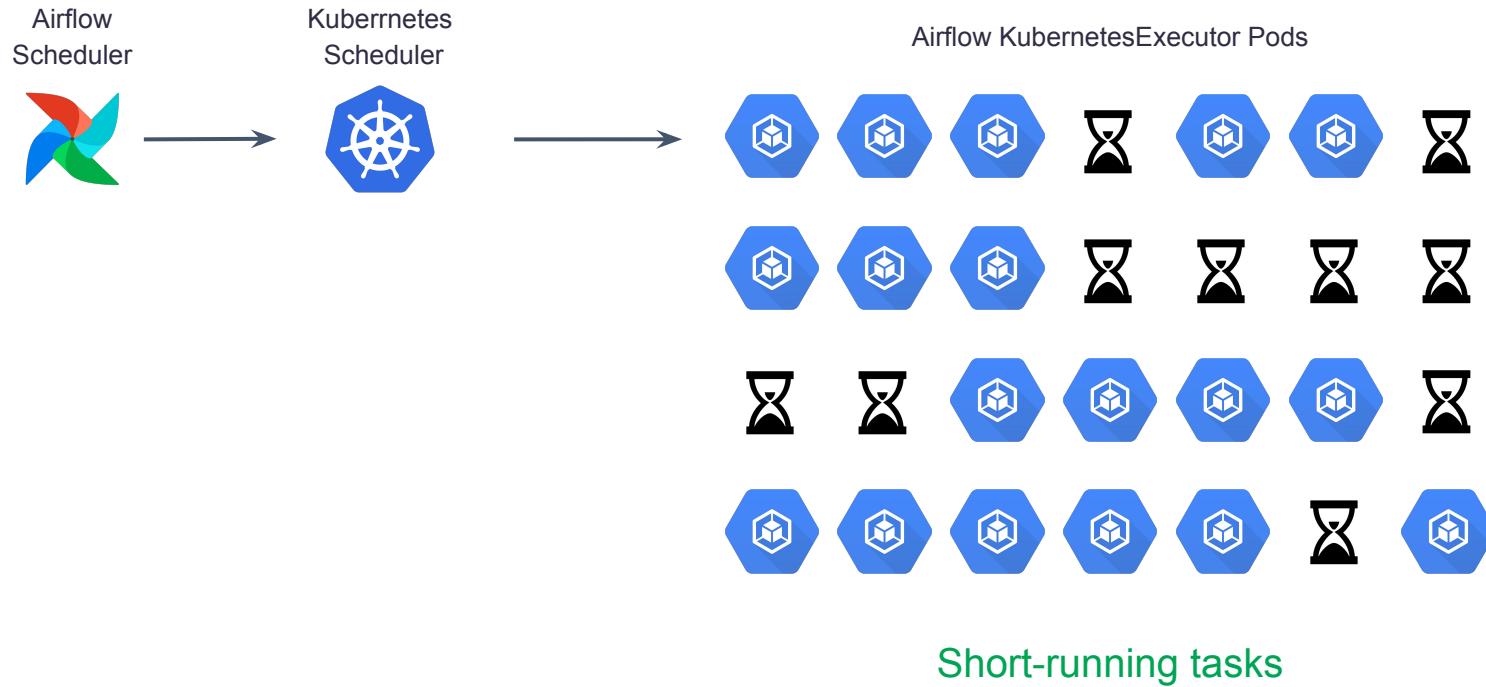
The challenge w/ KubernetesExecutor



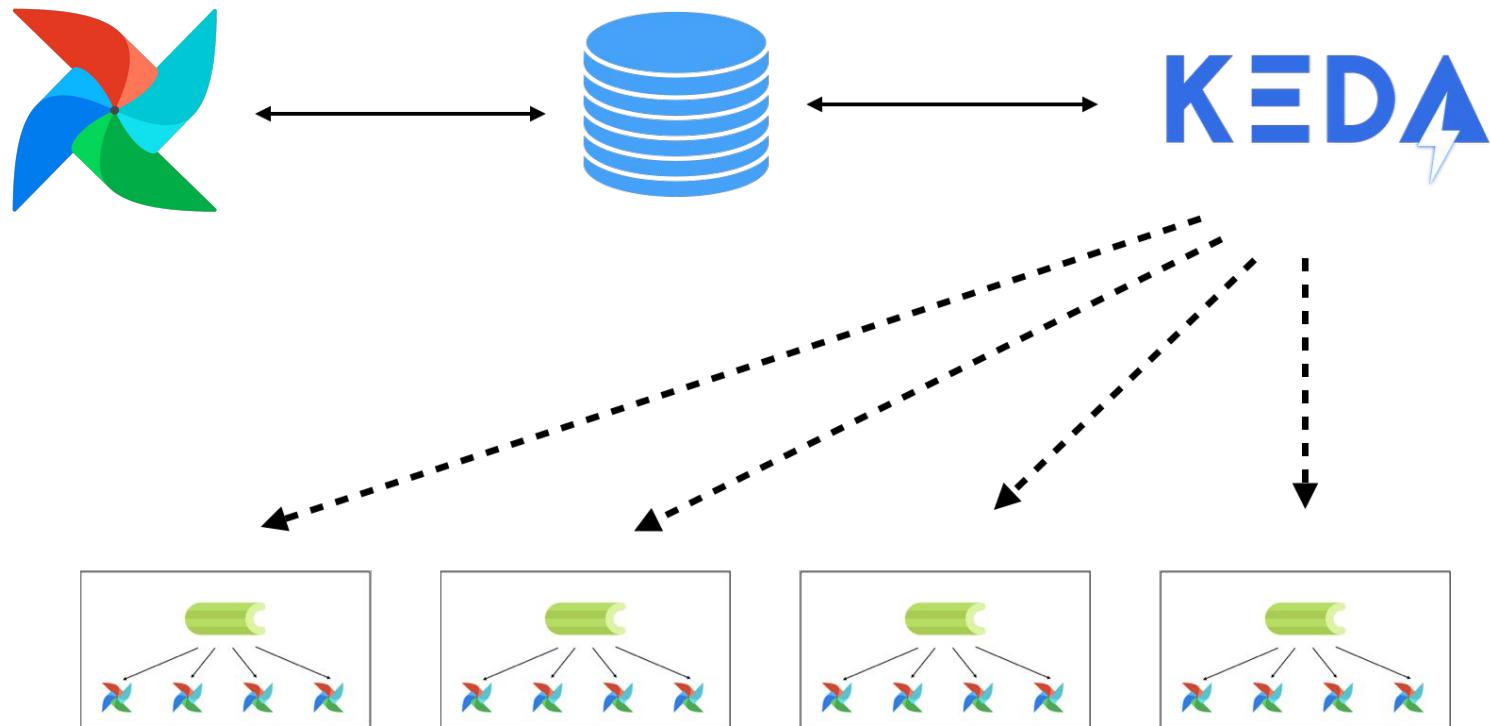
The challenge w/ KubernetesExecutor



The challenge w/ KubernetesExecutor



Celery with KEDA



CEIL((20 RUNNING + 20 QUEUED)/16) = 4 workers



Current

Most Airflow deployments running on virtual machines

Running in K8s enhances stability, observability, and ability to scale

Future

Highly Available Scheduler
“Fastfollow” task scheduling

HA Scheduler



Airflow
Scheduler

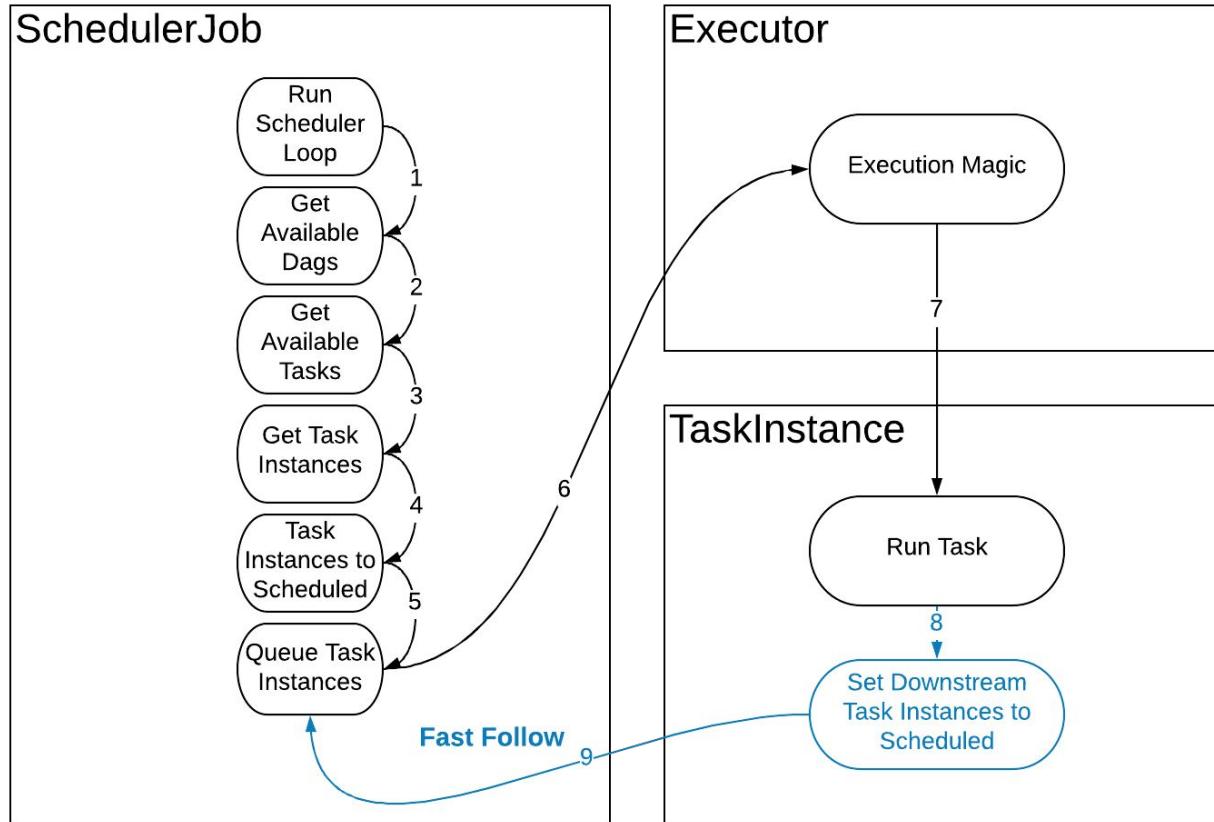


Airflow
Scheduler



...

Fast follow





Current

Airflow built-in dashboards based on task metadata

Airflow native statsd exporter offers deeper metrics

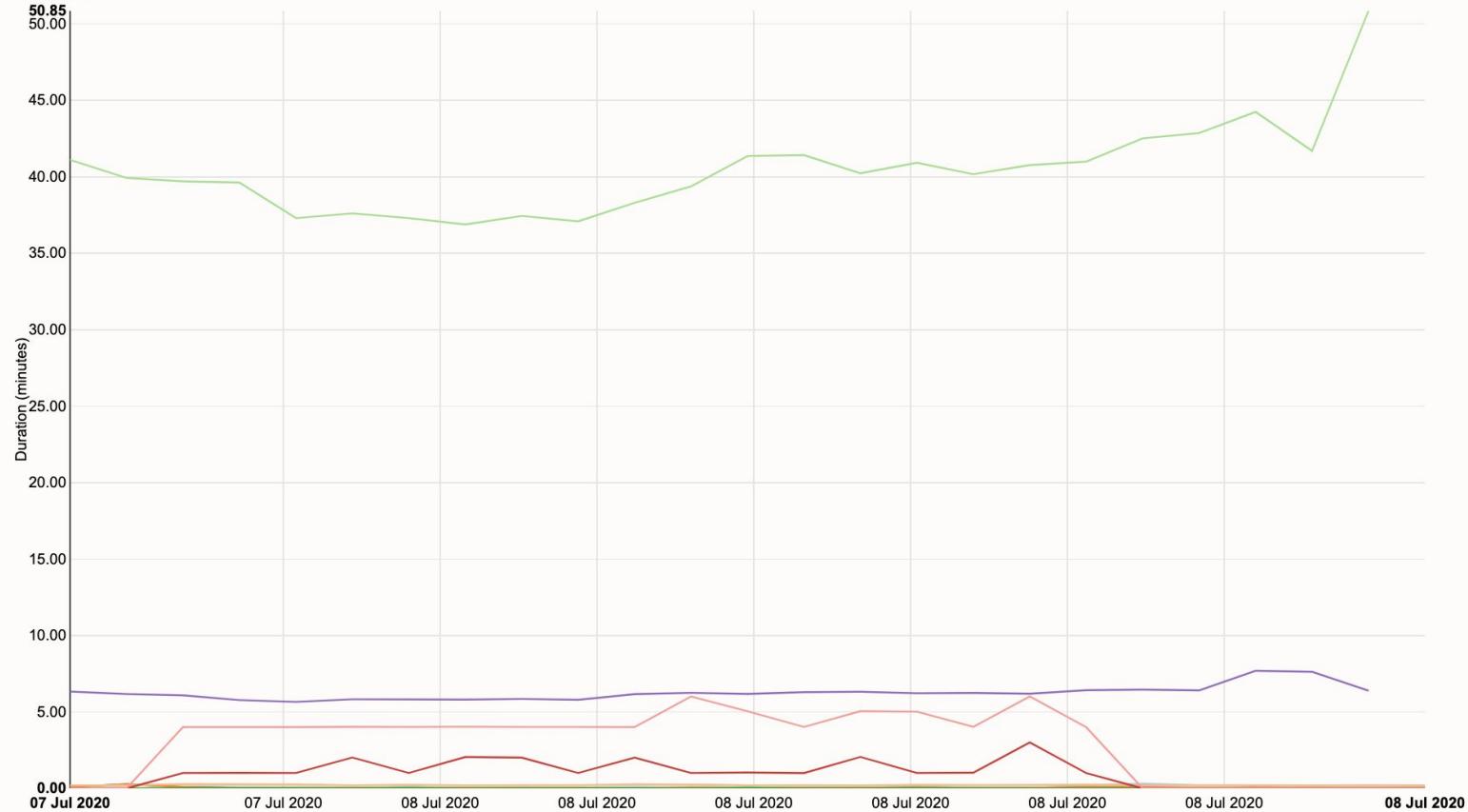
Cumulative Duration □

Base date:

2020-07-09 00:00:00

Number of runs: 25 ▾ Go

● prometheus_memory_to... ● load_used_memory_to... ● prometheus_cpu_to_gc... ● load_used_cpu_to_ps ● LatestOnly ● refresh_vw_usage_bil... ● wait_for_houston_dat...
● wait_for_old_houston... ● refresh_vw_invoice_r...





airflow.apache.org/docs/stable/metrics.html

Counters

<job_name>_start
<job_name>_end
operator_failures_<operator_name>
operator_successes_<operator_name>
ti_failures
ti_successes
zombies_killed
scheduler_heartbeat
dag_processing.processes
scheduler.tasks.killed_externally

Timers

dagrun.dependency-check.<dag_id>
dag.<dag_id>.<task_id>.duration
dag_processing.last_duration.<dag_file>
dagrun.duration.success.<dag_id>
dagrun.duration.failed.<dag_id>
dagrun.schedule_delay.<dag_id>

Gauges

dagbag_size
dag_processing.import_errors
dag_processing.total_parse_time
dag_processing.last_runtime.<dag_file>
dag_processing.last_run.seconds_ago.<dag_file>
dag_processing.processor_timeouts
executor.open_slots
executor.queued_tasks
executor.running_tasks
pool.open_slots.<pool_name>
pool.used_slots.<pool_name>
pool.starving_tasks.<pool_name>



Airflow Database Activity

airflow

Airflow Deployment Overview

airflow

Airflow Resource Utilization

airflow

Airflow Scheduler

airflow

Airflow State

airflow

Availability

Blackbox Exporter Overview

blackbox prometheus

Docker Registry

platform registry

Elasticsearch

elasticsearch platform

Fluentd

fluentd platform

Istio Dashboard

Istio Performance Dashboard

Kubernetes All Nodes

prometheus

Kubernetes Pods

airflow platform

NGINX Ingress Controller

nginx platform

Platform Overview

platform

Prometheus

platform prometheus

Velero

velero



Deployment

All

Total Scheduler Heartbeat

134011654

Ongoing Local Task Jobs

8566

Zombies Killed

7665

Dagbag Size

2429

Collect DAGs

37.8 min

DAG Bag Import Errors

15

DAG parsing processes

1138665432

Ongoing Scheduler Jobs

823

Processor Timeouts

59056

Scheduler Tasks Executable

361

Scheduler Tasks Pending

1208

Scheduler Tasks Running

0

Scheduler Tasks Starving

233



Saved Views

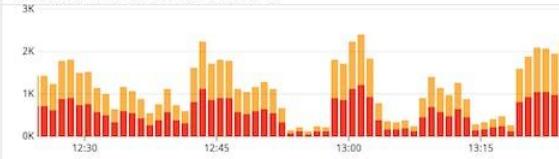
\$scope * \$host *



1

Tasks

Task Instances Successes & Failures

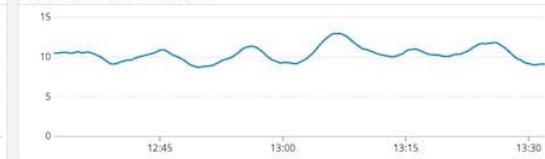


DAGs

DAG Run Task Average Duration

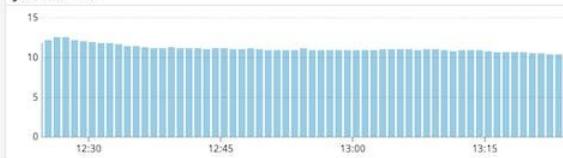


DAG Run Failed Duration

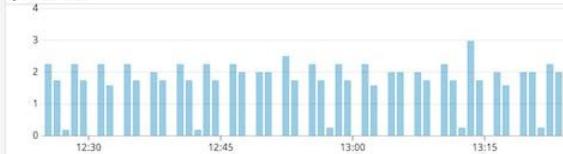


Jobs

Job Started



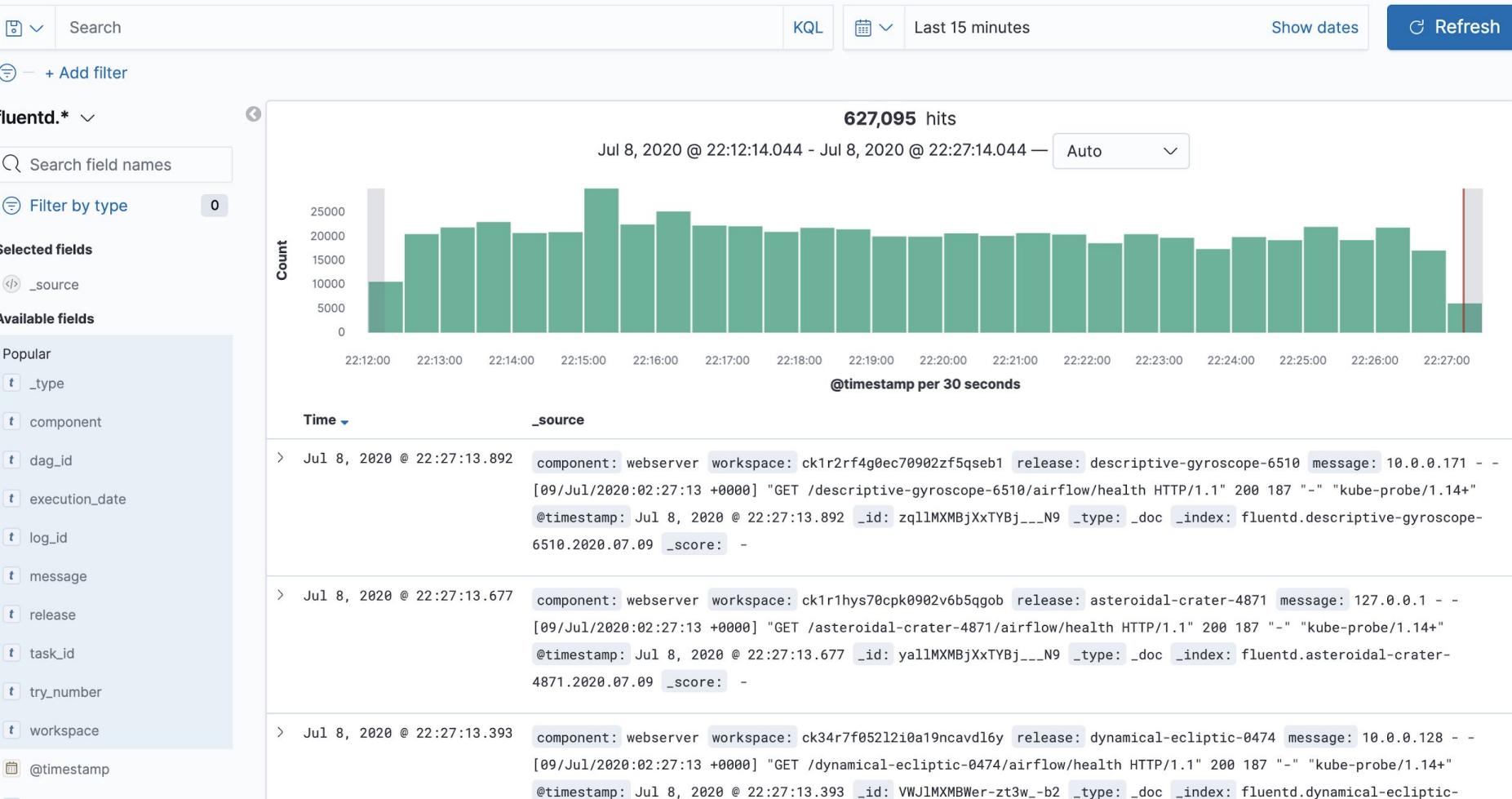
Job Ended

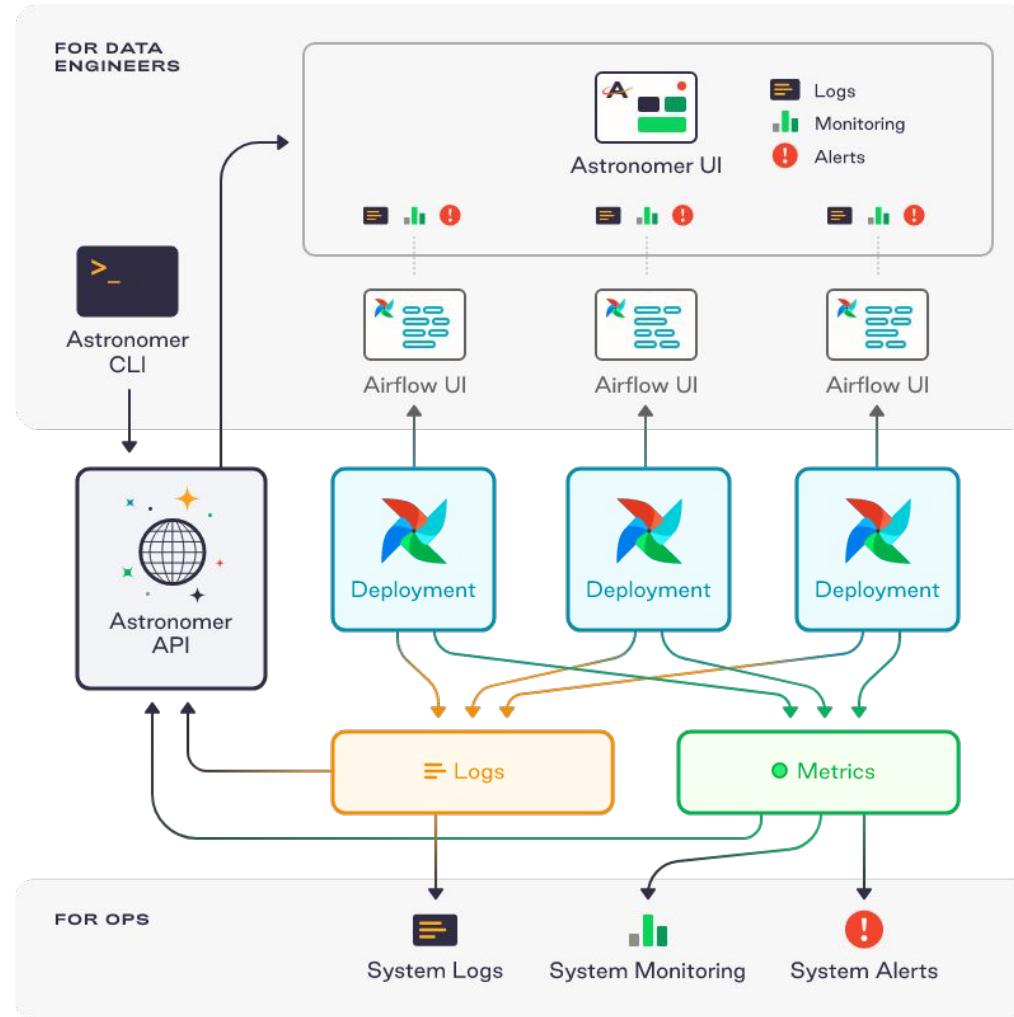


Scheduler

Job Scheduler Heartbeat









Current

Airflow built-in dashboards based on task metadata

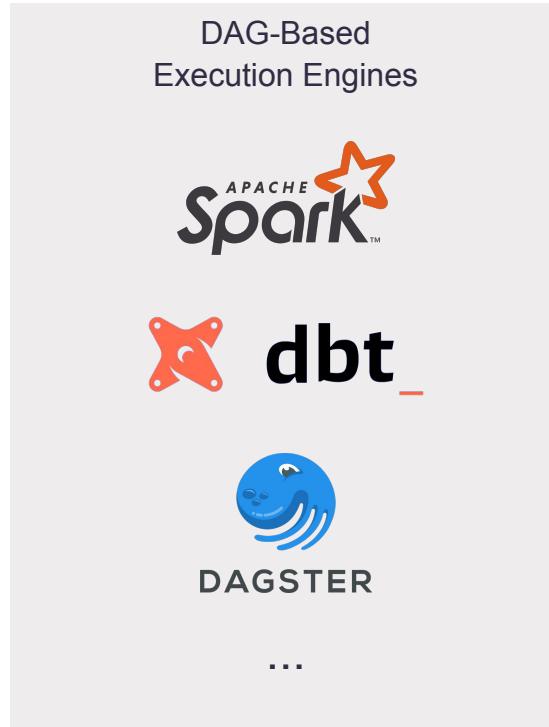
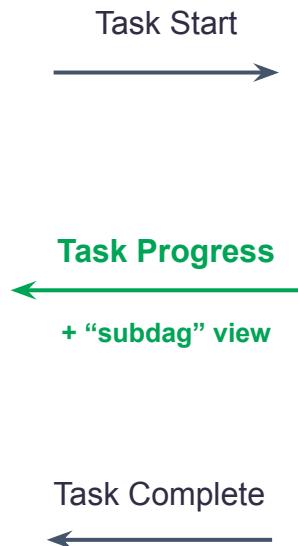
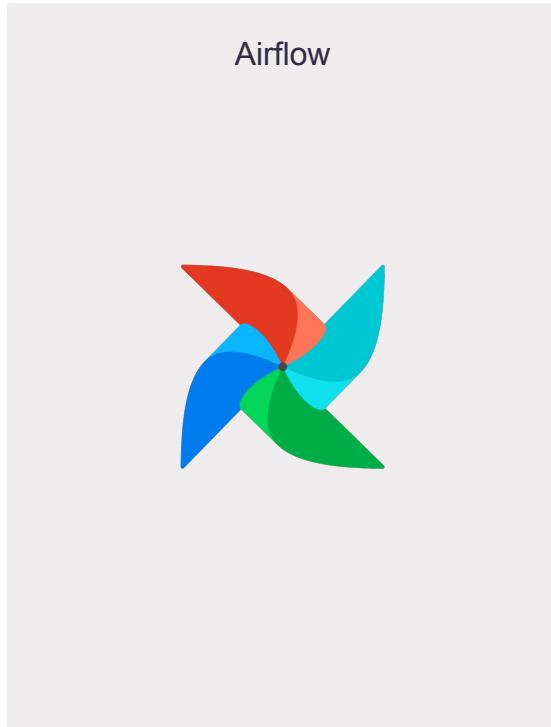
Airflow native statsd exporter offers deeper metrics

Future

Enhance integration options with third party services (Sumologic, Splunk, etc)

Task progress API







Thank You!

Now Q&A