KubeCon | CloudNativeCon

North America 2018

Airflow + Kubernetes

Daniel Imberman, Bloomberg
Barni Seetharaman, Google

Bio: Daniel + Barni

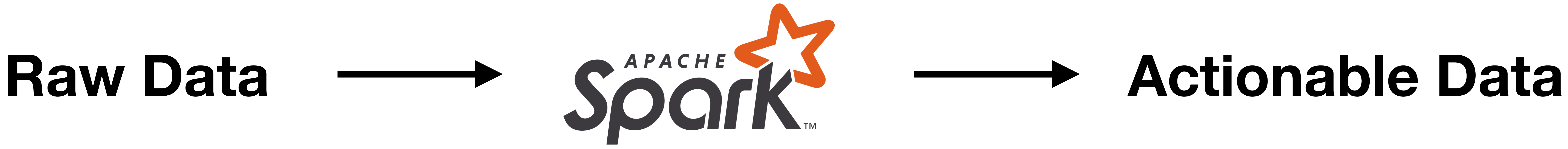
- Daniel
  - Data Science Infrastructure @ Bloomberg LP
  - See our talk tomorrow: Machine Learning the Kubernetes Way
- Barni Seethraman
  - Kubernetes @ Google Cloud
  - Works on Kubernetes Workloads API

Pipelines are hard

Pipelines are hard

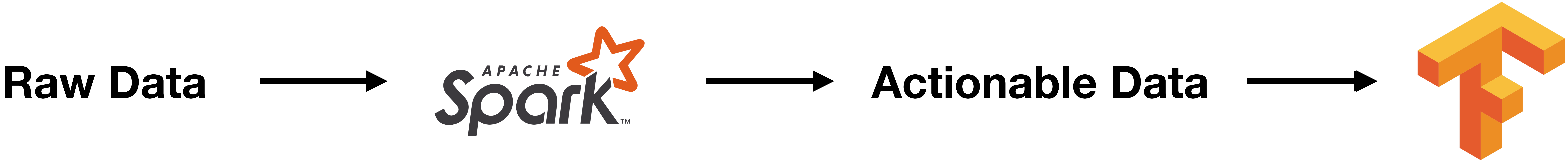
Raw Data → **Actionable Data**

Pipelines are hard



Raw Data → Apache Spark → Actionable Data

Pipelines are hard



Raw Data → Apache Spark → Actionable Data →

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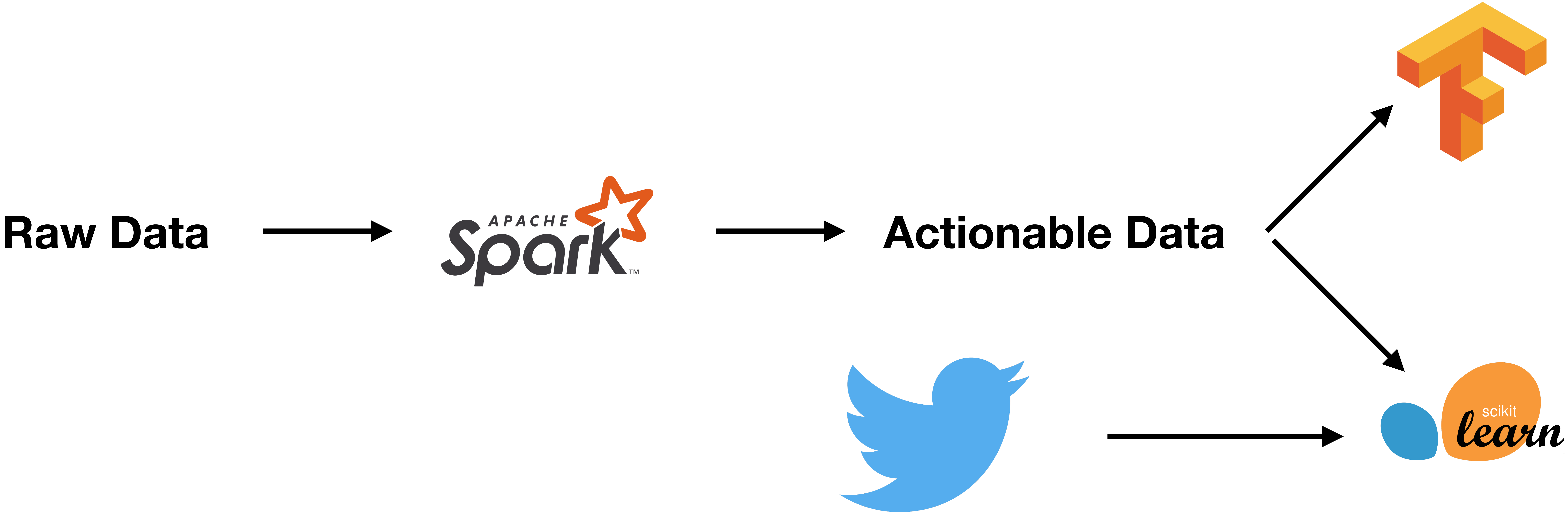

Raw Data → Actionable Data

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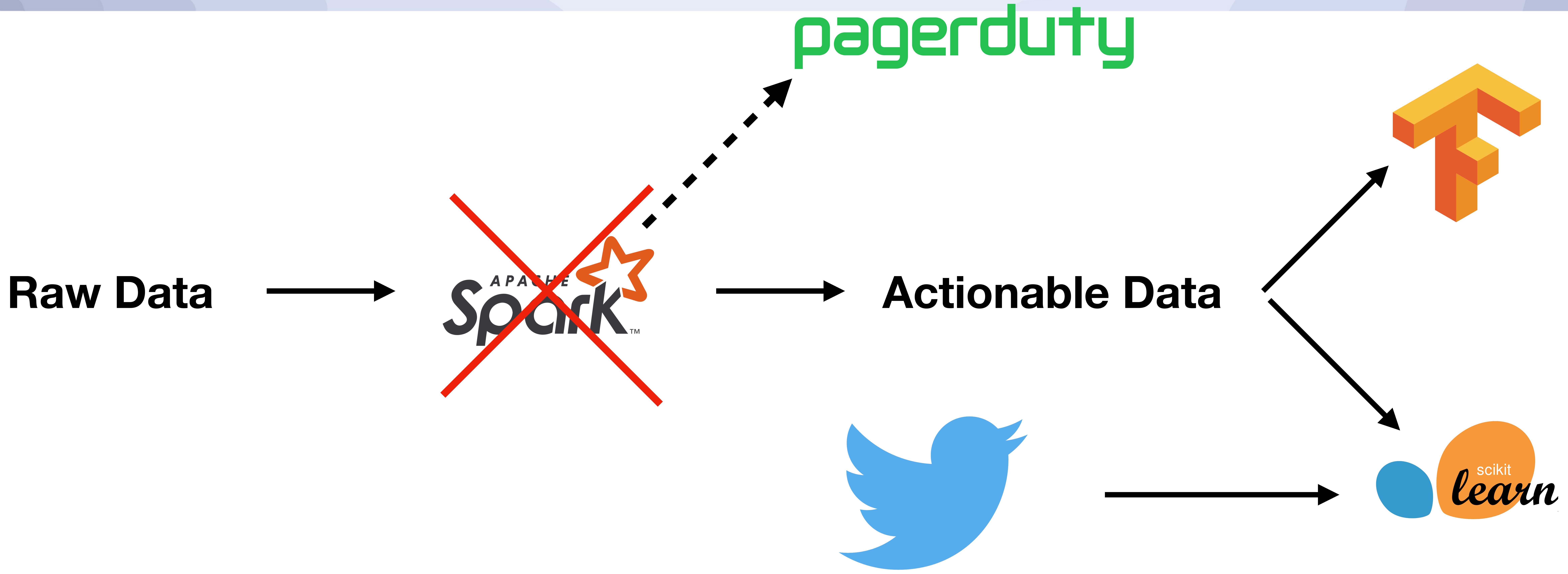
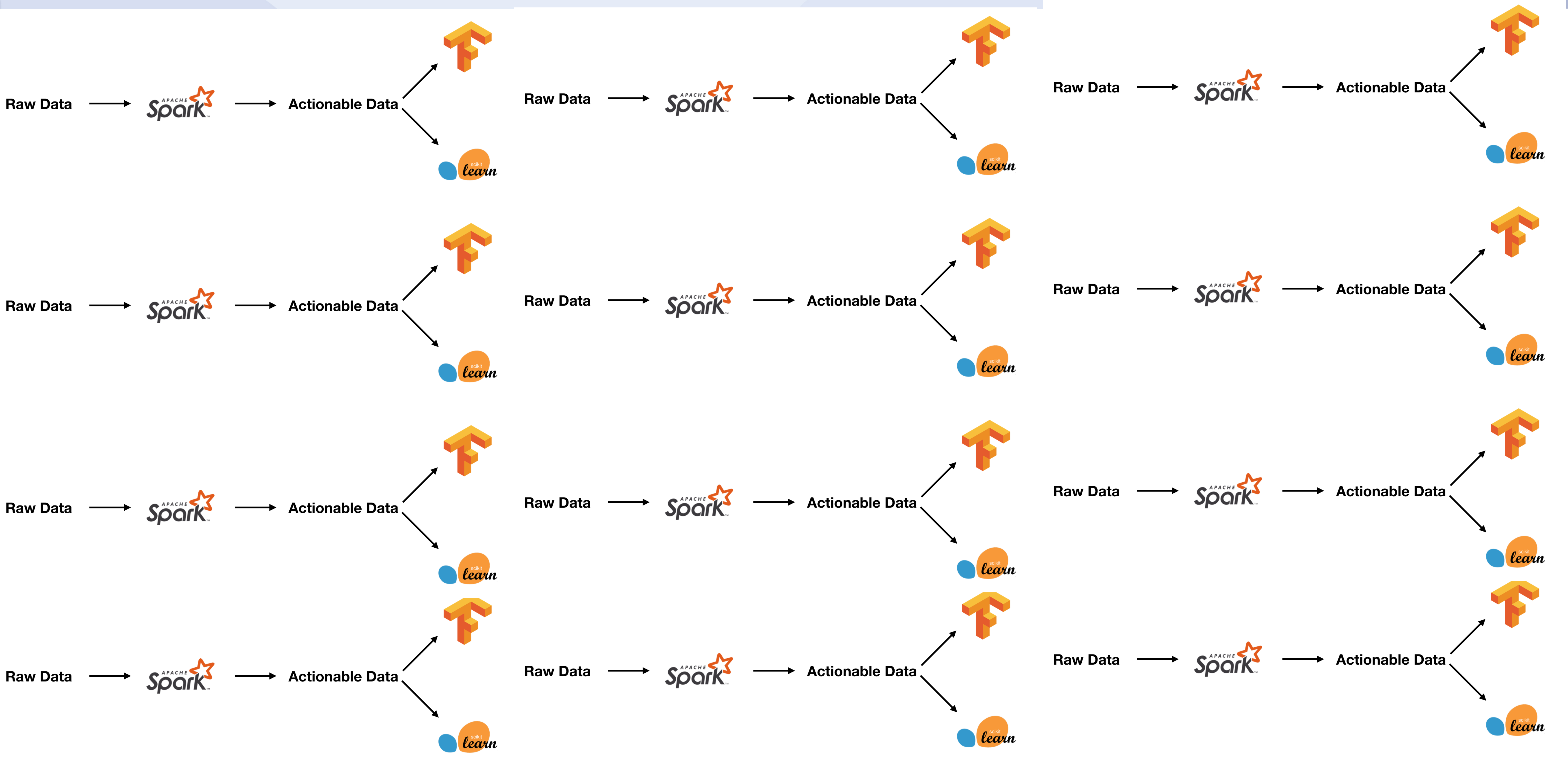
Pipelines are hard



Raw Data

Actionable Data

Lots of pipelines are really hard



Raw Data → Spark → Actionable Data

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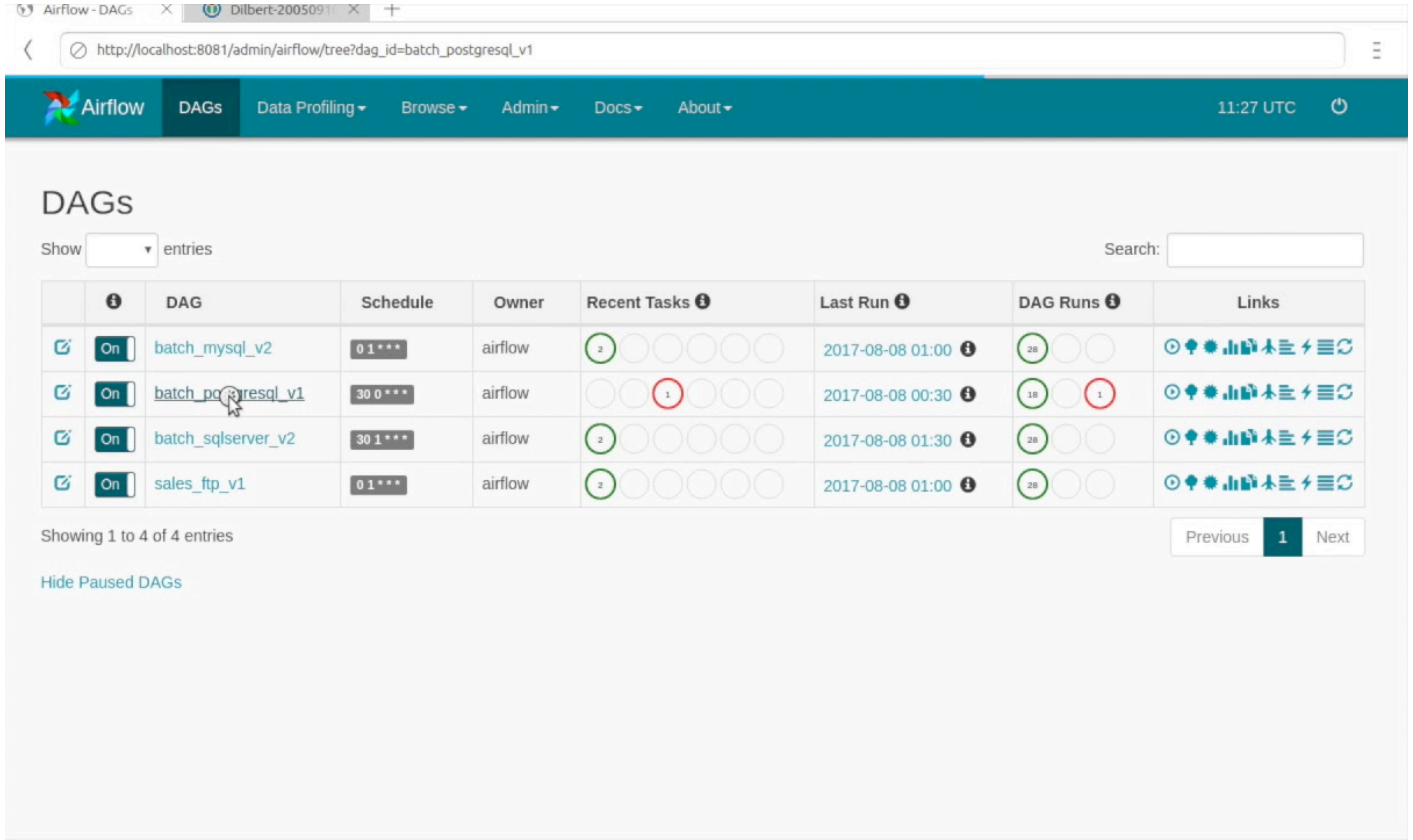
Enter Apache Airflow

Apache Airflow

- Workflow Scheduler developed @ Airbnb
- Converts Python code into DAGs
- Has large number of operators/hooks (HDFS, Spark, Bash, Hive, etc…)

Apache Airflow



Airflow - DAGs | Dilbert-200509

http://localhost:8081/admin/airflow/tree?dag_id=batch_postgresql_v1

DAGs

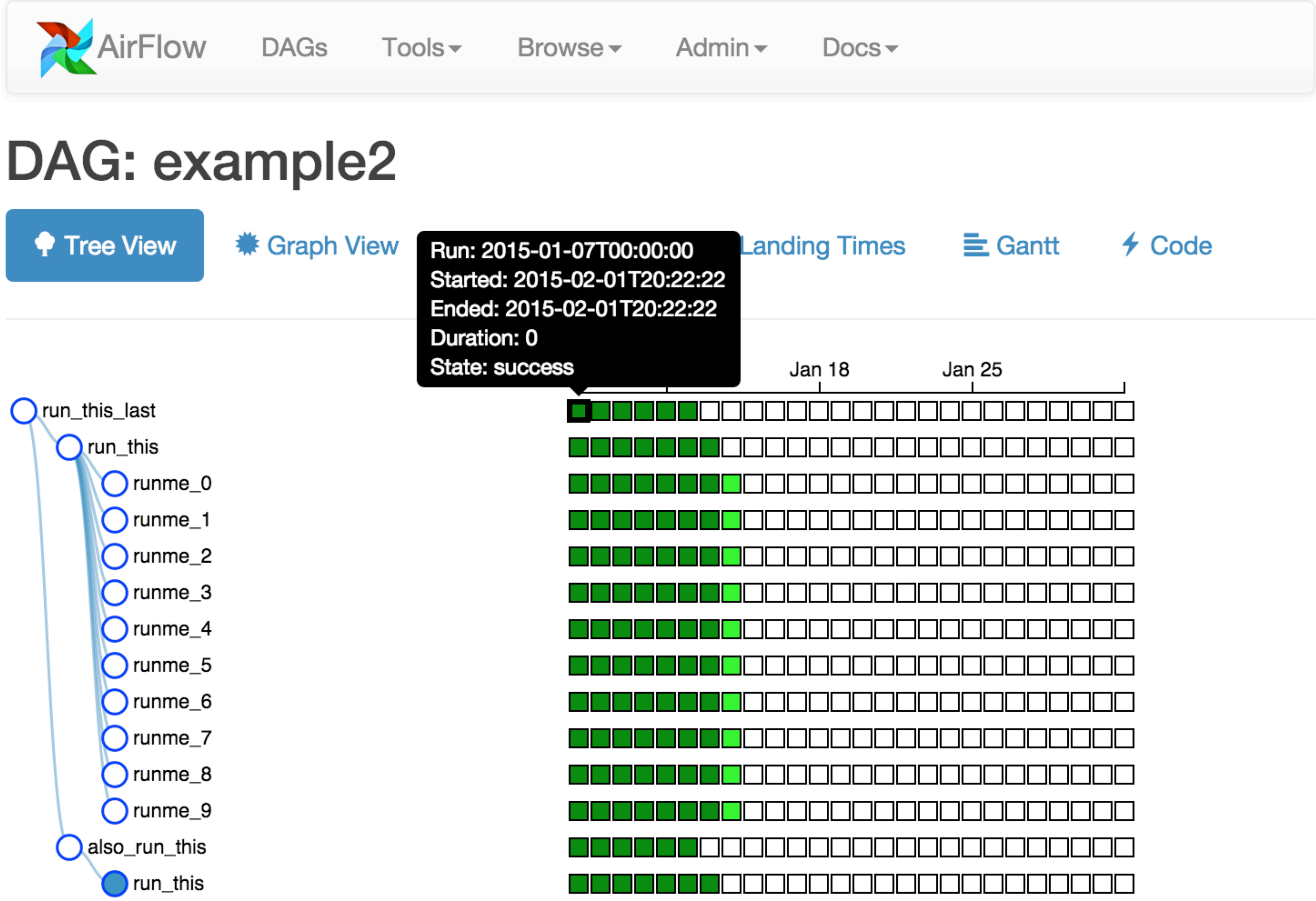
Show entries | Search:

		DAG	Schedule	Owner	Recent Tasks	Last Run	DAG Runs	Links
	On	batch_mysql_v2	0 1 * * *	airflow	2	2017-08-08 01:00	28	
	On	batch_postgresql_v1	30 0 * * *	airflow	1	2017-08-08 00:30	18 1	
	On	batch_sqlserver_v2	30 1 * * *	airflow	2	2017-08-08 01:30	28	
	On	sales_ftp_v1	0 1 * * *	airflow	2	2017-08-08 01:00	28	

Showing 1 to 4 of 4 entries

Hide Paused DAGs

Apache Airflow

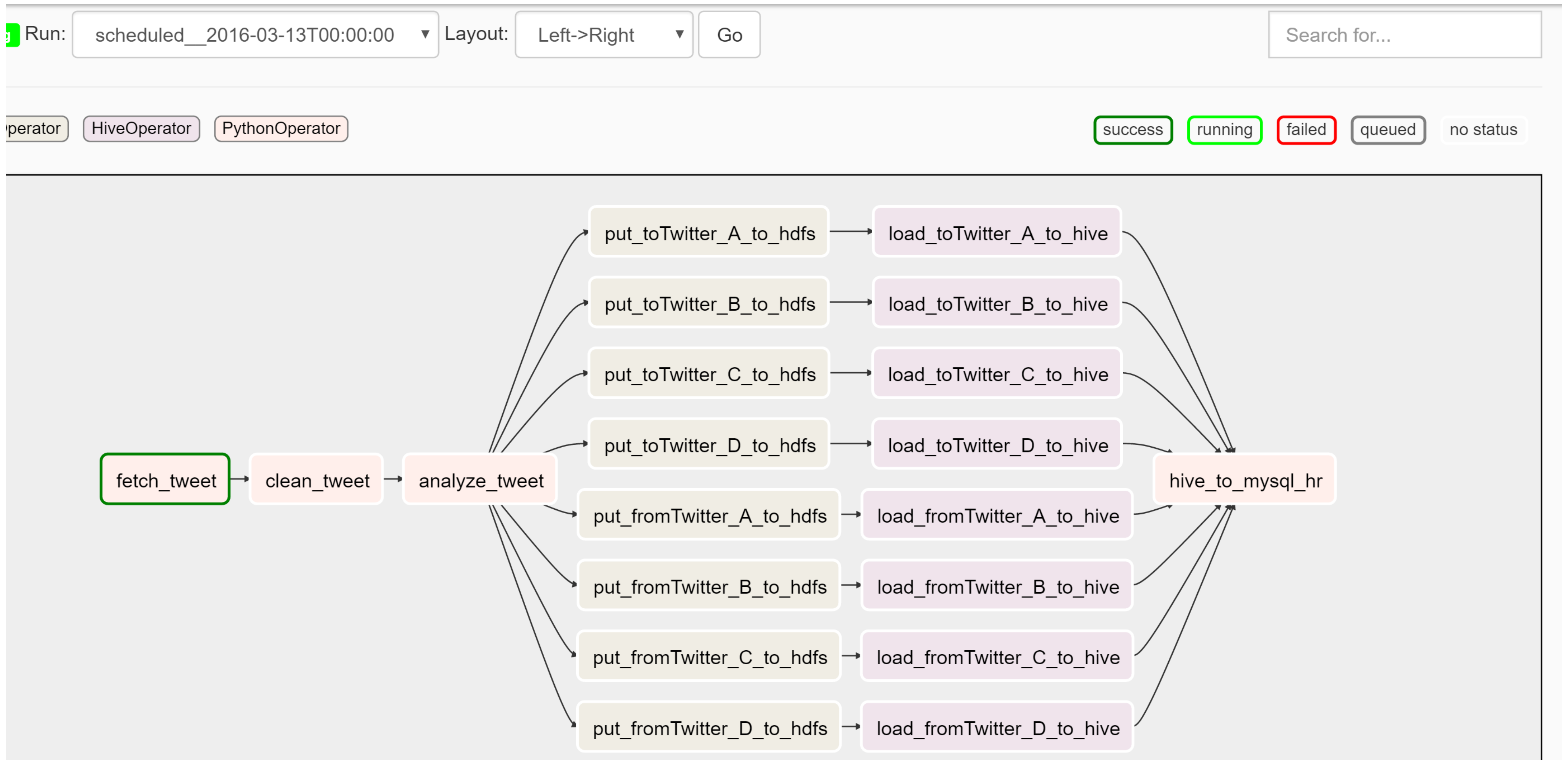


AirFlow DAGs Tools▾ Browse▾ Admin▾ Docs▾

DAG: example2

Tree View | Graph View | Landing Times | Gantt | Code

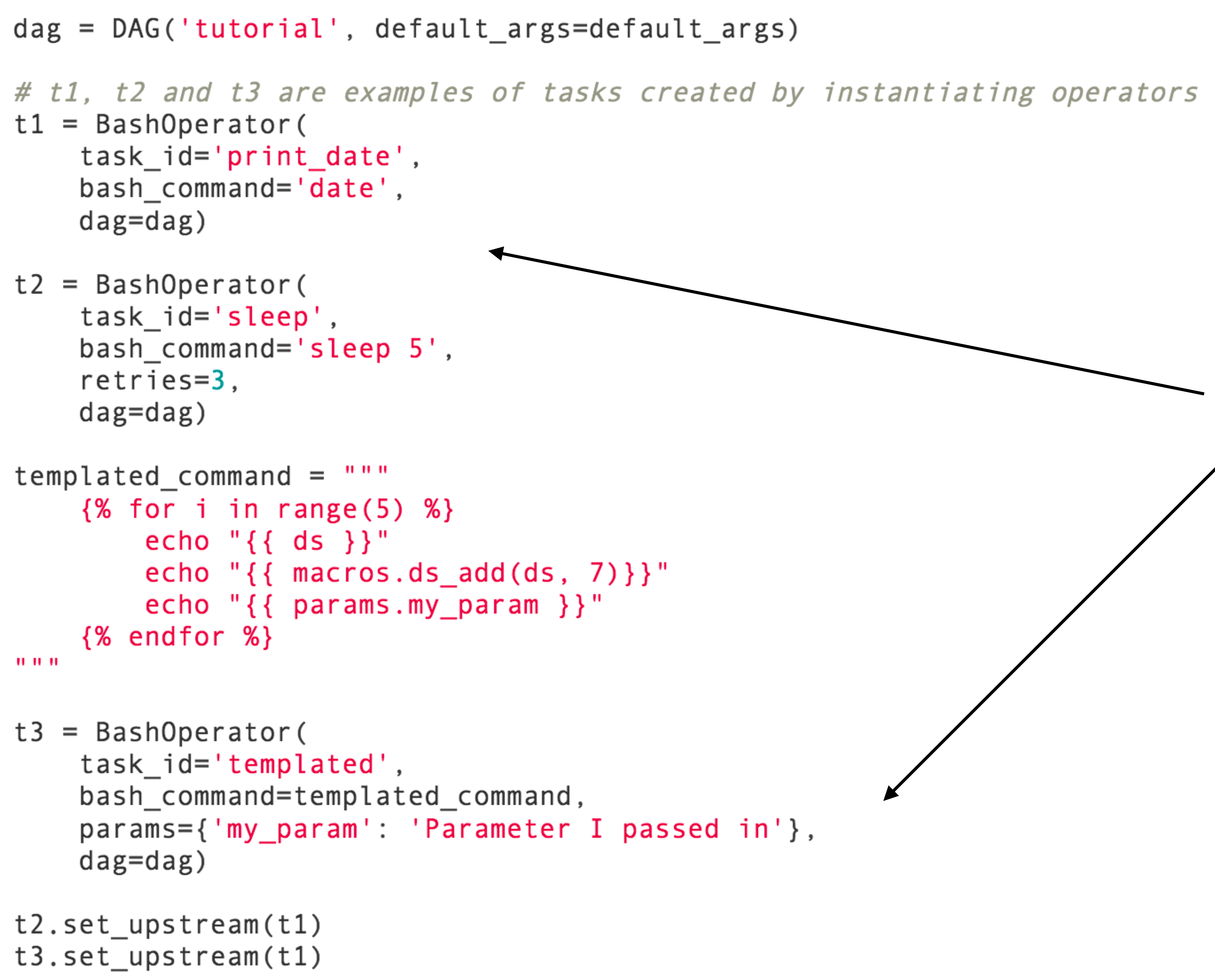
Run: 2015-01-07T00:00:00
Started: 2015-02-01T20:22:22
Ended: 2015-02-01T20:22:22
Duration: 0
State: success



Run: scheduled__2016-03-13T00:00:00 ▾ Layout: Left->Right ▾ Go

Search for...

Creating a pipeline with Airflow



```
dag = DAG('tutorial', default_args=default_args)

# t1, t2 and t3 are examples of tasks created by instantiating operators
t1 = BashOperator(
    task_id='print_date',
    bash_command='date',
    dag=dag)

t2 = BashOperator(
    task_id='sleep',
    bash_command='sleep 5',
    retries=3,
    dag=dag)

templated_command = """
    {% for i in range(5) %}
        echo "{{ ds }}"
        echo "{{ macros.ds_add(ds, 7)}}"
        echo "{{ params.my_param }}"
    {% endfor %}
"""

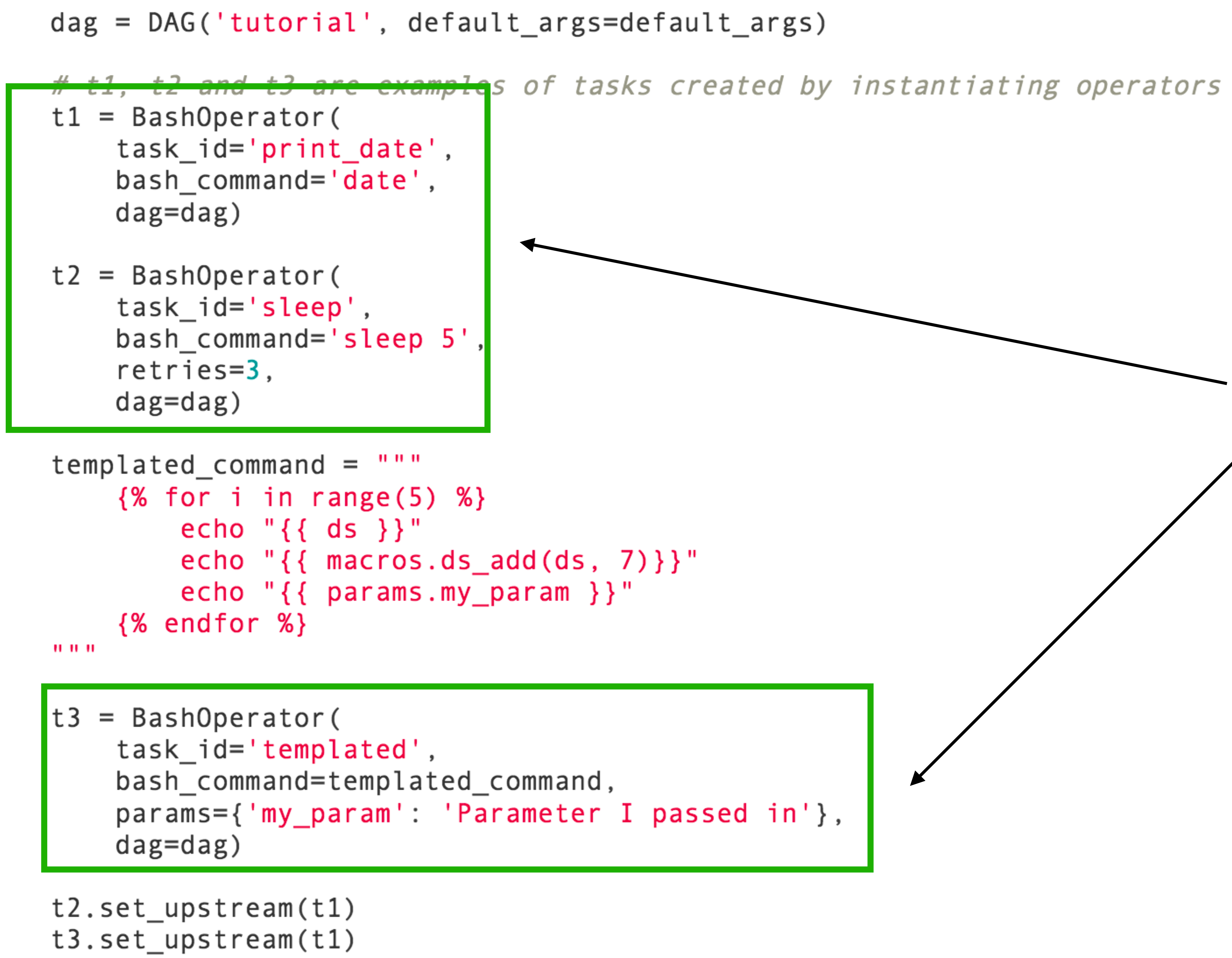
t3 = BashOperator(
    task_id='templated',
    bash_command=templated_command,
    params={'my_param': 'Parameter I passed in'},
    dag=dag)

t2.set_upstream(t1)
t3.set_upstream(t1)
```

Define Operators

Set Dependencies

Creating a pipeline with Airflow



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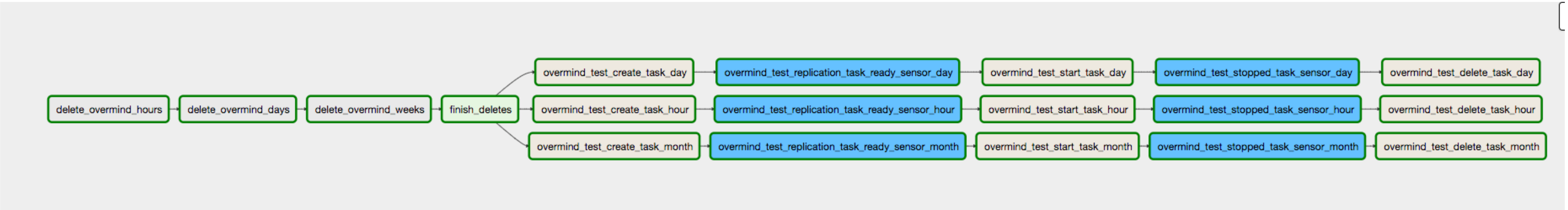
Define Operators

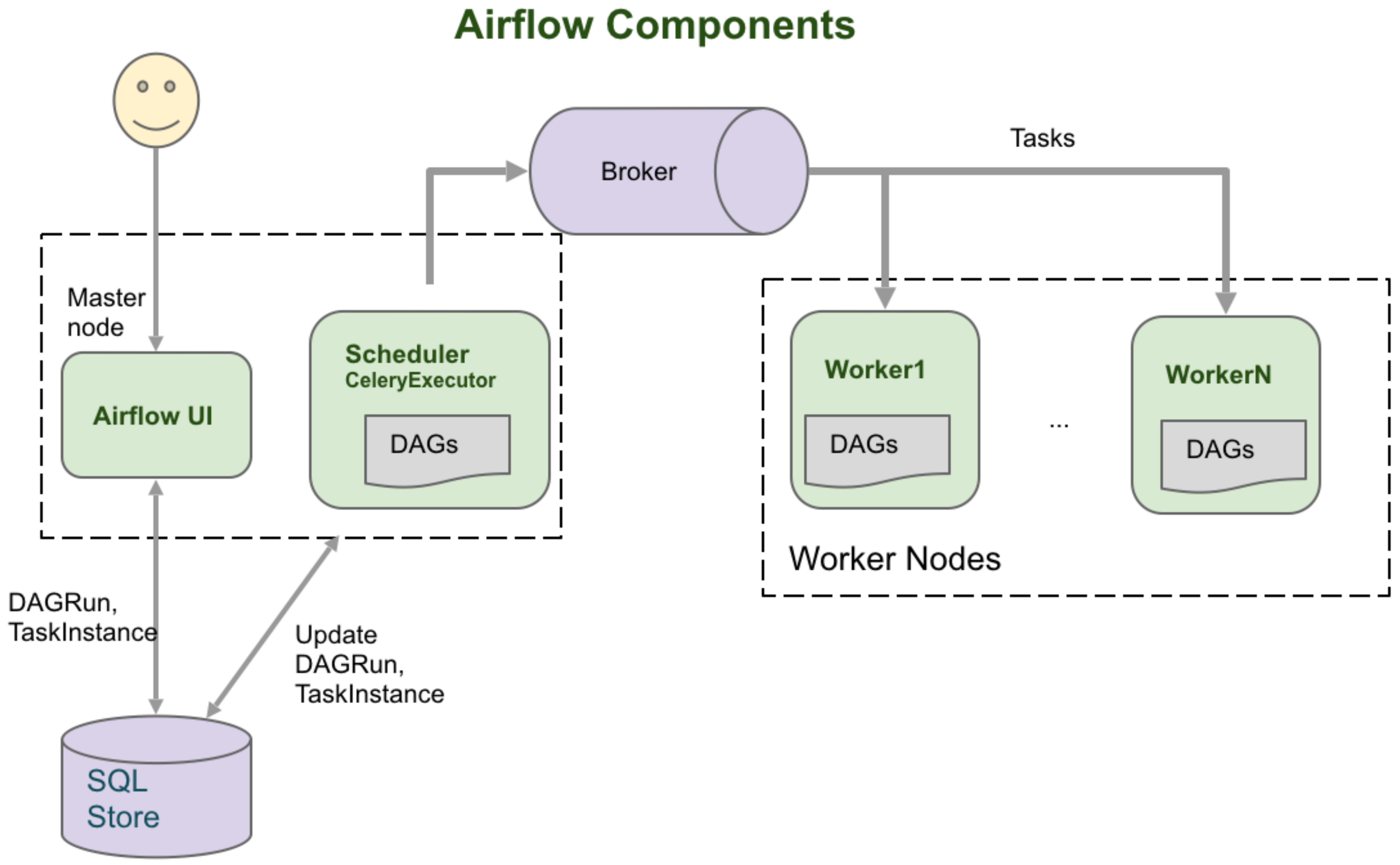
Set Dependencies

Managing a pipeline with Airflow

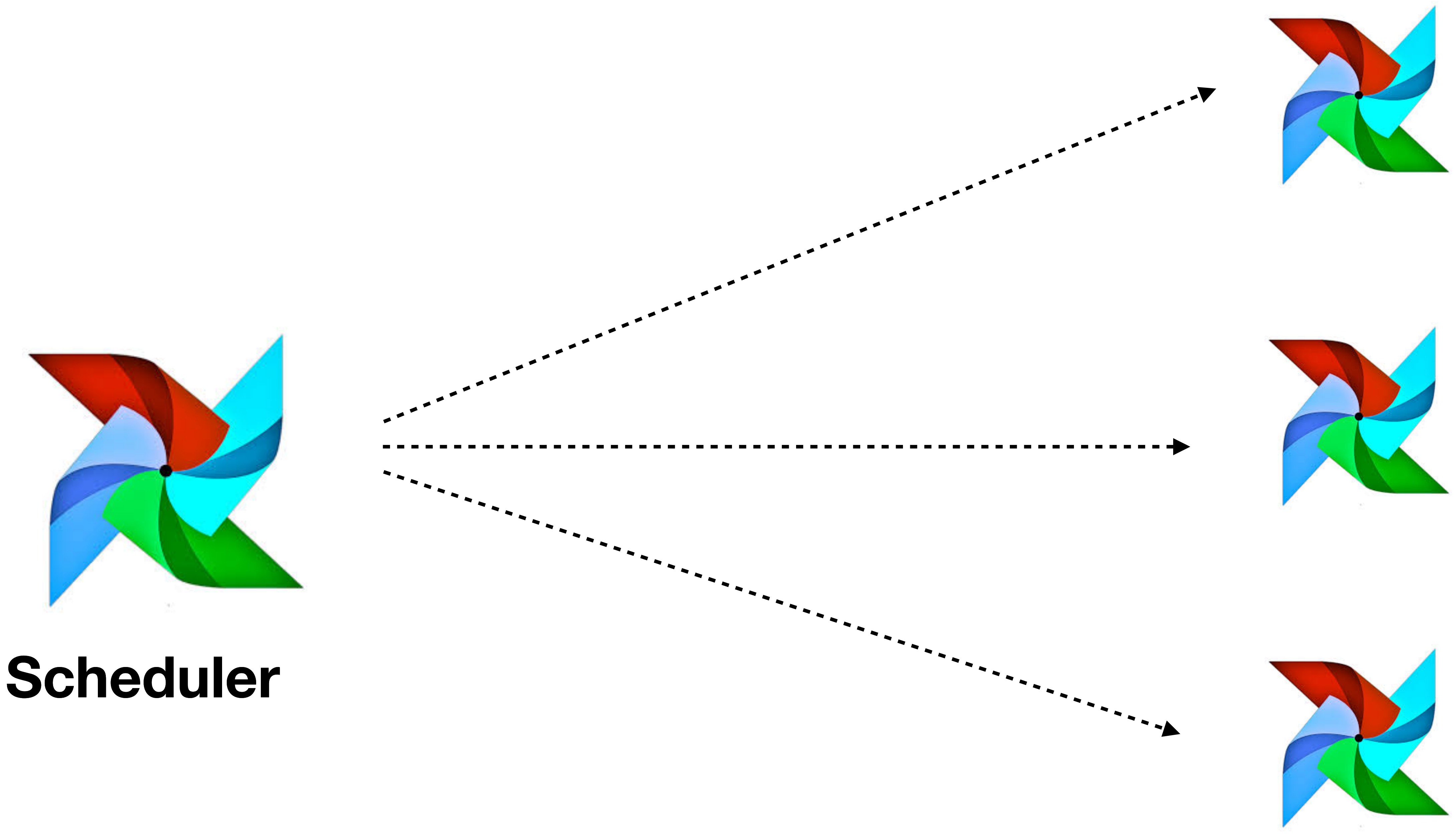

delete_overmind_hours
delete_overmind_days
delete_overmind_weeks
finish_deletes
overmind_test_create_task_day
overmind_test_replication_task_ready_sensor_day
overmind_test_start_task_day
overmind_test_stopped_task_sensor_day
overmind_test_delete_task_day
overmind_test_create_task_hour
overmind_test_replication_task_ready_sensor_hour
overmind_test_start_task_hour
overmind_test_stopped_task_sensor_hour
overmind_test_delete_task_hour
overmind_test_create_task_month
overmind_test_replication_task_ready_sensor_month
overmind_test_start_task_month
overmind_test_stopped_task_sensor_month
overmind_test_delete_task_month

State of things: Complexity

- Complex to deploy and manage
- Multiple components
- Varied configurations
    - Executor
    - DAG source
- Different failure points



State of things: Static Allocation



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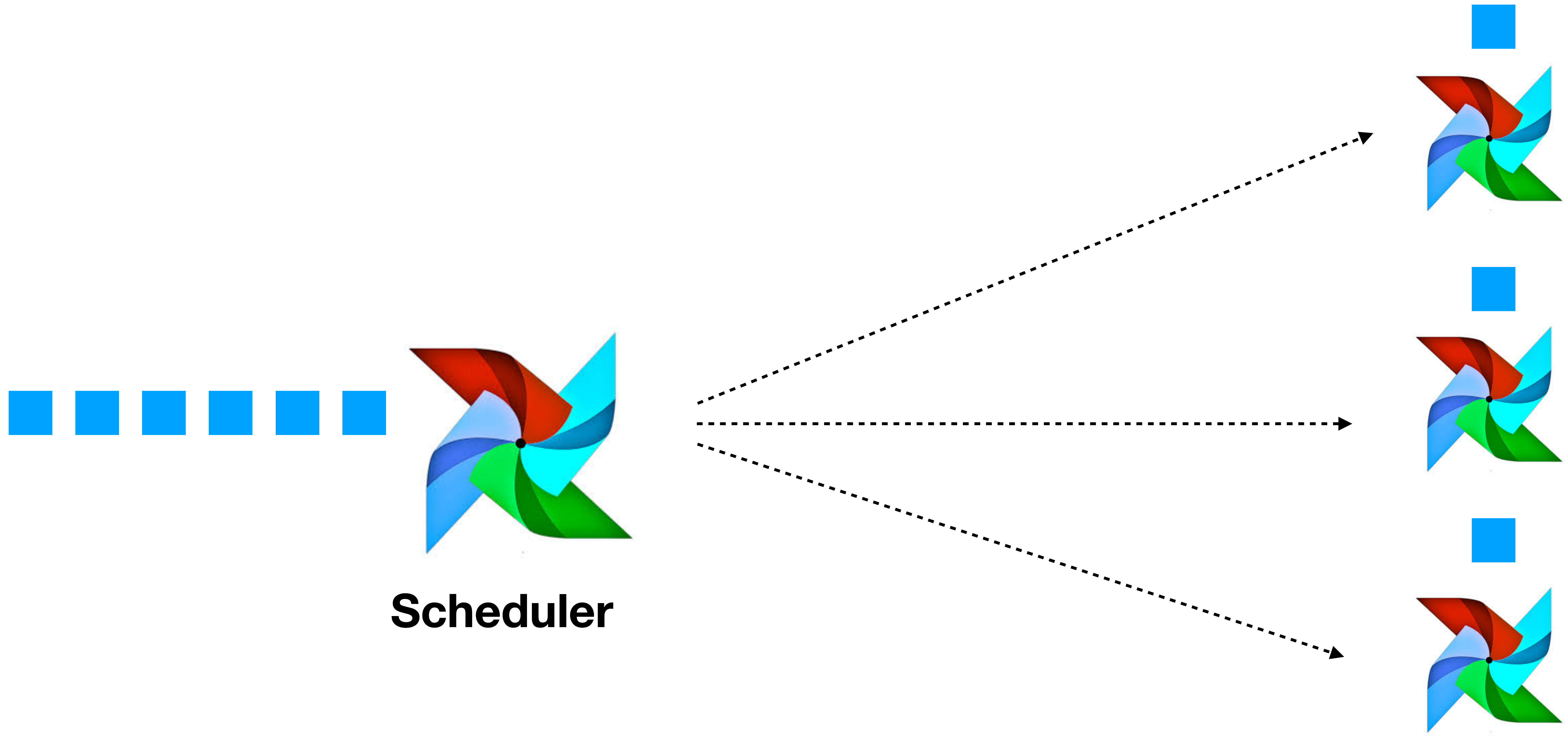
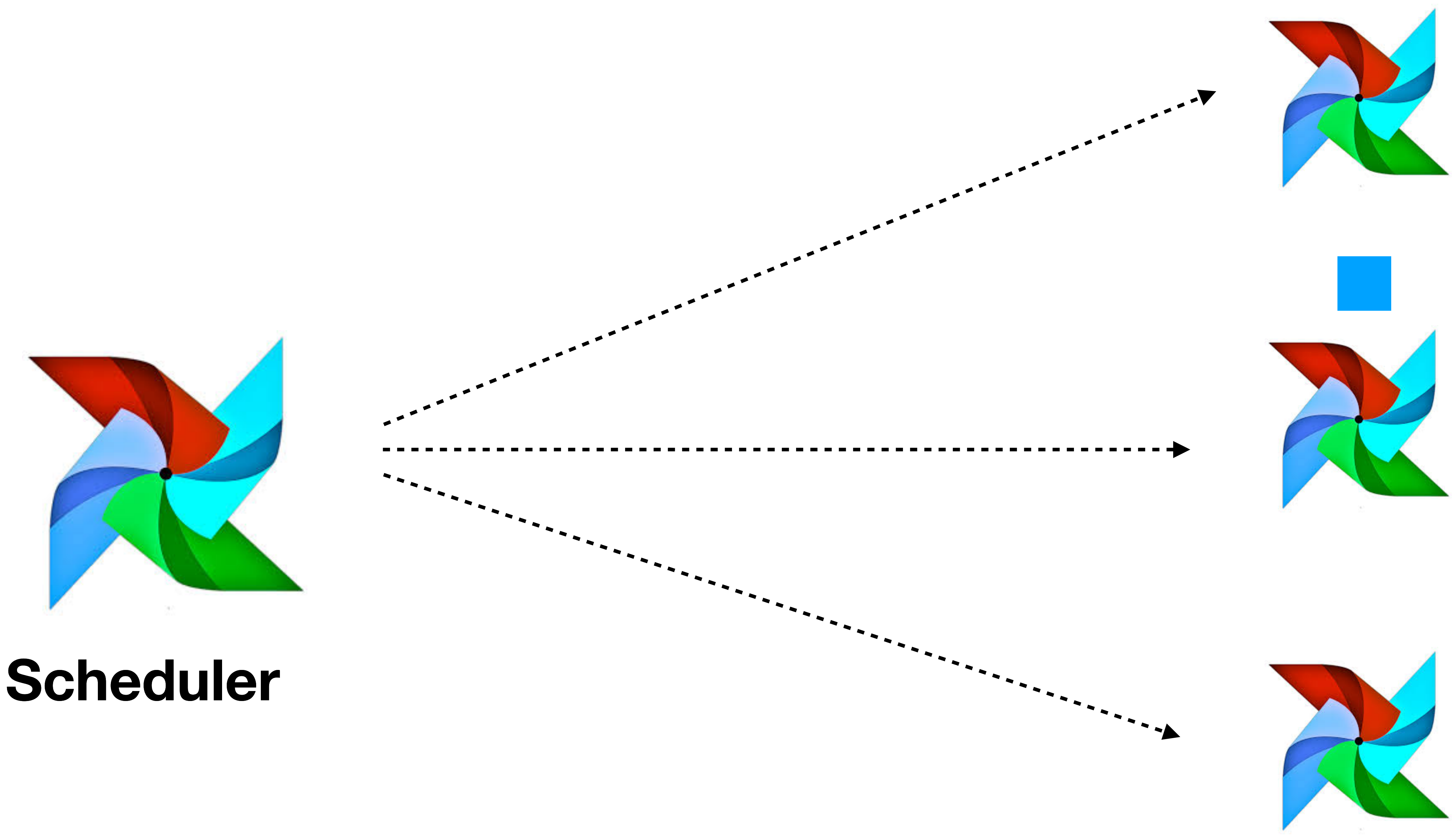


State of things: Static Allocation

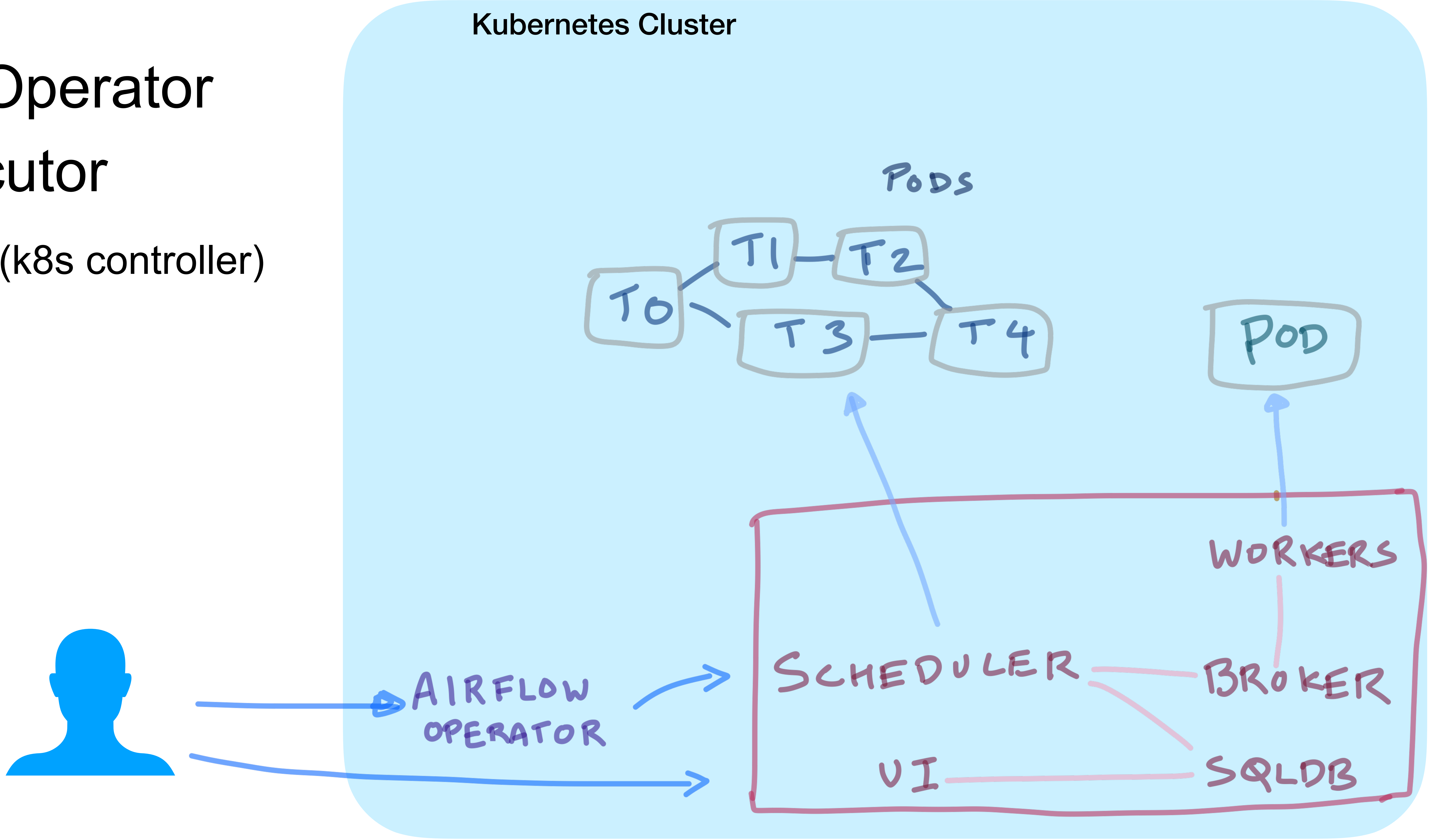


Kubernetes + Airflow

- Modernized stack using containers + k8s
- Reduced Deployment and Management complexity
- Dynamic Resource Allocation
- Automatic Fault remediation
- Improved resource utilization

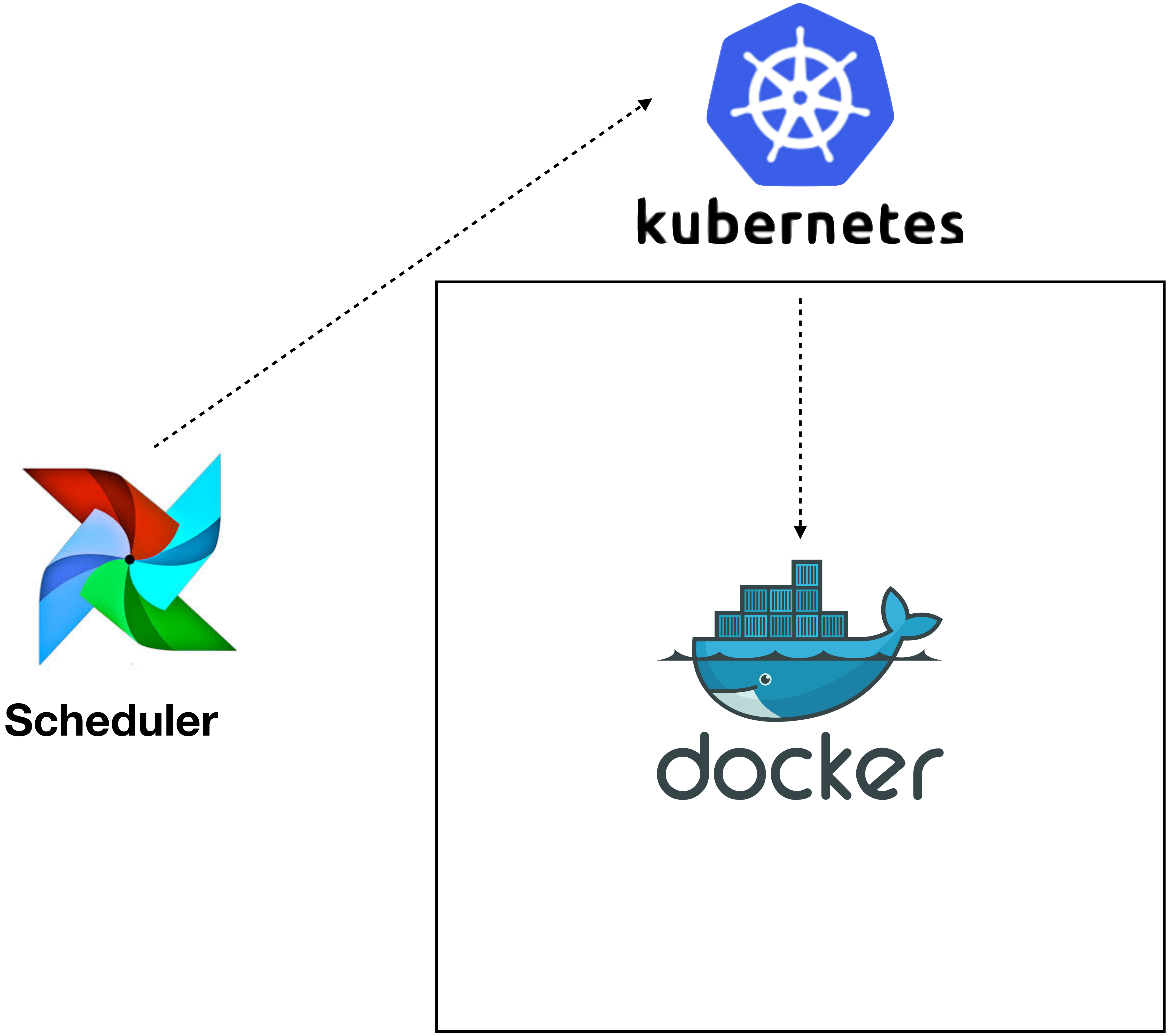
Airflow + Kubernetes

1. KubernetesPodOperator
2. KubernetesExecutor
3. AirflowOperator (k8s controller)



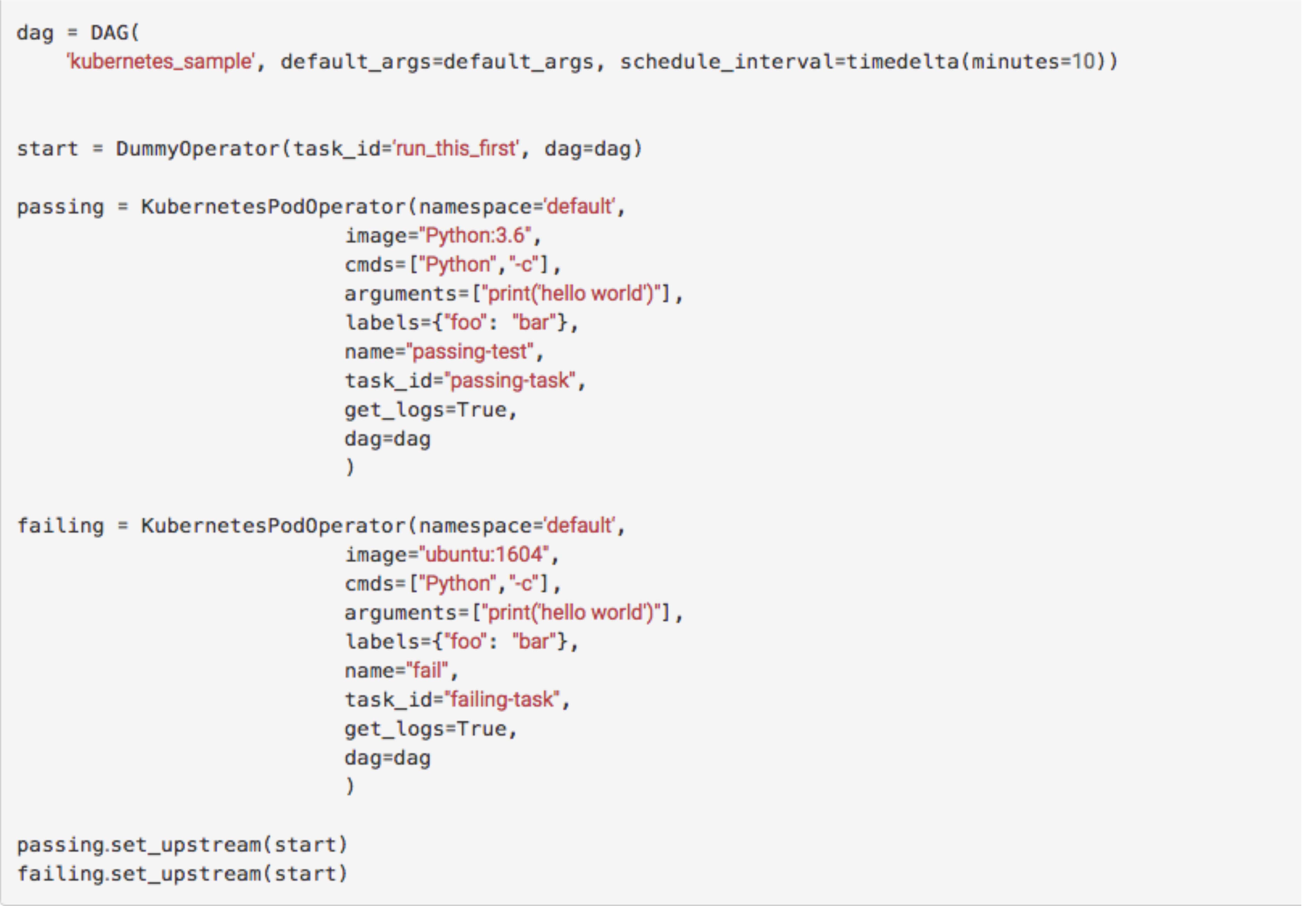
KubernetesPodOperator

- Allow users to deploy arbitrary Docker images
- Users can offload dependencies to containers
- “Lets Airflow focus on scheduling tasks”



KubernetesPodOperator

- Airflow workers are much lighter (don’t require extra libraries)
- Easy rollbacks + deployments through tags



```
dag = DAG(
    'kubernetes_sample', default_args=default_args, schedule_interval=timedelta(minutes=10))


start = DummyOperator(task_id='run_this_first', dag=dag)

passing = KubernetesPodOperator(namespace='default',
                                image="Python:3.6",
                                cmds=["Python","-c"],
                                arguments=["print('hello world')"],
                                labels={"foo": "bar"},
                                name="passing-test",
                                task_id="passing-task",
                                get_logs=True,
                                dag=dag
                                )

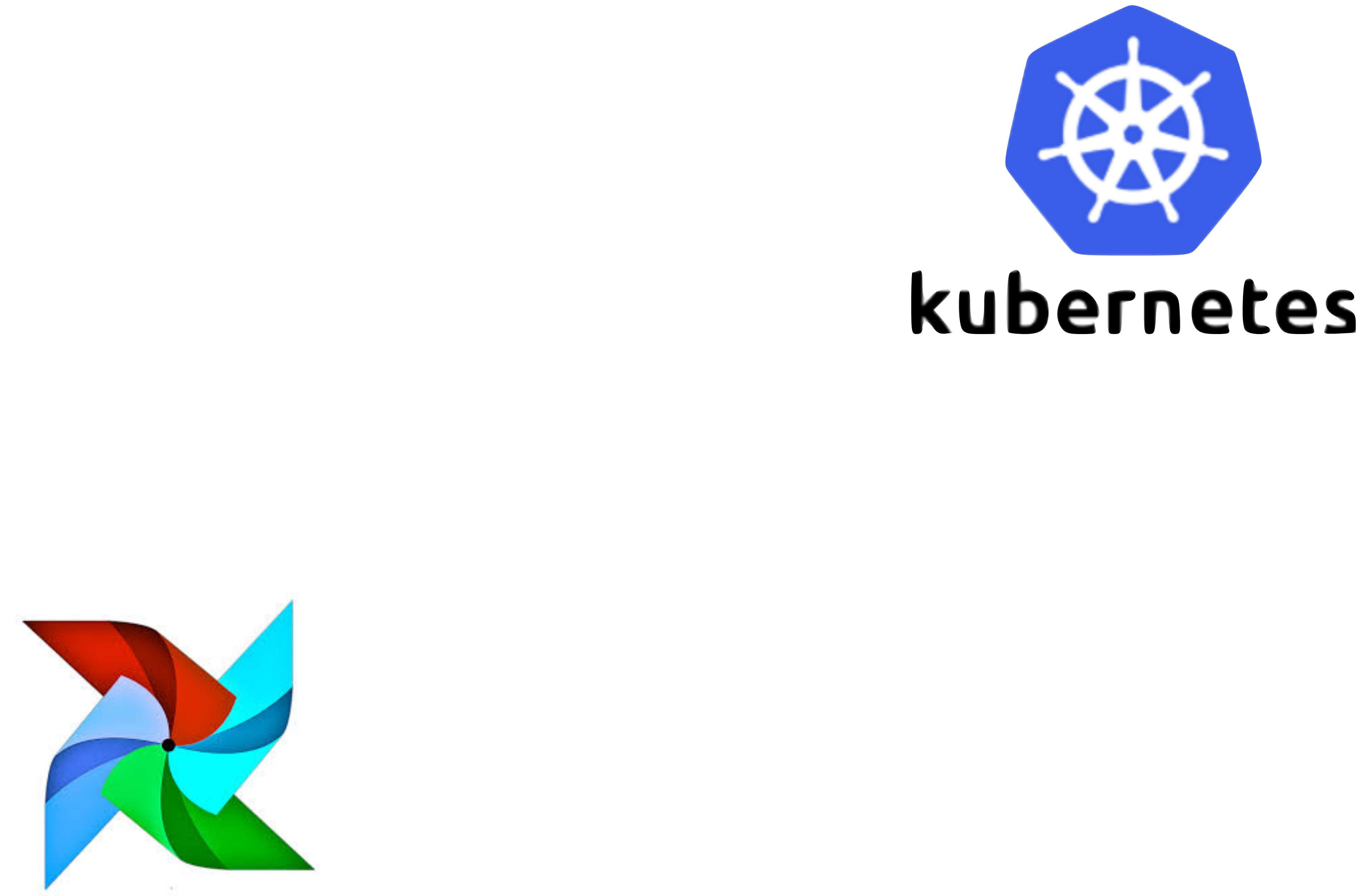
failing = KubernetesPodOperator(namespace='default',
                                image="ubuntu:1604",
                                cmds=["Python","-c"],
                                arguments=["print('hello world')"],
                                labels={"foo": "bar"},
                                name="fail",
                                task_id="failing-task",
                                get_logs=True,
                                dag=dag
                                )

passing.set_upstream(start)
failing.set_upstream(start)
```

KubernetesExecutor

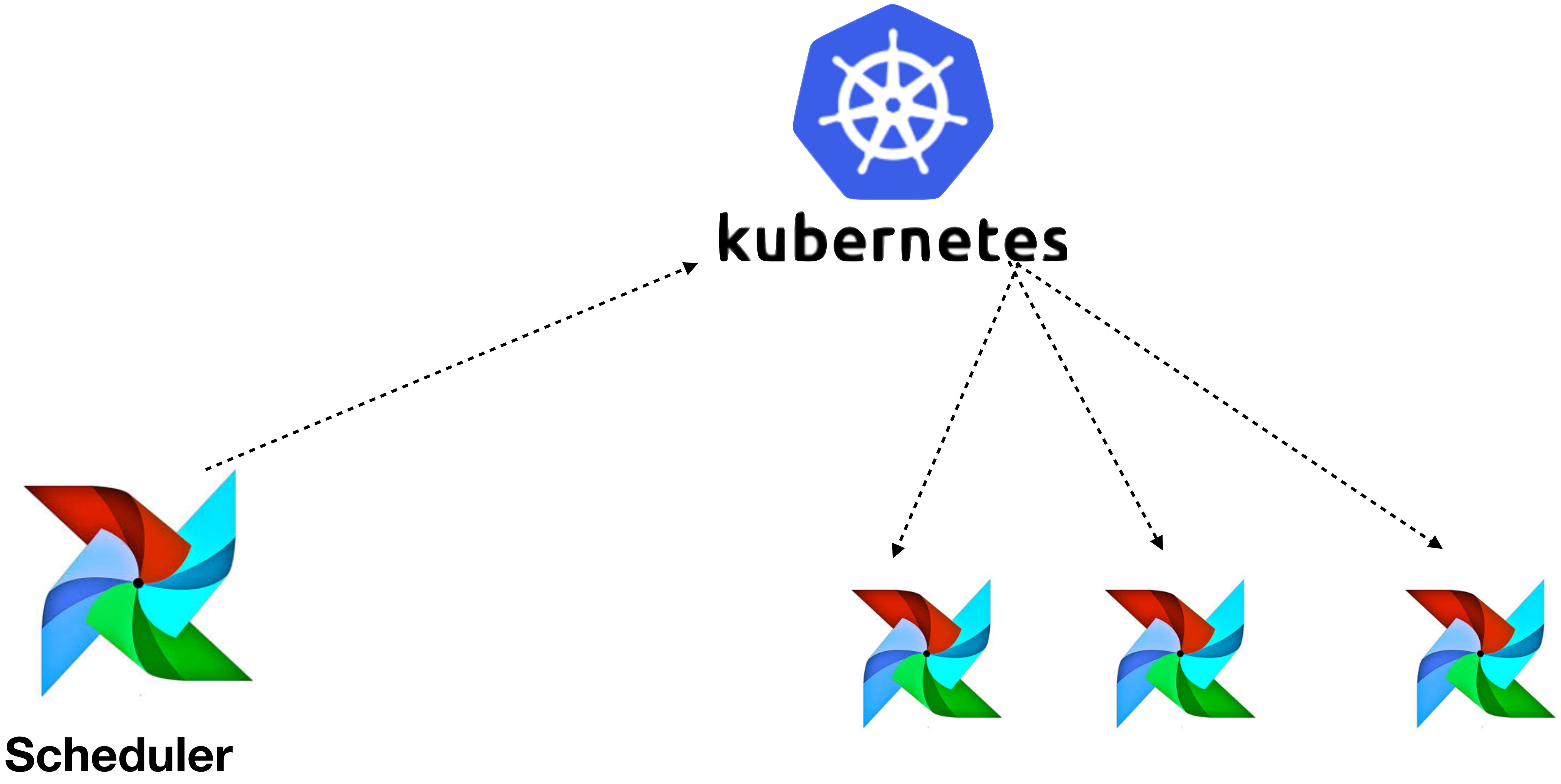
- High levels of parallelism (dynamic allocation)
- Task-level pod configuration
- Fault Tolerance

Dynamic Allocation



Scheduler

Dynamic Allocation



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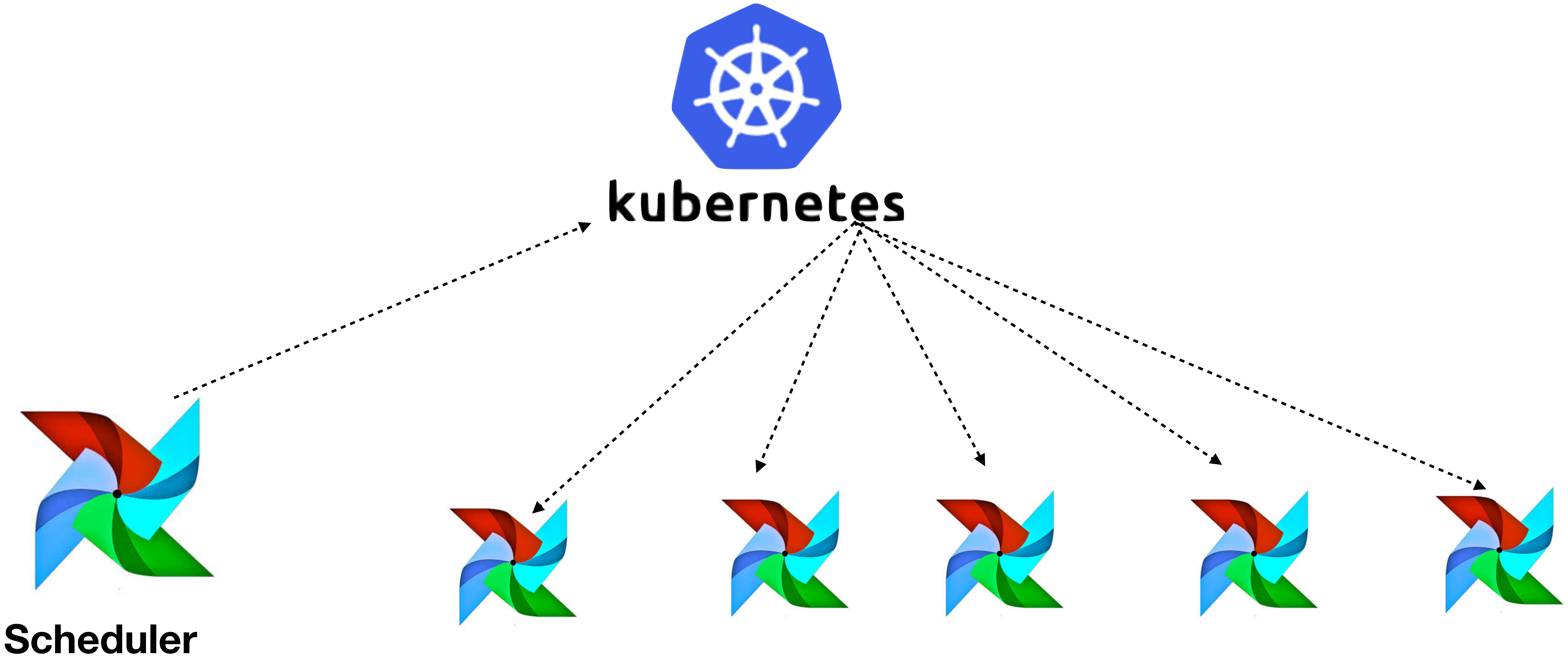

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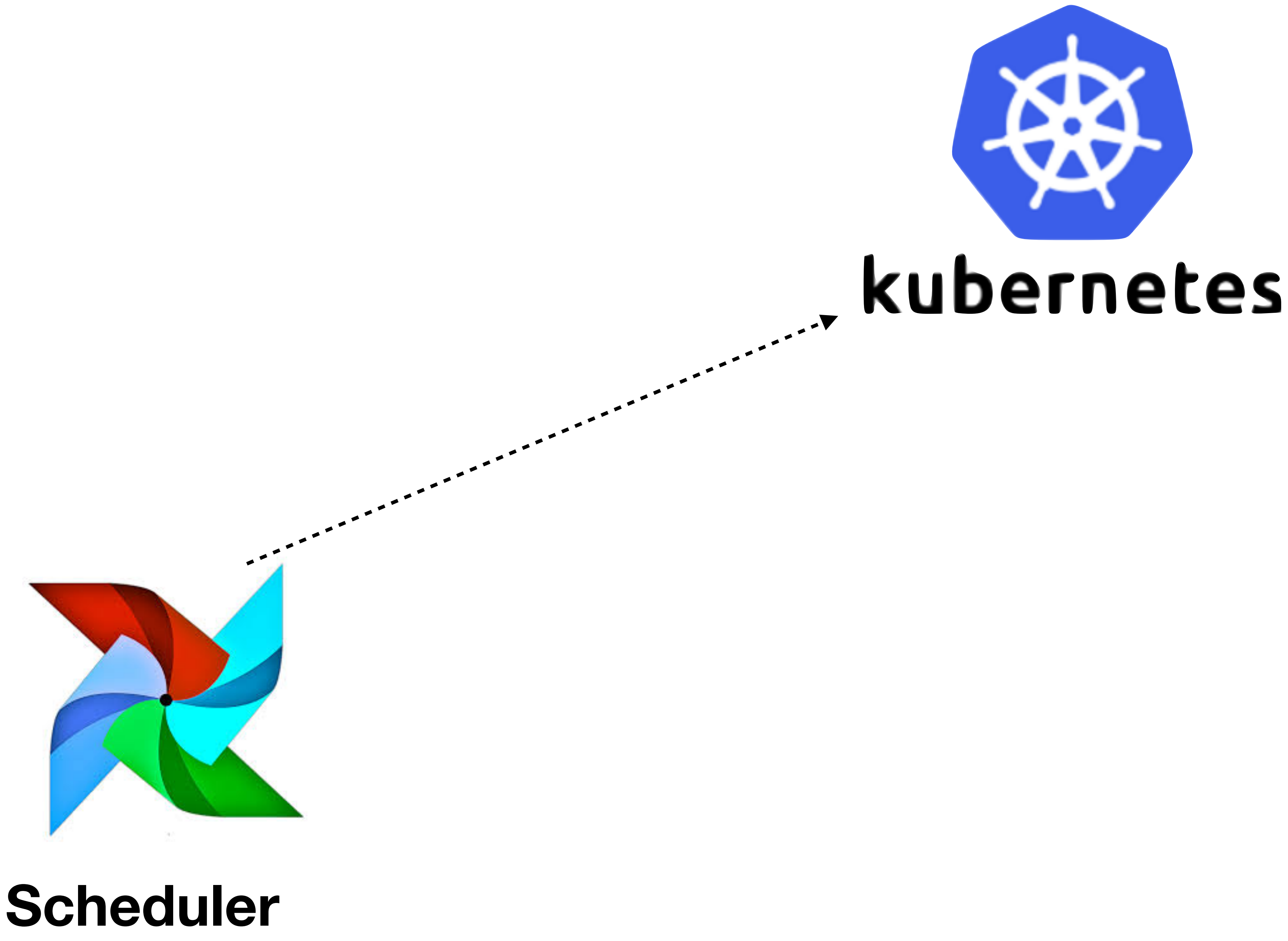

Scheduler

Task Level Configs

```
t = BashOperator(
  task_id = ‘account-test’,
  bash_command = ‘gcloud auth application-default login’,
  dag = dag,

  executor_config = {
  ‘request_memory’: ‘128Mi’,
  ‘limit_memory’: ‘128Mi’
  ‘image’: ‘airflow/scipy:1.1.5’
   ‘gcp-service-account’ : ‘service-account@xxx.iam.gserviceaccount.com’
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)
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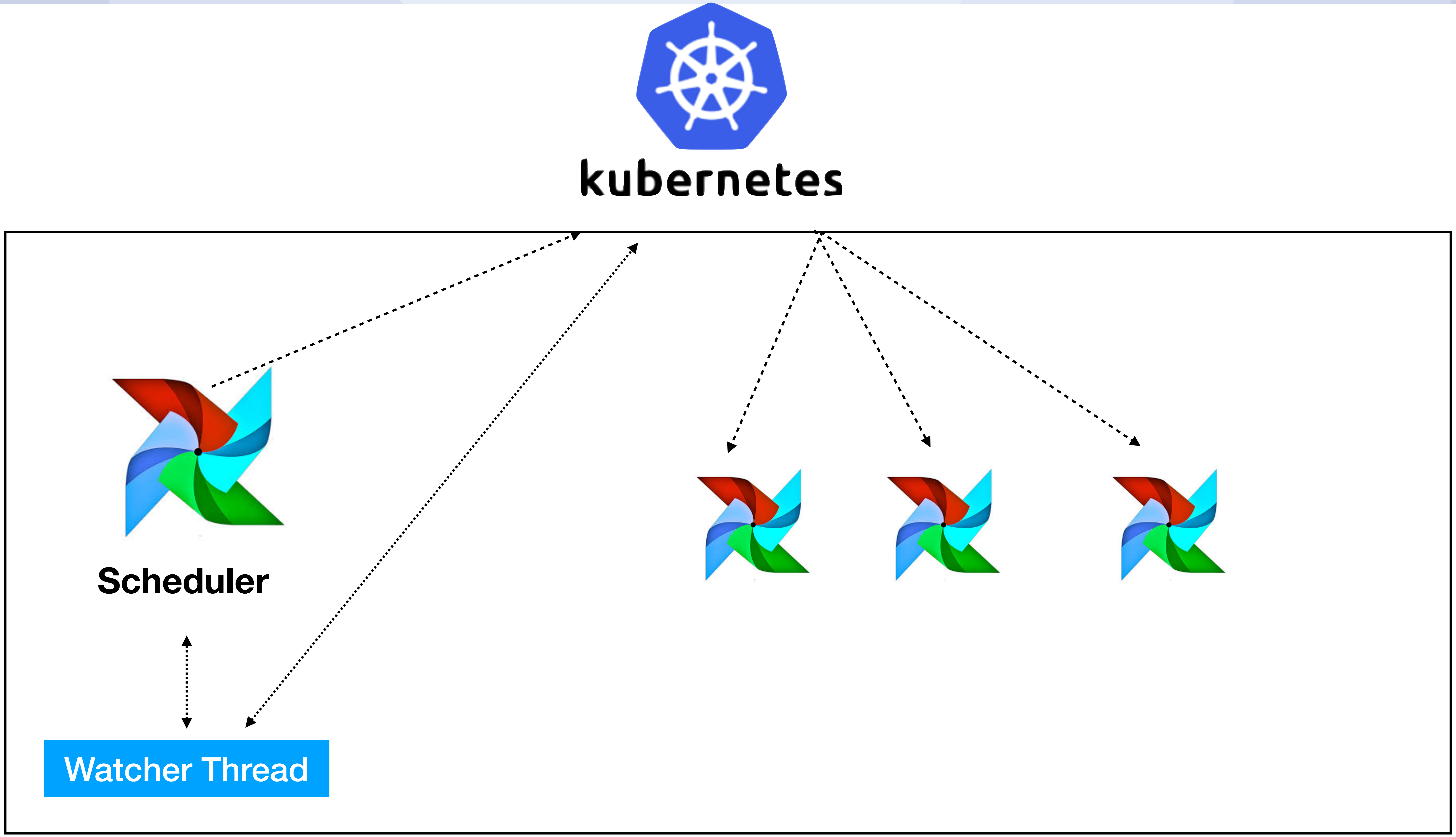
Kubernetes Executor



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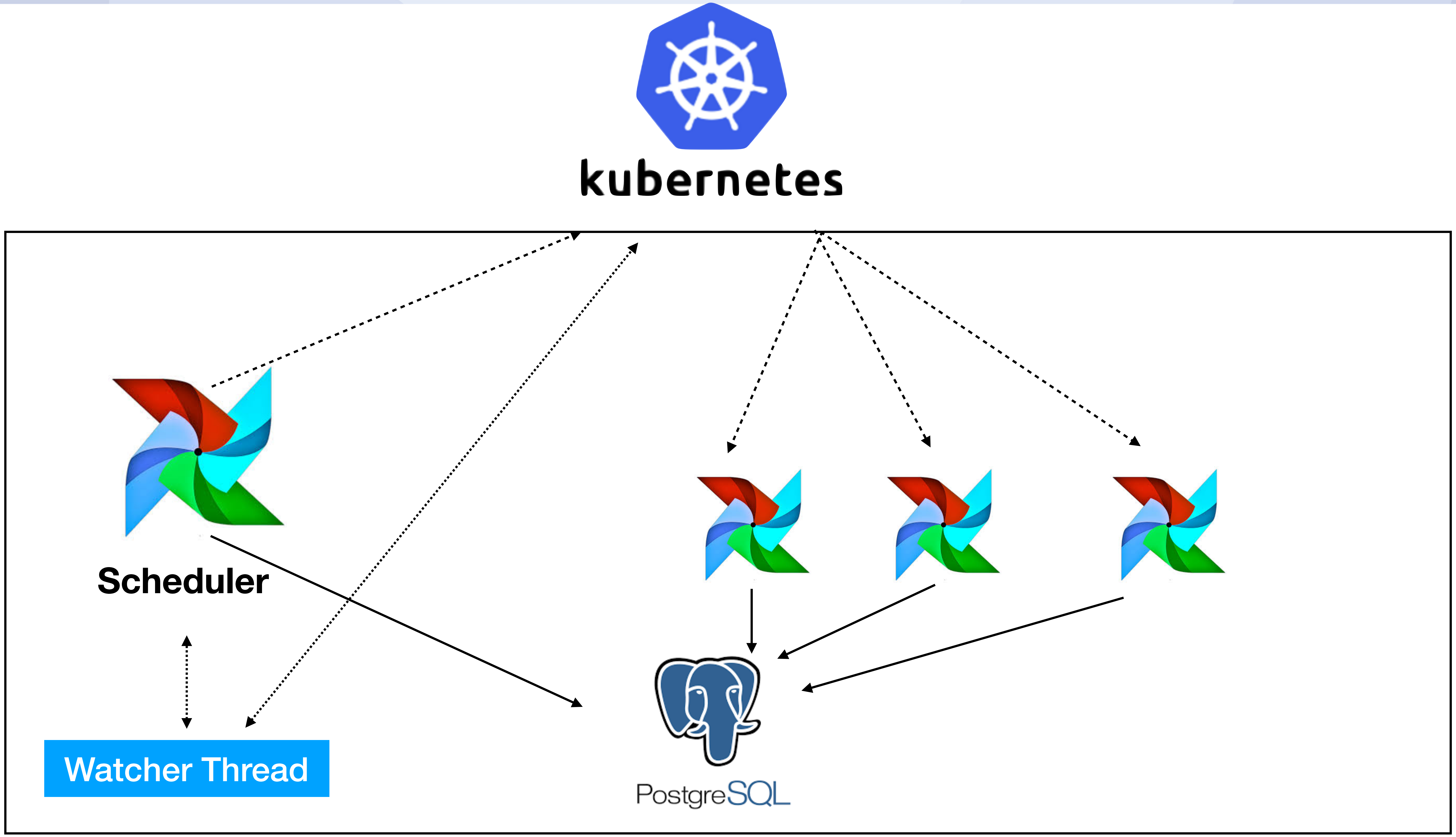

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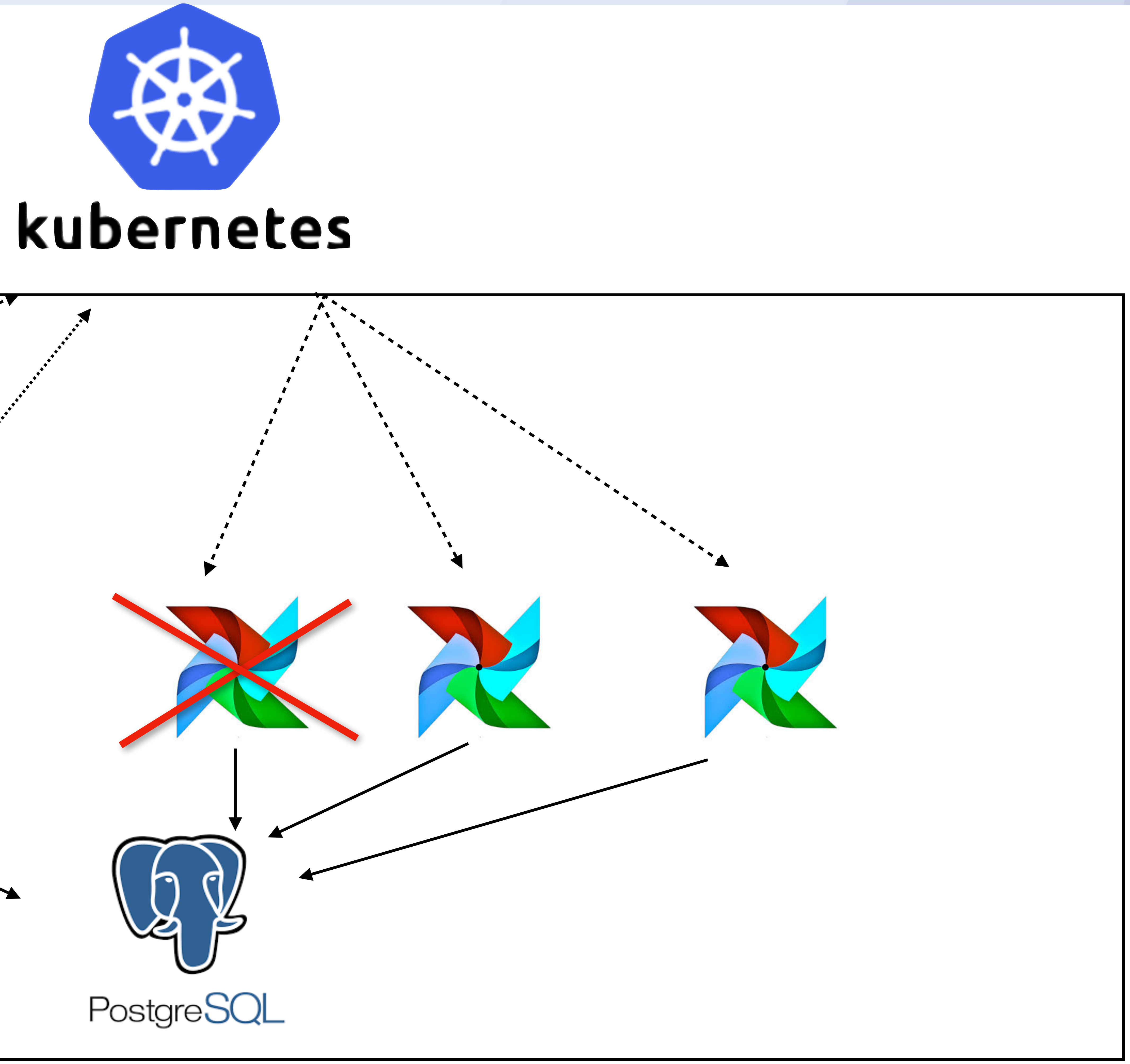
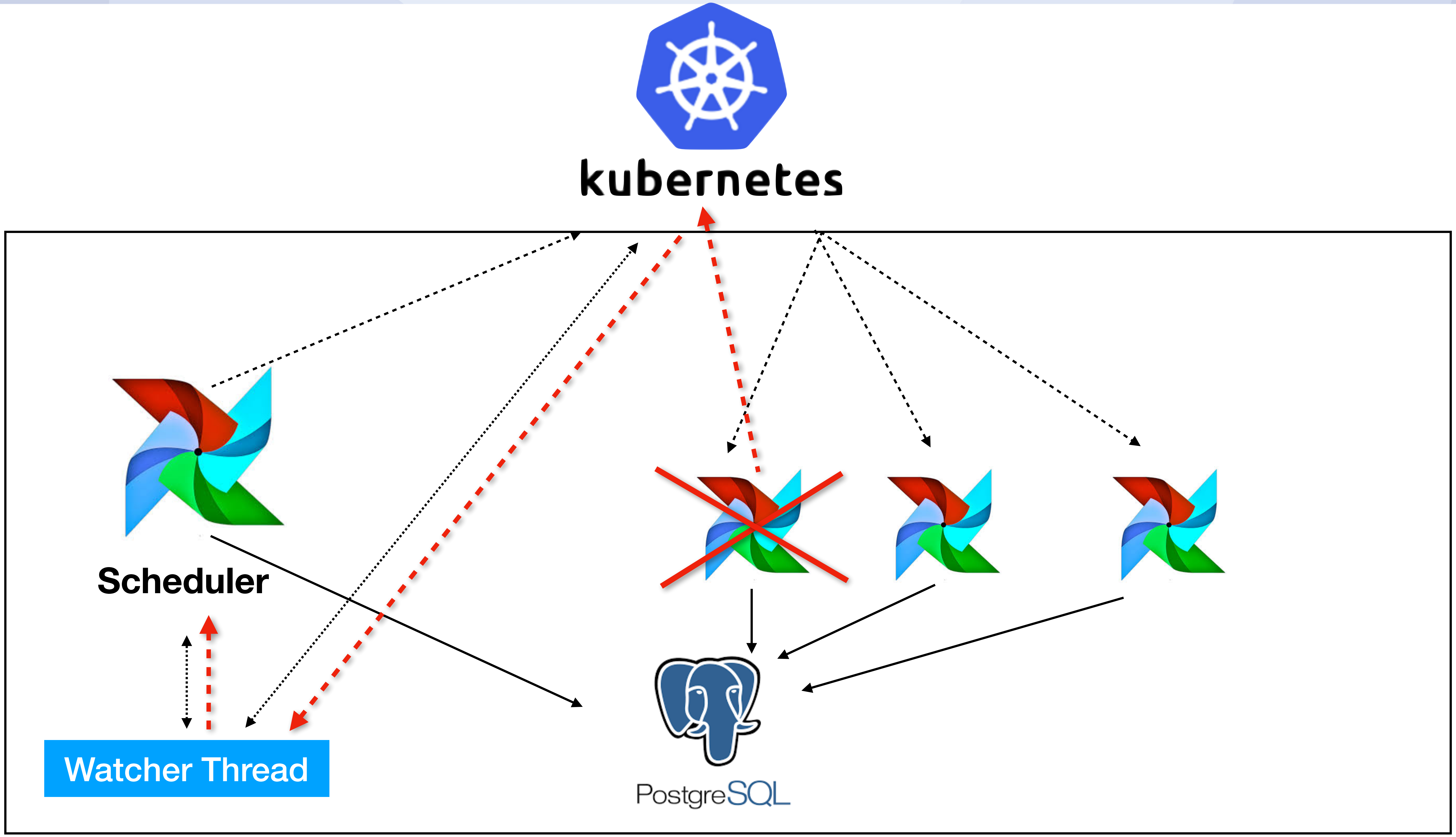
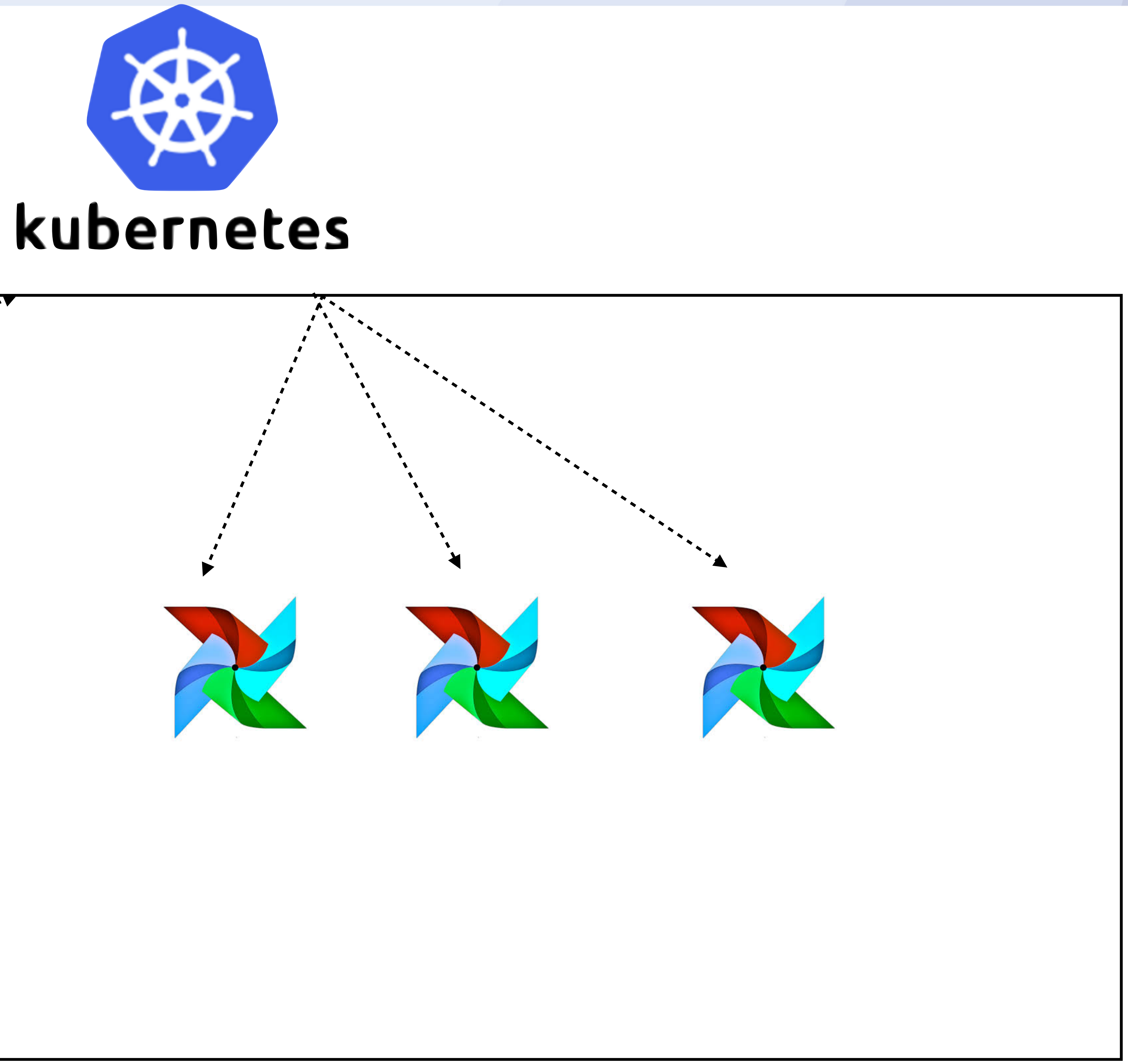


Kubernetes Executor



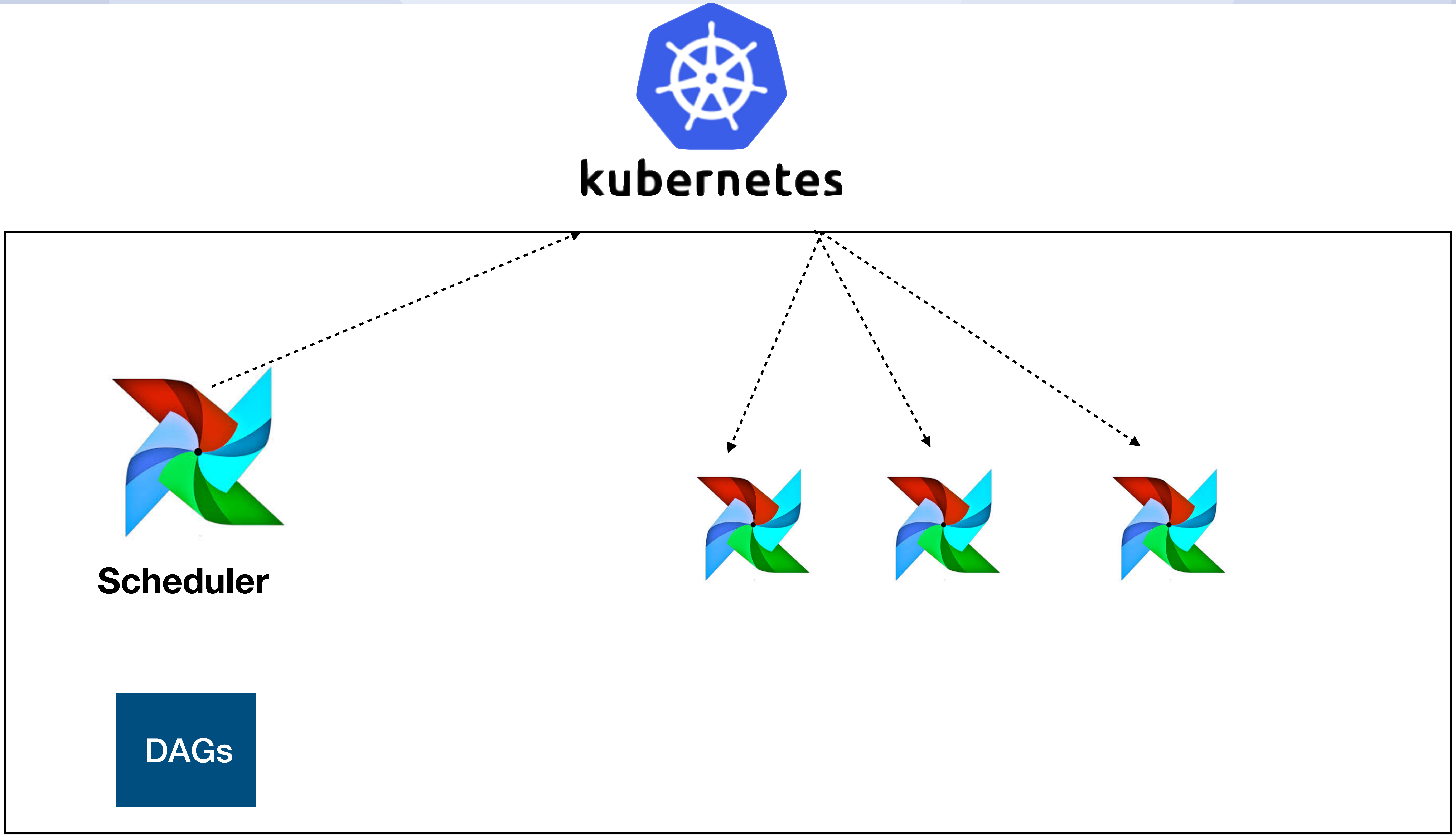
Fault Tolerance



Fault Tolerance

- Uses “resourceVersion” to re-create state
- Maintain a resourceVersion in SQL table for state recovery

DAG Propagation



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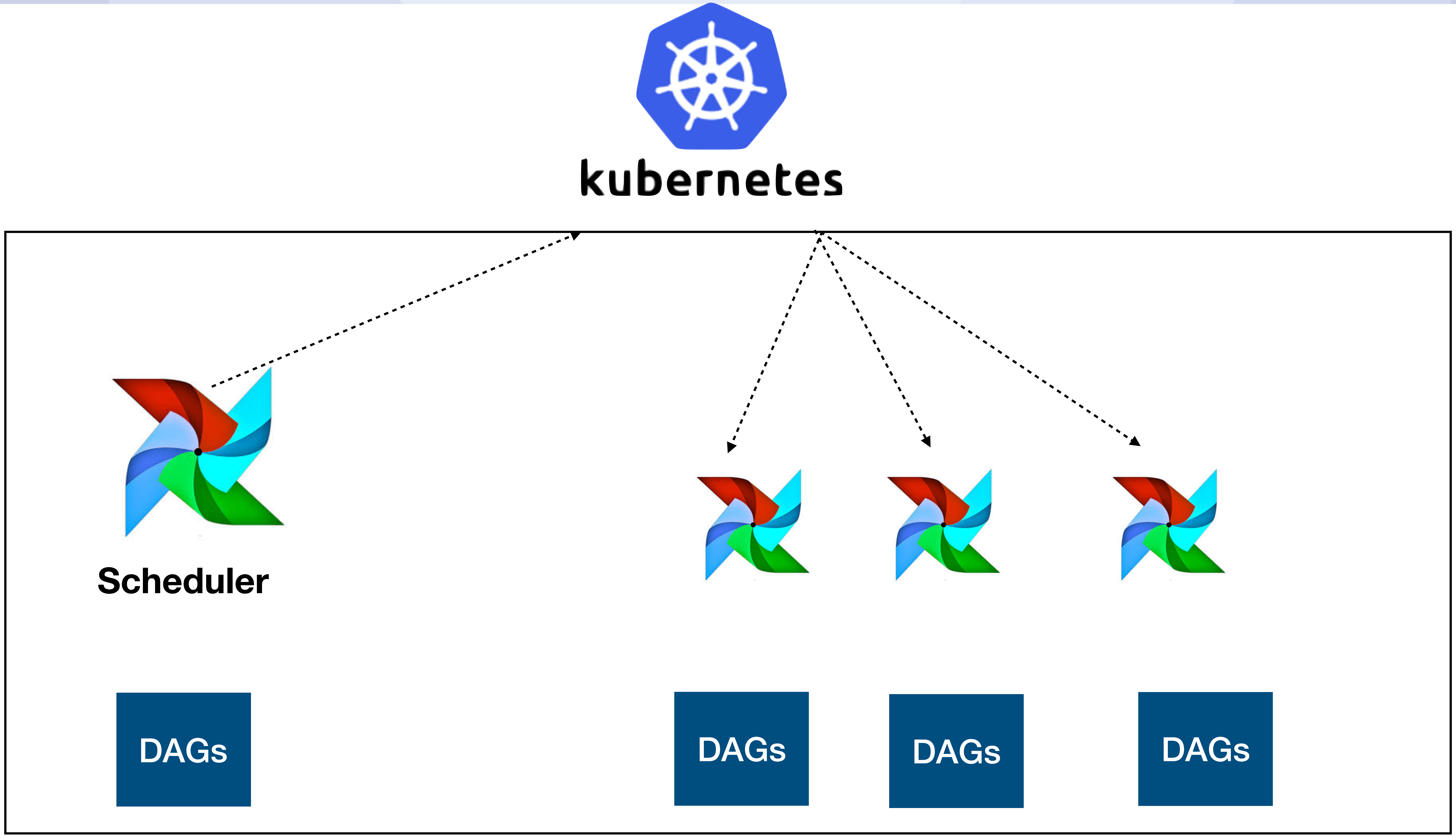


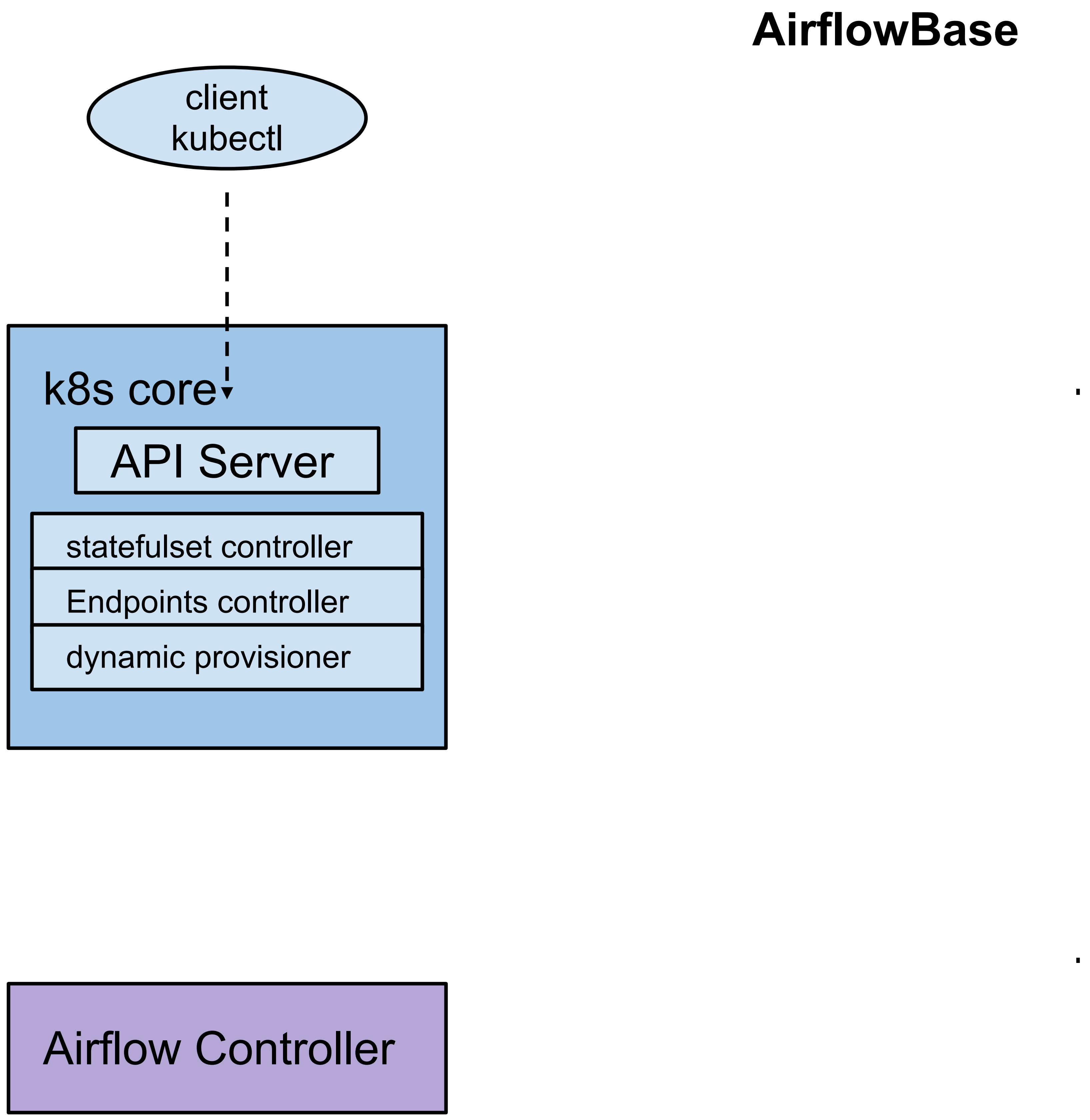
DAG Injection

- Three modes: Git-init mode, persistent volume mode, and “pre-baked” mode (1.10.2)
- Git-init mode + pre-baked is recommended for development and small instances of Airflow, because it does not involve any distributed file systems
- Persistent volume mode recommended for large DAG folders

AirflowOperator (k8s controller)

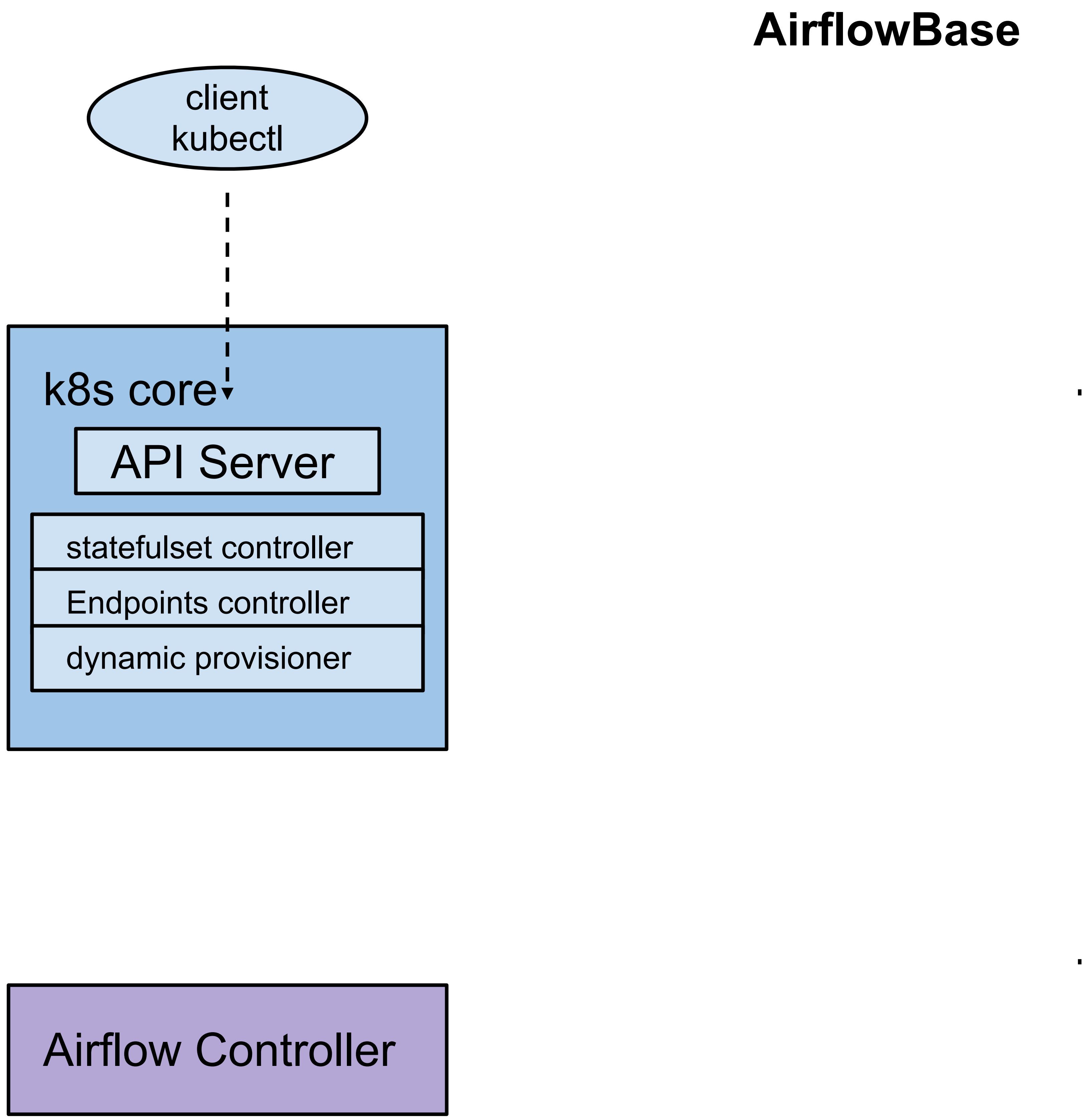
- Simplifies Airflow deployment and management
- Is a Custom Kubernetes controller
- Using CRDs, user creates declarative specs describing his intent
    - AirflowBase
    - AirflowCluster

AirflowBase CRD



- AirflowBase CRD
  - MySQL/Postgres/SQLProxy
  - NFS
- Used by multiple Airflow Clusters

AirflowBase CRD



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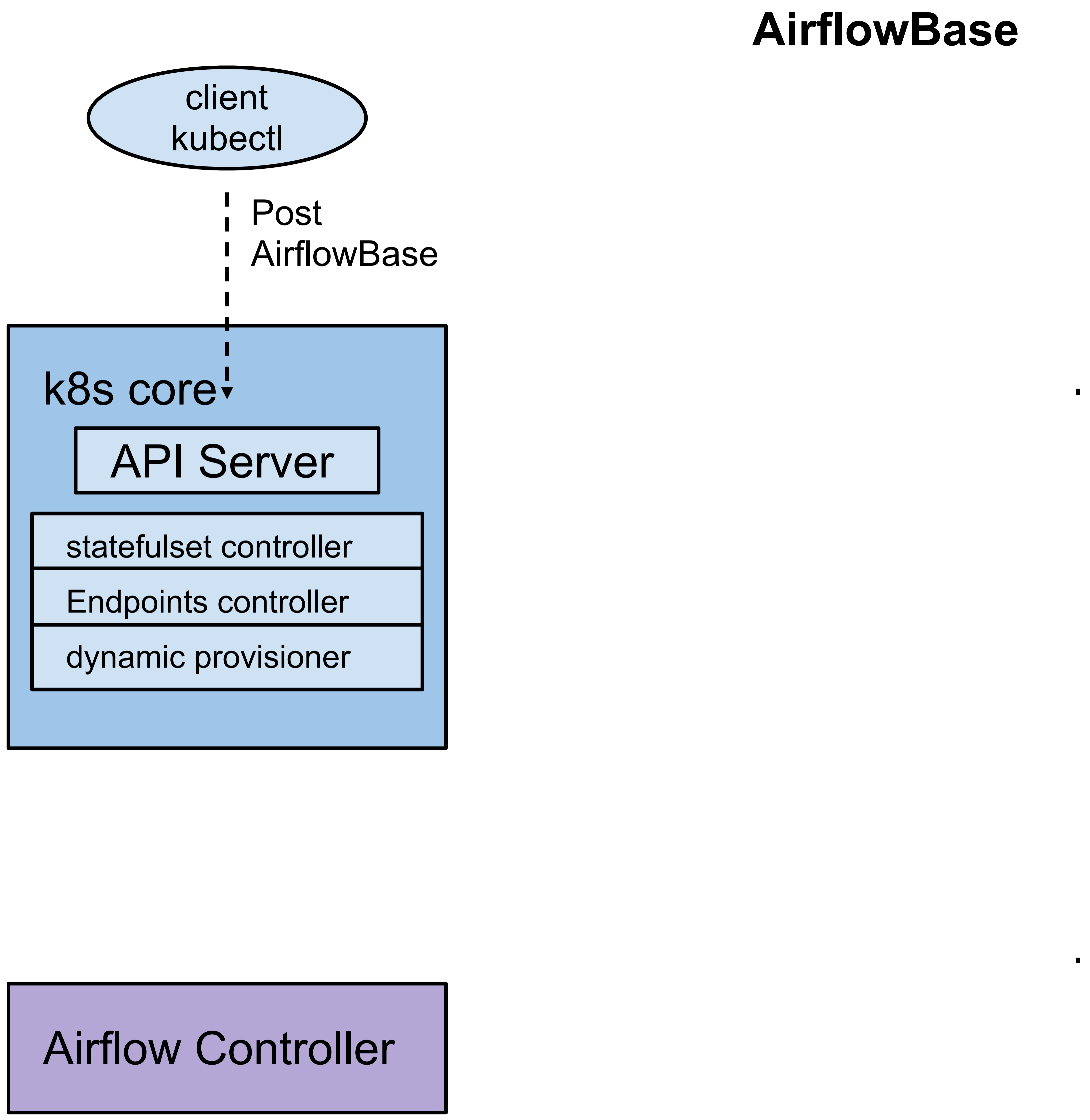
```
apiVersion: airflow.k8s.io/v1alpha1
kind: AirflowBase
metadata:
  name: mc-base
spec:
  mysql:
    operator: False
  storage:
    version: ""
```

AirflowBase CRD



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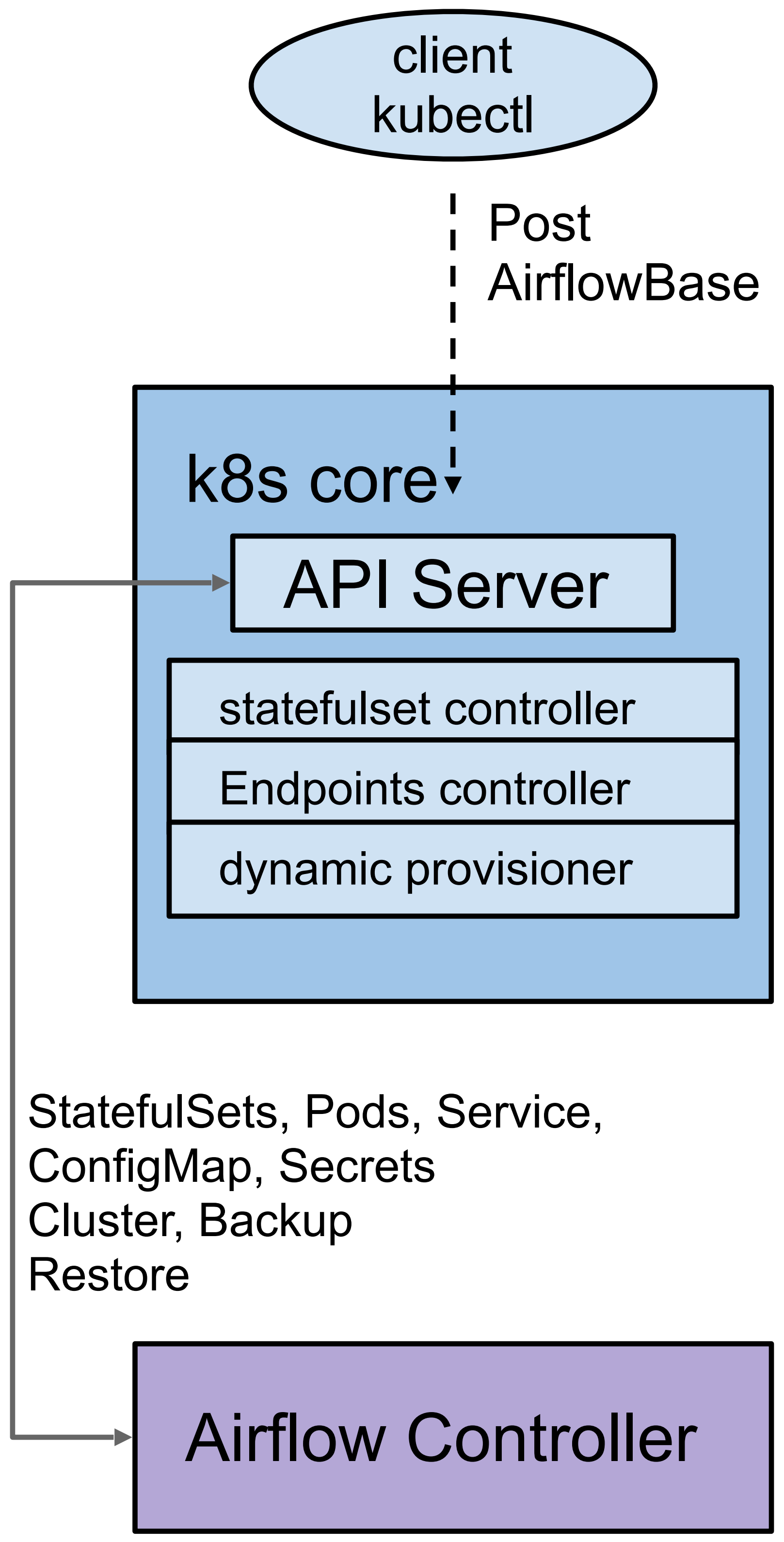

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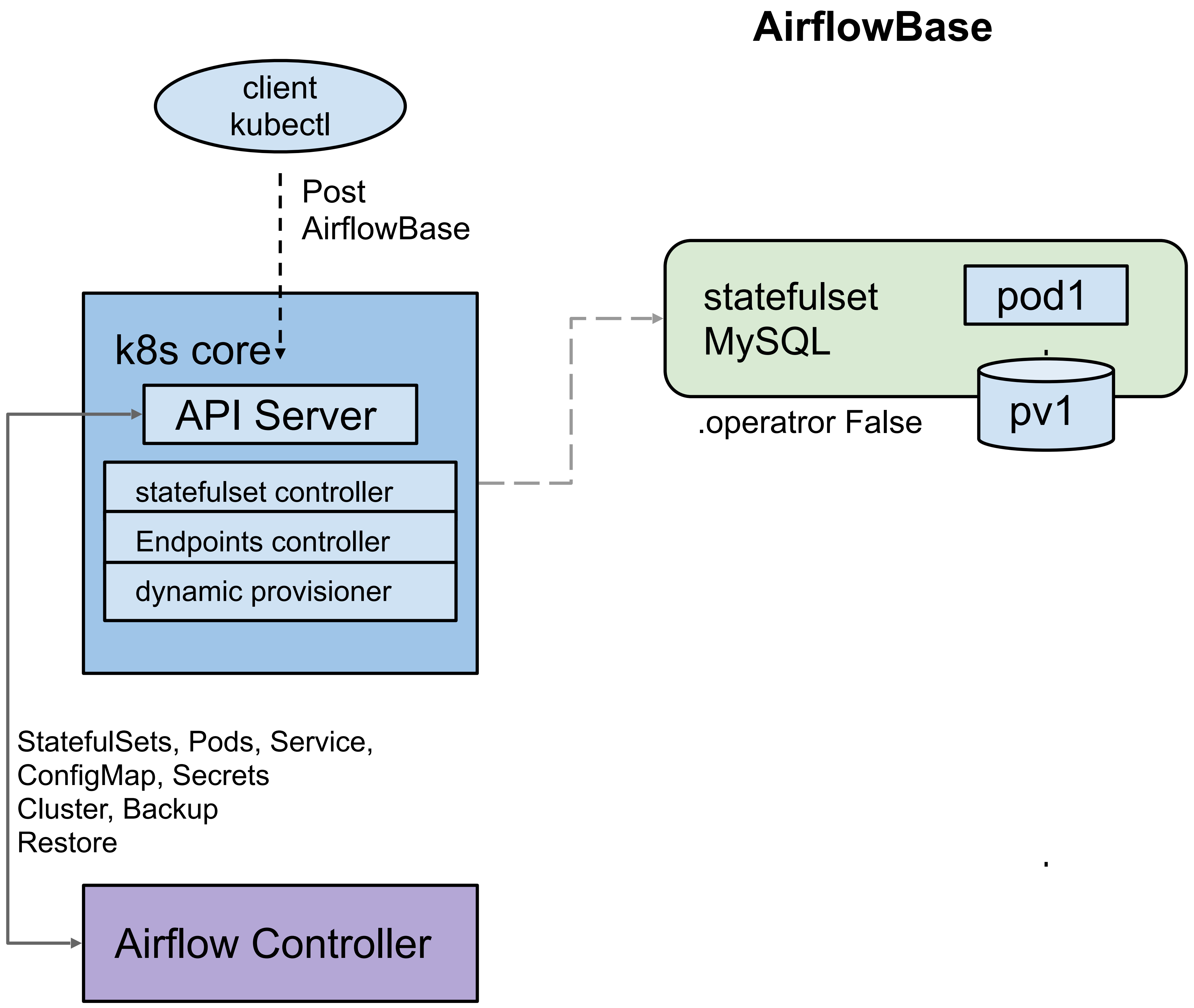

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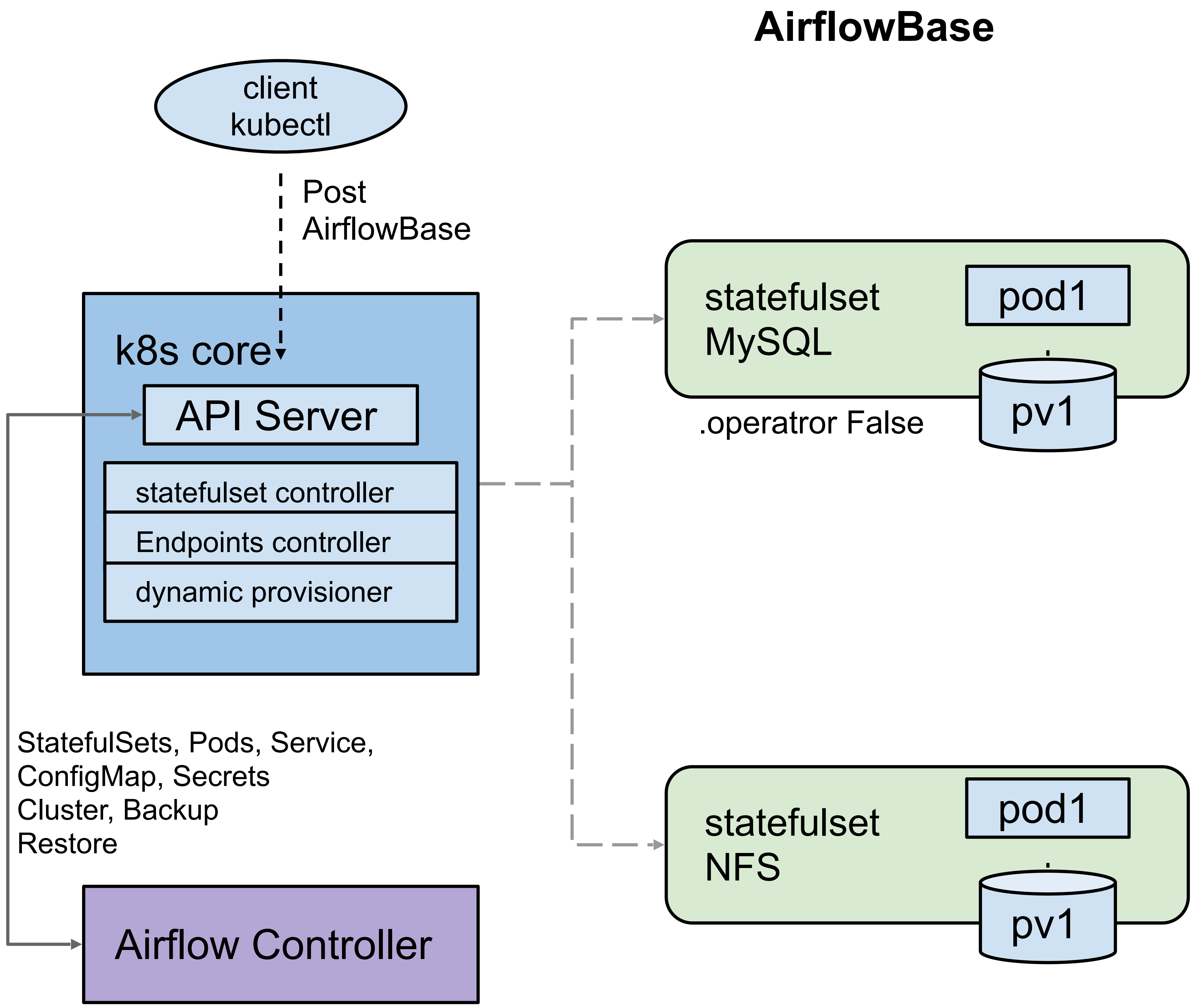

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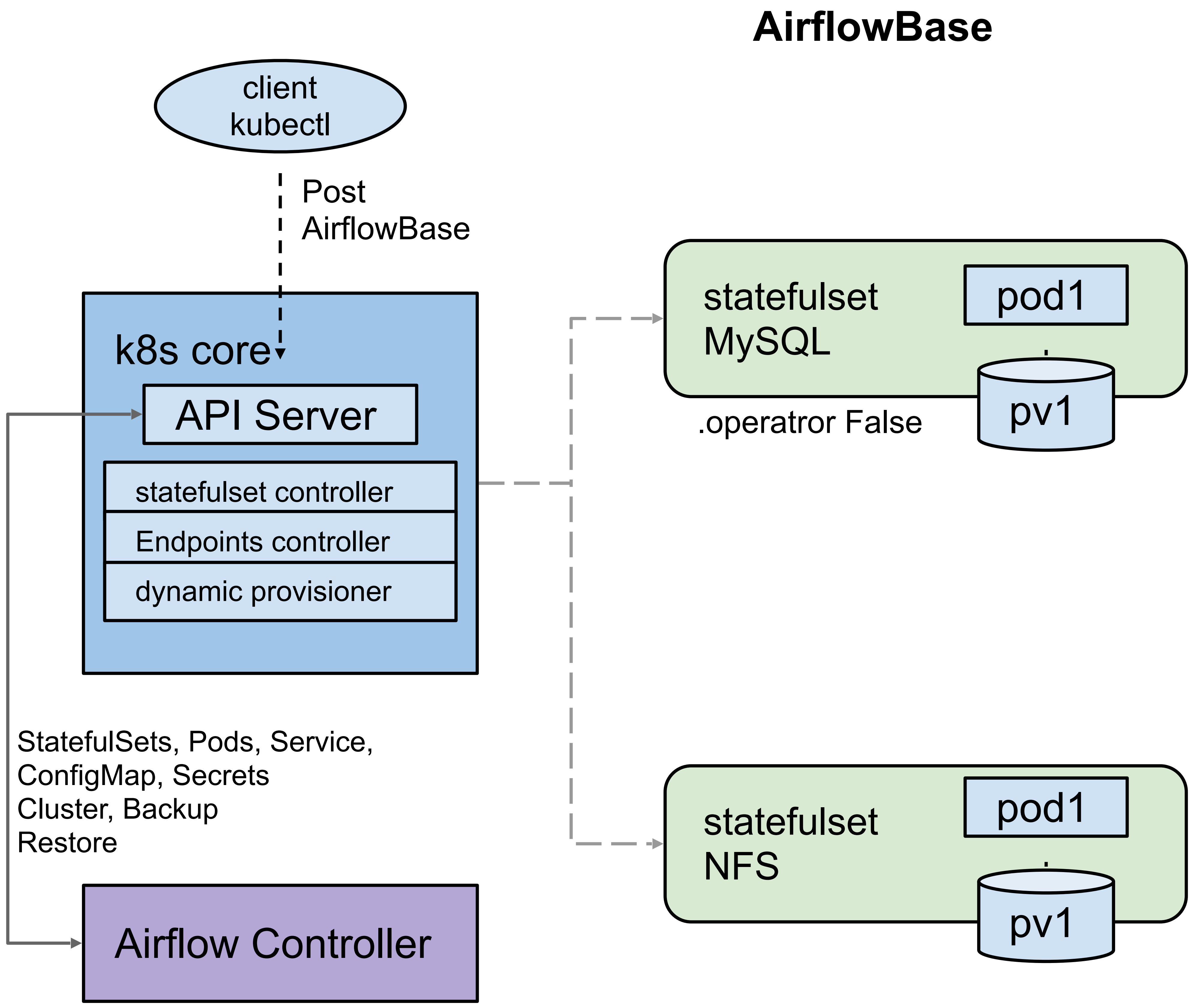

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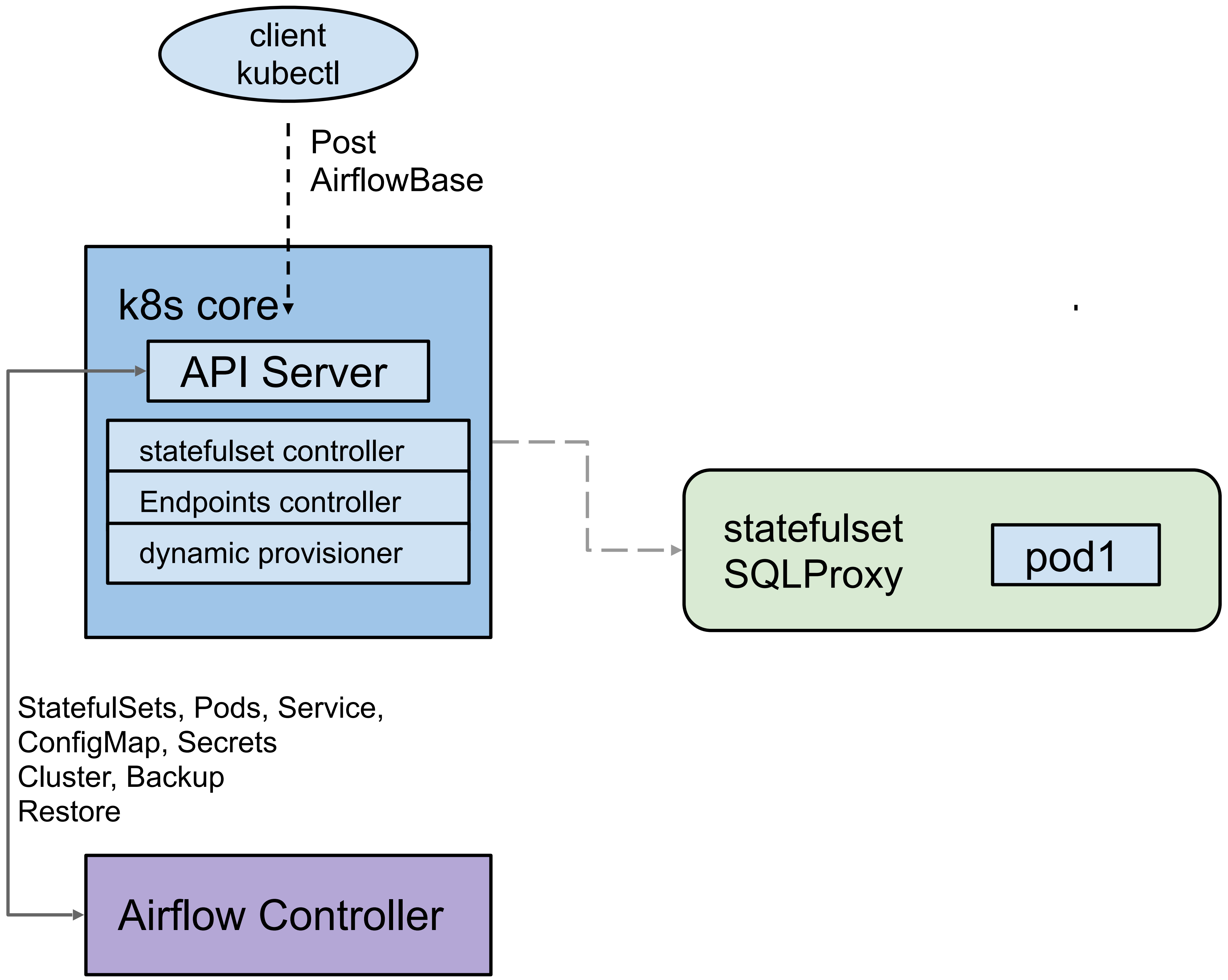
metadata:
  name: ck-base
spec:
  sqlproxy:
          project: someproject
          region: us-central1
          instance: testsql-cluster
  storage:
    version: ""
```

AirflowBase CRD

AirflowBase



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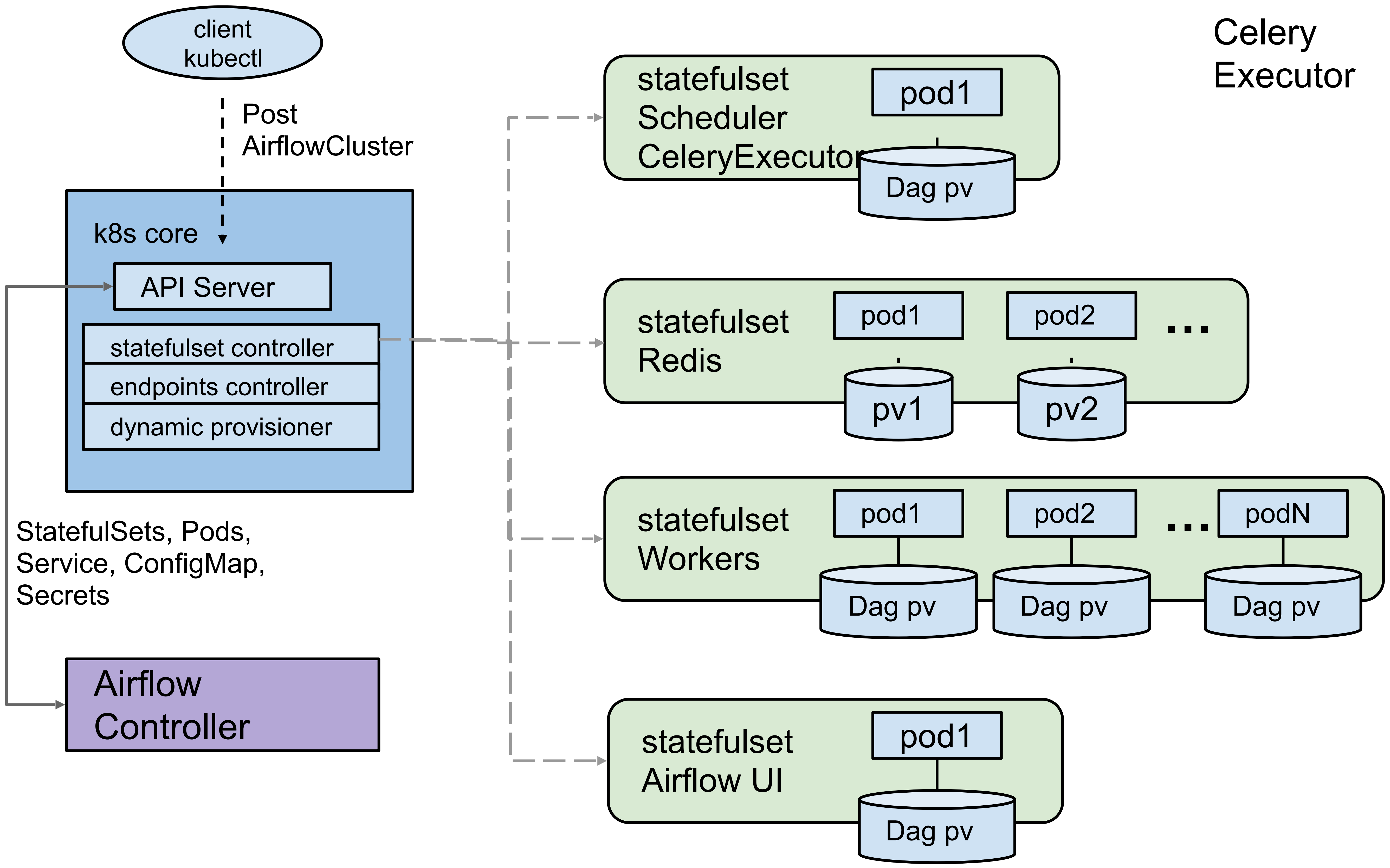
  storage:
    version: ""
```

AirflowCluster CRD

AirflowCluster

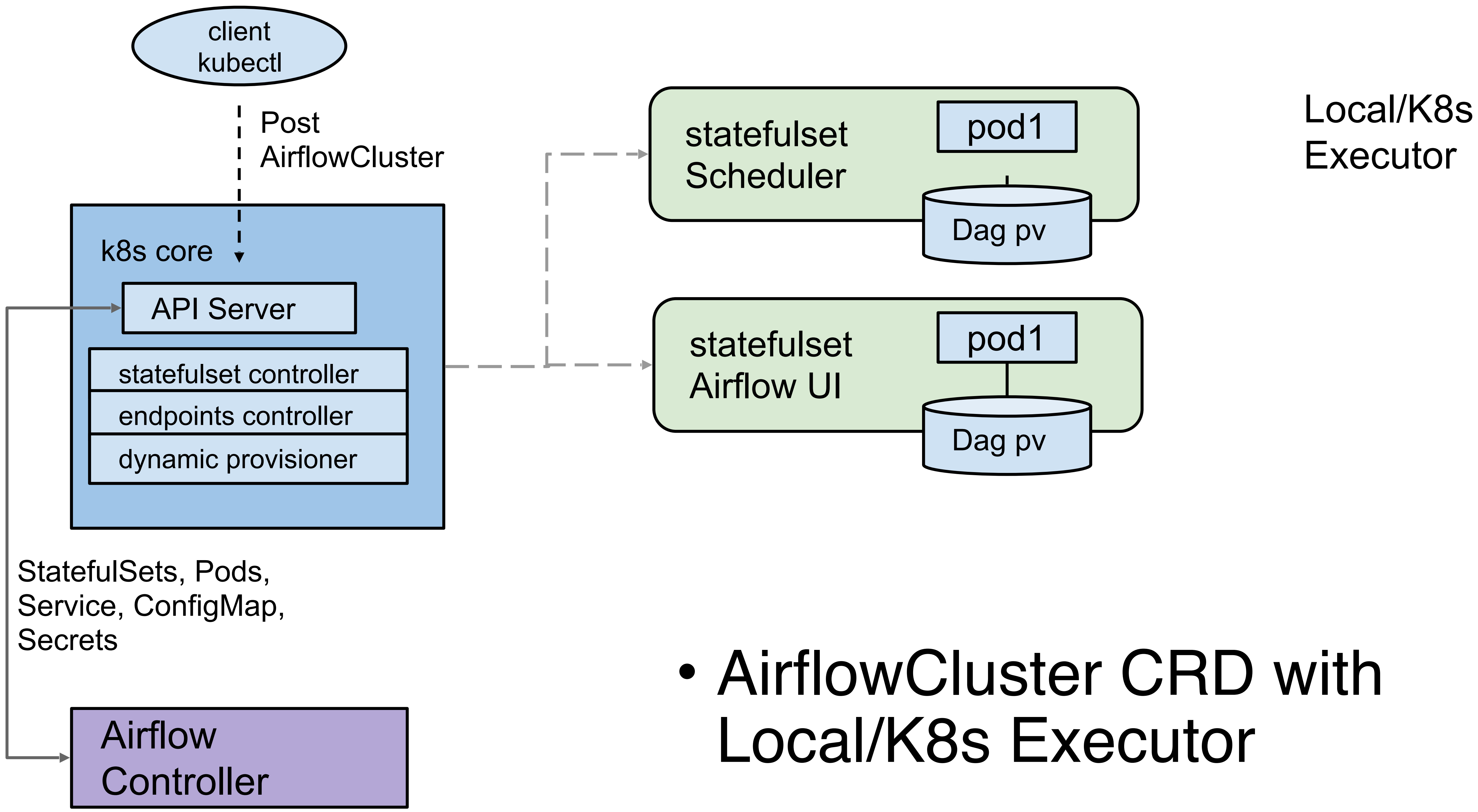


- Celery Executor
  - Redis
  - Airflow UI
  - Airflow Scheduler
  - Airflow Workers
- Each cluster gets its own unique SQL connection string (user:password/dB).

```
apiVersion: airflow.k8s.io/v1alpha1
kind: AirflowCluster
metadata:
  name: mc-cluster
spec:
  executor: Celery
  config:
    airflow:
      AIRFLOW_SOME_CONFIG: SomeValue
  redis:
    operator: False
  scheduler:
    version: "1.10.1"
  ui:
    replicas: 1
    version: "1.10.1"
  worker:
    replicas: 2
    version: "1.10.1"
  flower:
    replicas: 1
    version: "1.10.1"
  dags:
    subdir: "airflow/example_dags/"
    git:
      repo: "https://github.com/apache/incubator
airflow/"
      once: true
  airflowbase:
    name: mc-base
```

AirflowCluster CRD

AirflowCluster



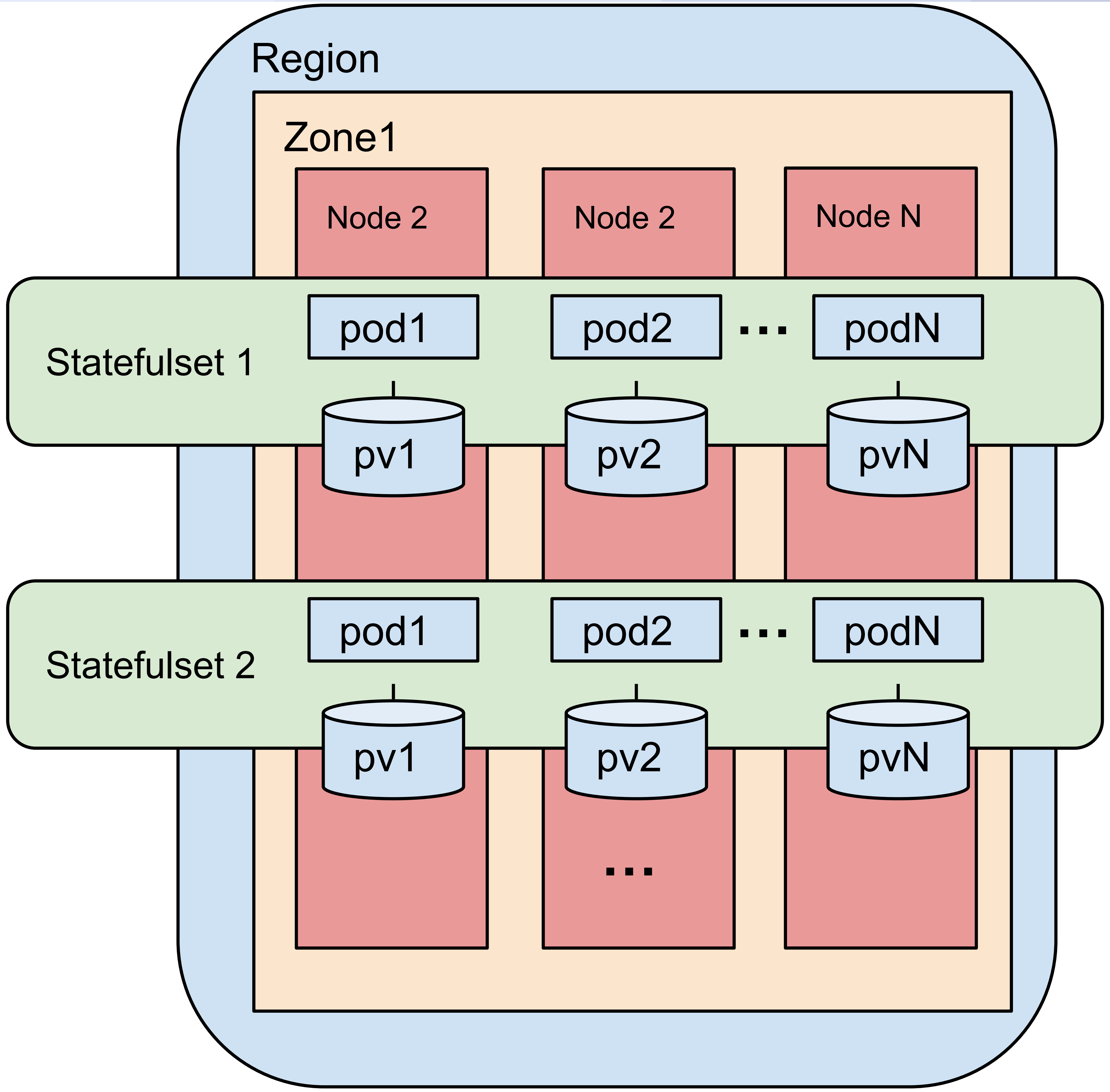
- AirflowCluster CRD with Local/K8s Executor

- Airflow UI
- Airflow Scheduler

```
apiVersion: airflow.k8s.io/v1alpha1
kind: AirflowCluster
metadata:
  name: mk-cluster
spec:
  executor: Kubernetes
  ui:
    replicas: 1
    version: "1.10.1"
  scheduler:
    version: "1.10.1"
  worker:
    version: "1.10.1"
  dags:
    subdir: "airflow/example_dags/"
    git:
      repo: "https://github.com/apache/
incubator-airflow/"
      once: true
      branch: master
  airflowbase:
    name: mc-base
```

AirflowCluster CRD

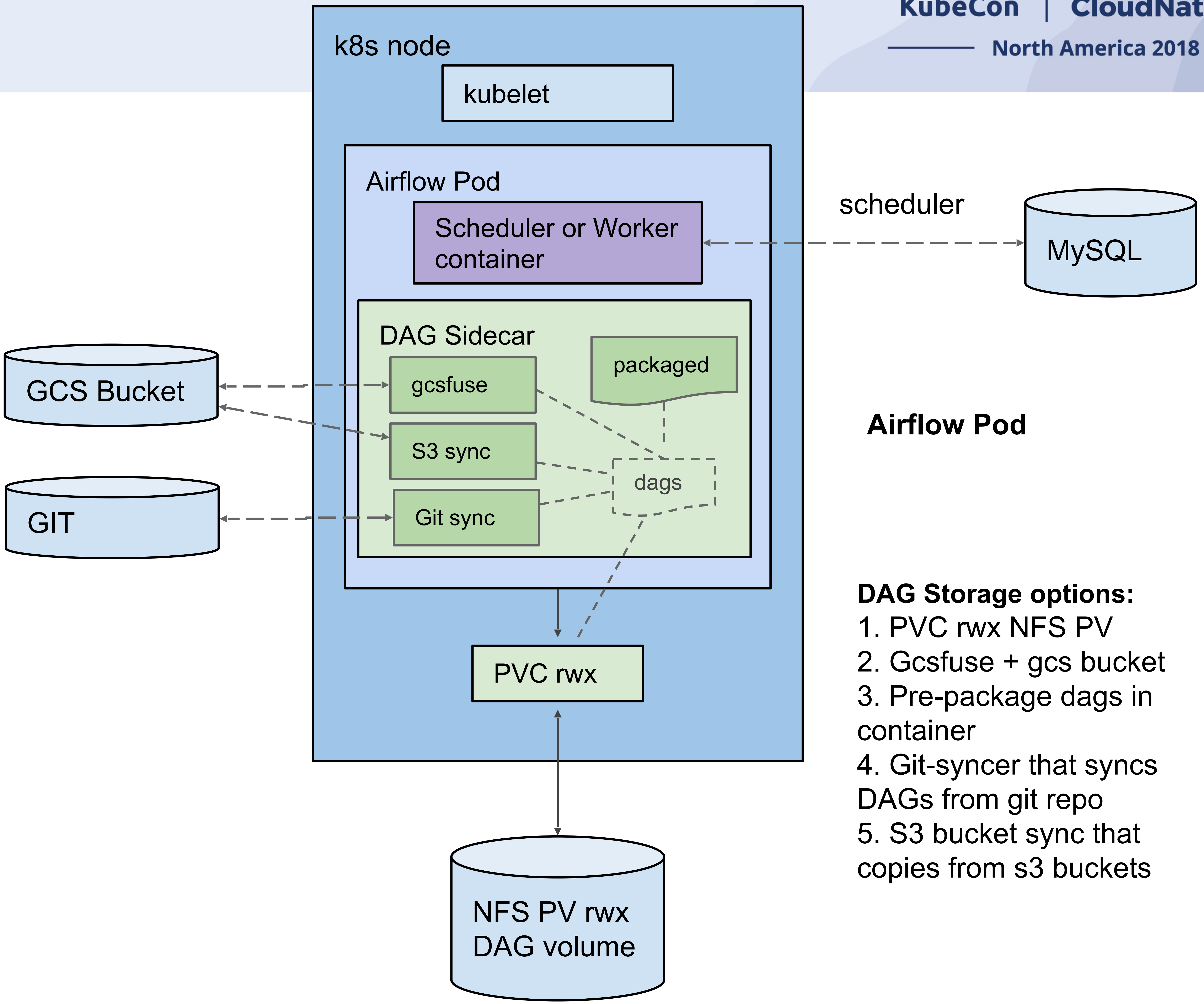
- Pod affinity rules cluster.Spec.Affinity.*.topology can be set to “kubernetes.io/hostname” to spread Pods across Nodes within a Zone.
- Limit the impact of node failures within a zone



Pods spread across Nodes in Zone

AirflowOperator

- Multiple DAG sources are supported via a DAG Sidecar
- Custom Airflow Pod images are supported



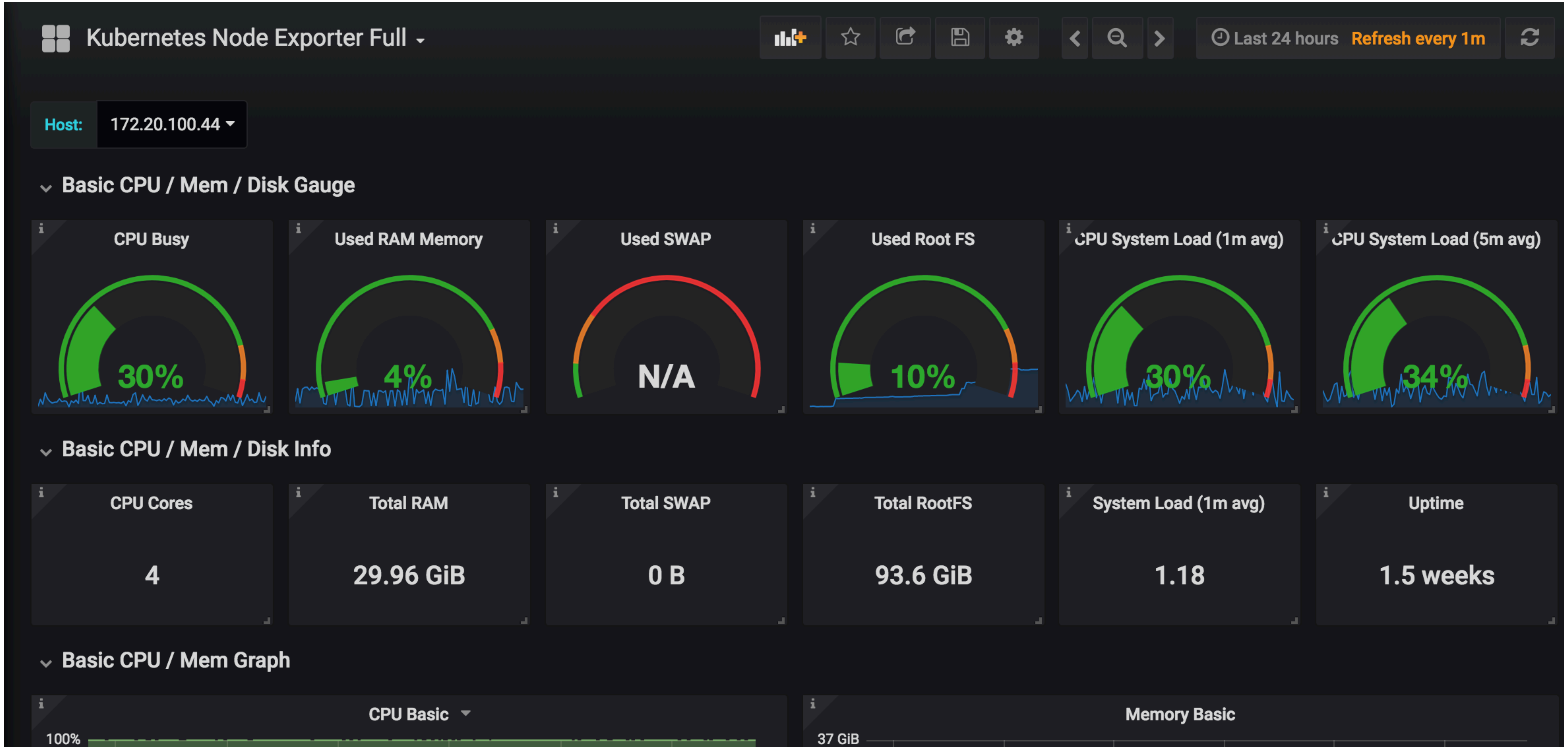
Airflow Pod

DAG Storage options:
1. PVC rwx NFS PV
2. Gcsfuse + gcs bucket
3. Pre-package dags in container
4. Git-syncer that syncs DAGs from git repo
5. S3 bucket sync that copies from s3 buckets

Monitoring

- Can use existing Kubernetes infrastructure
- Only needed to think about Airflow, not machines

Prometheus



Kubernetes Node Exporter Full

Host: 172.20.100.44

Basic CPU / Mem / Disk Gauge

CPU Busy	Used RAM Memory	Used SWAP	Used Root FS	CPU System Load (1m avg)	CPU System Load (5m avg)
30%	4%	N/A	10%	30%	34%

Basic CPU / Mem / Disk Info

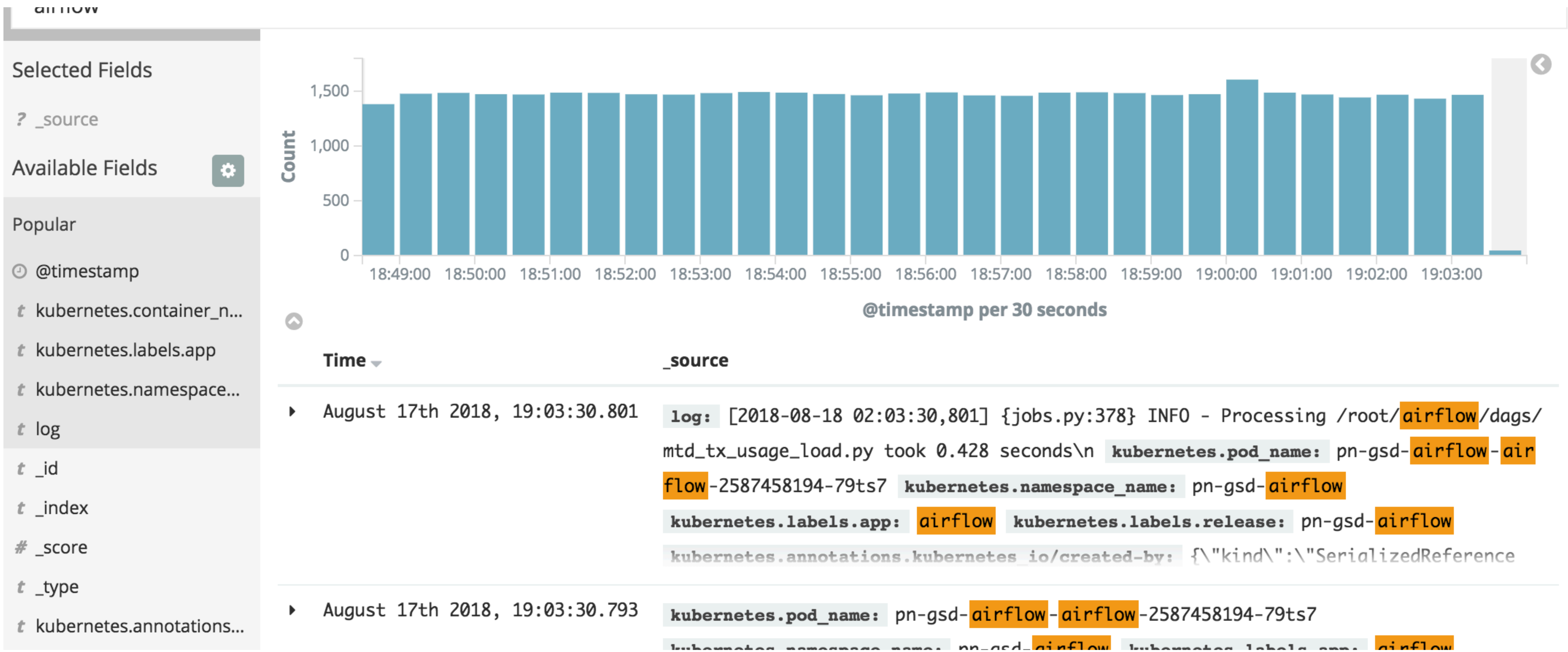
CPU Cores	Total RAM	Total SWAP	Total RootFS	System Load (1m avg)	Uptime
4	29.96 GiB	0 B	93.6 GiB	1.18	1.5 weeks

Basic CPU / Mem Graph

CPU Basic

Memory Basic

Elasticsearch



```
August 17th 2018, 19:03:30.801   log: [2018-08-18 02:03:30,801] {jobs.py:378} INFO - Processing /root/airflow/dags/
                                 mtd_tx_usage_load.py took 0.428 seconds\n kubernetes.pod_name: pn-gsd-airflow-air
                                 flow-2587458194-79ts7 kubernetes.namespace_name: pn-gsd-airflow
                                 kubernetes.labels.app: airflow kubernetes.labels.release: pn-gsd-airflow
                                 kubernetes.annotations.kubernetes_io/created-by: {\"kind\":\"SerializedReference

August 17th 2018, 19:03:30.793   kubernetes.pod_name: pn-gsd-airflow-airflow-2587458194-79ts7
                                 kubernetes.namespace_name: pn-gsd-airflow kubernetes.labels.app: airflow
```

K8sExecutor Status

- Has been released with Airflow 1.10 in experimental mode
- Multiple companies already using in production
- Helm chart in progress
- AirflowOperator by end of 2018
- Active community in #sig-big-data on kubernetes.slack.com
- Seeking beta testers, devs, and brave souls

Airflow Operator Status

- Supports Airflow 1.10.1
- Available on Kubernetes Marketplace in GCP
- Slack channels kubernetes.slack.com

  #sig-big-data

  #airflow-operator

Demo

Thank You

Learn more:

github.com/apache/incubator-airflow/

@danimberman

github.com/GoogleCloudPlatform/airflow-operator

@bharanis

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