Democratized data workflows at scale

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FINANCIAL TIMES

Our agenda for today

- Why Airflow?
- Architecture
- Security
- Execution environment in Kubernetes

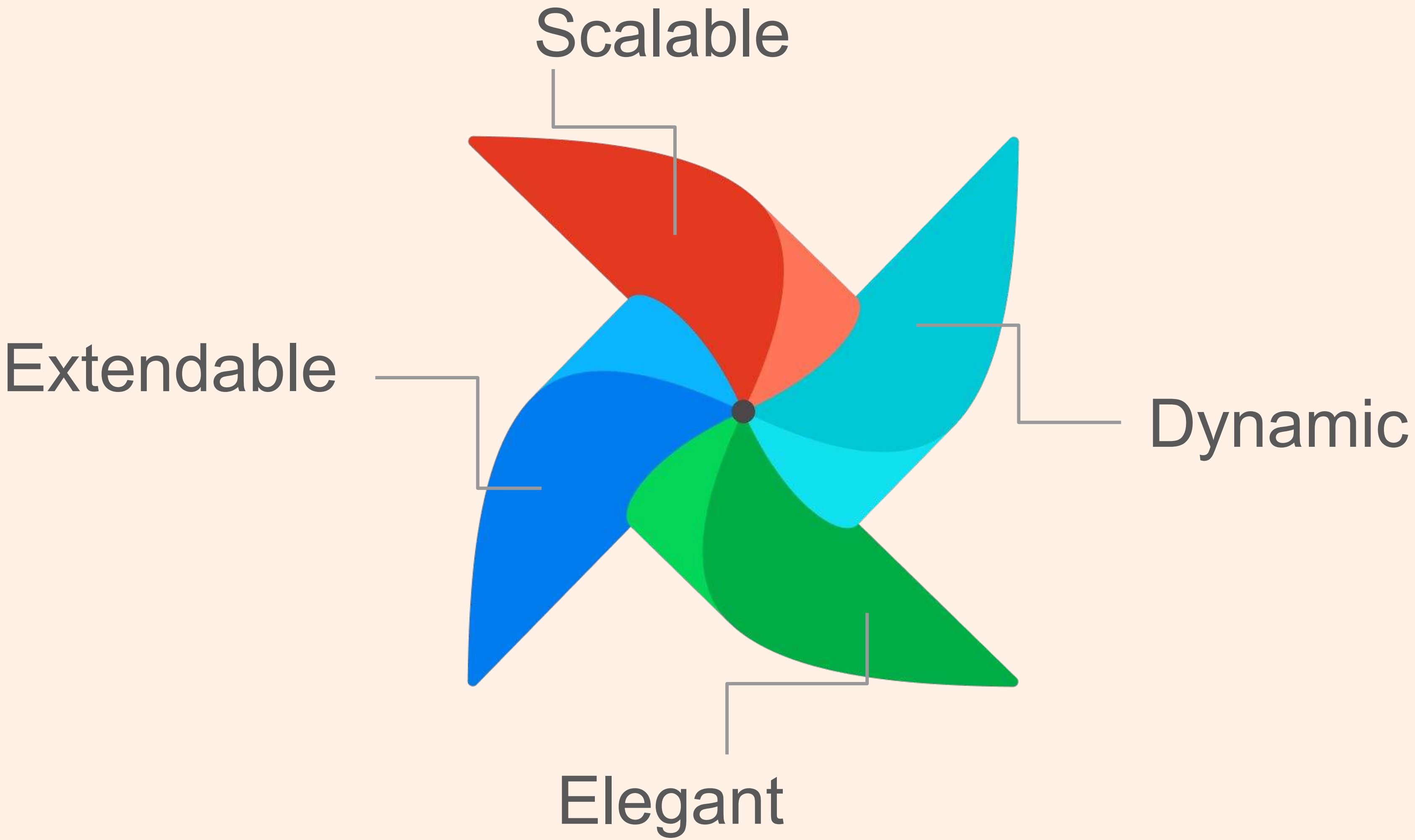
FT

FT is a data driven organization

Time for a change

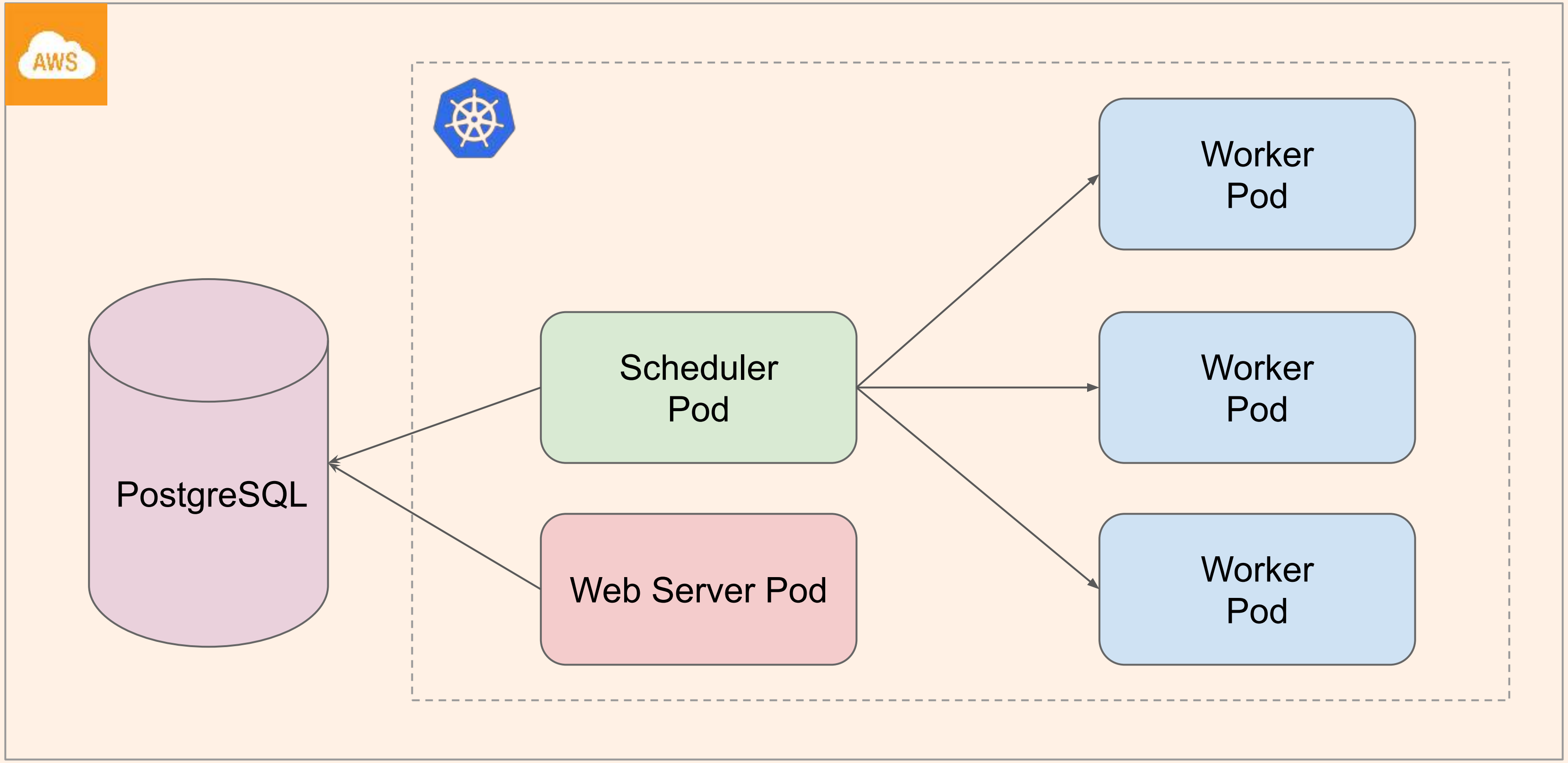
Apache
Airflow

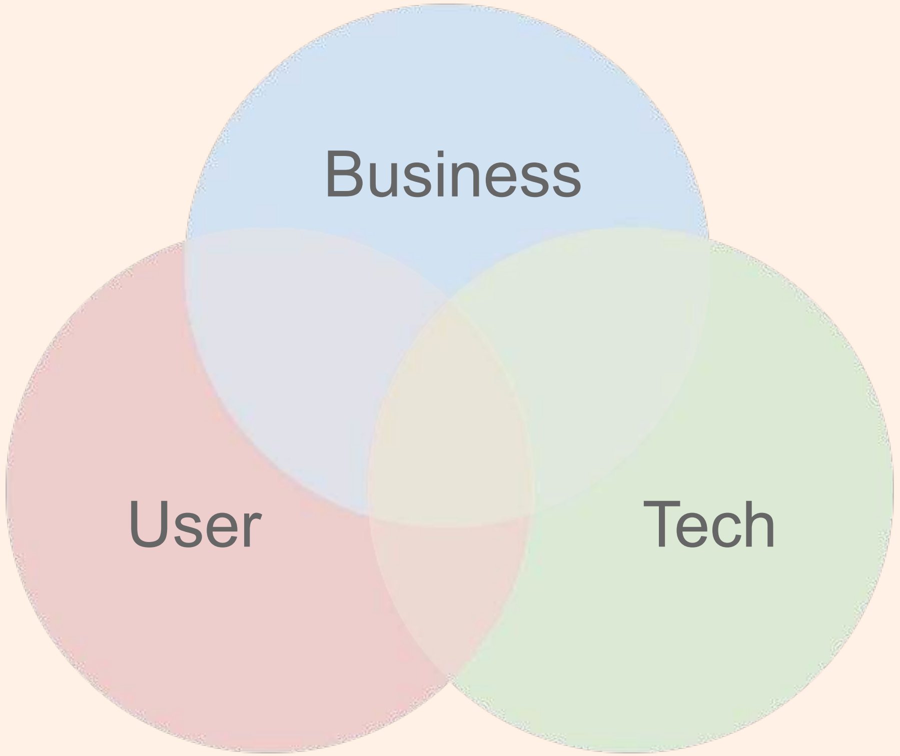
Why Airflow?


Scalable
Extendable
Dynamic
Elegant

Architecture

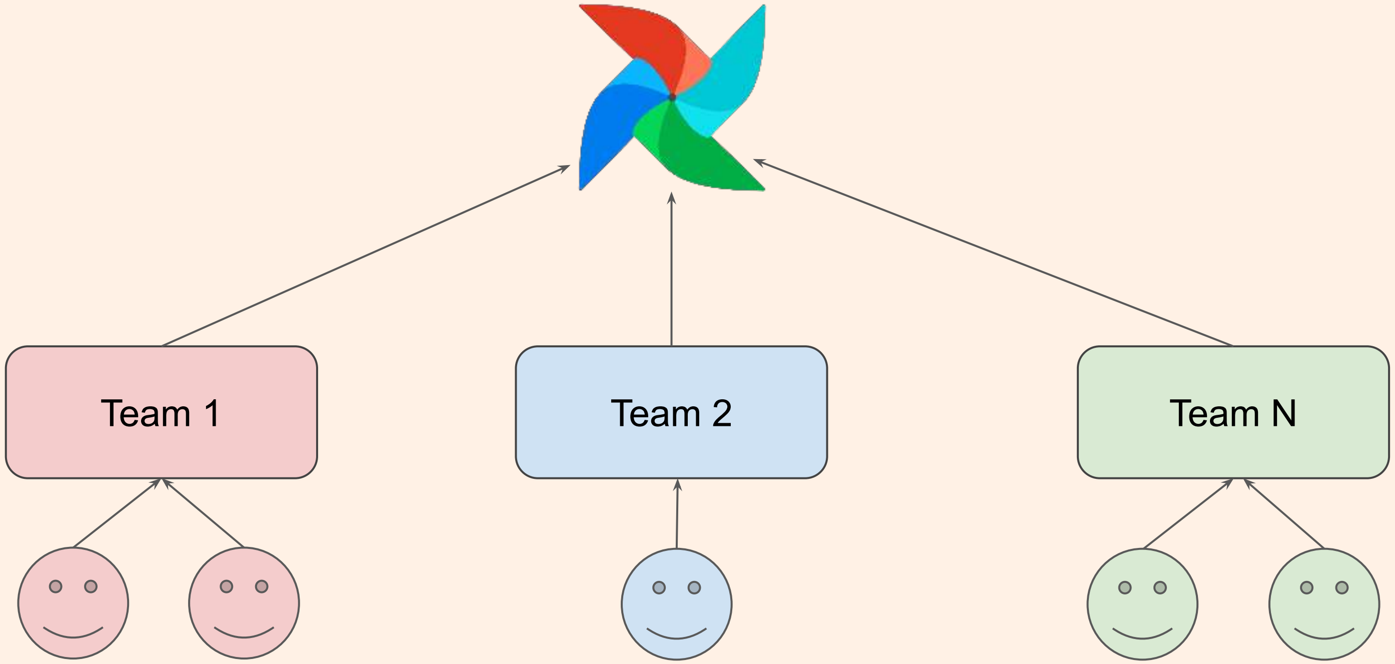
Architecture

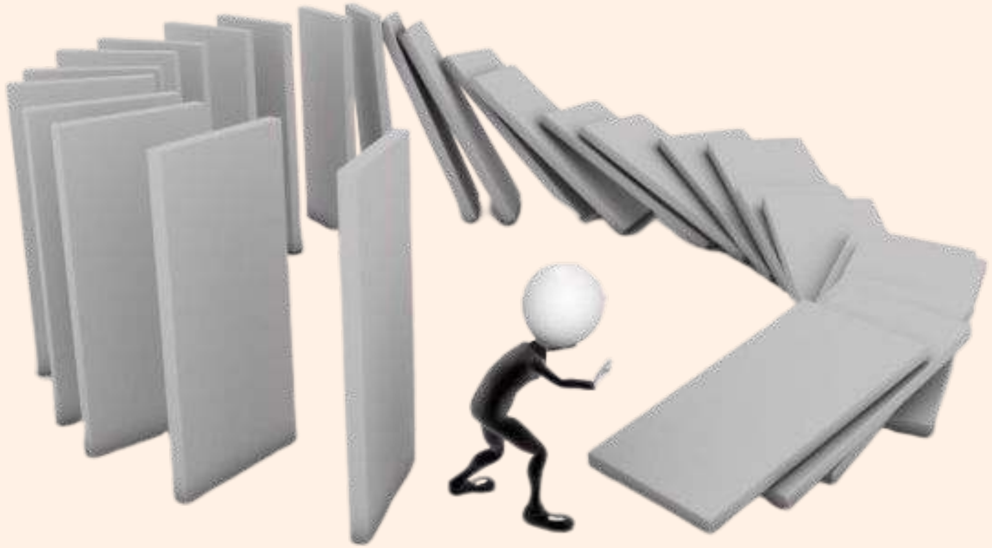



Business
User
Tech

Airflow will be used by multiple teams

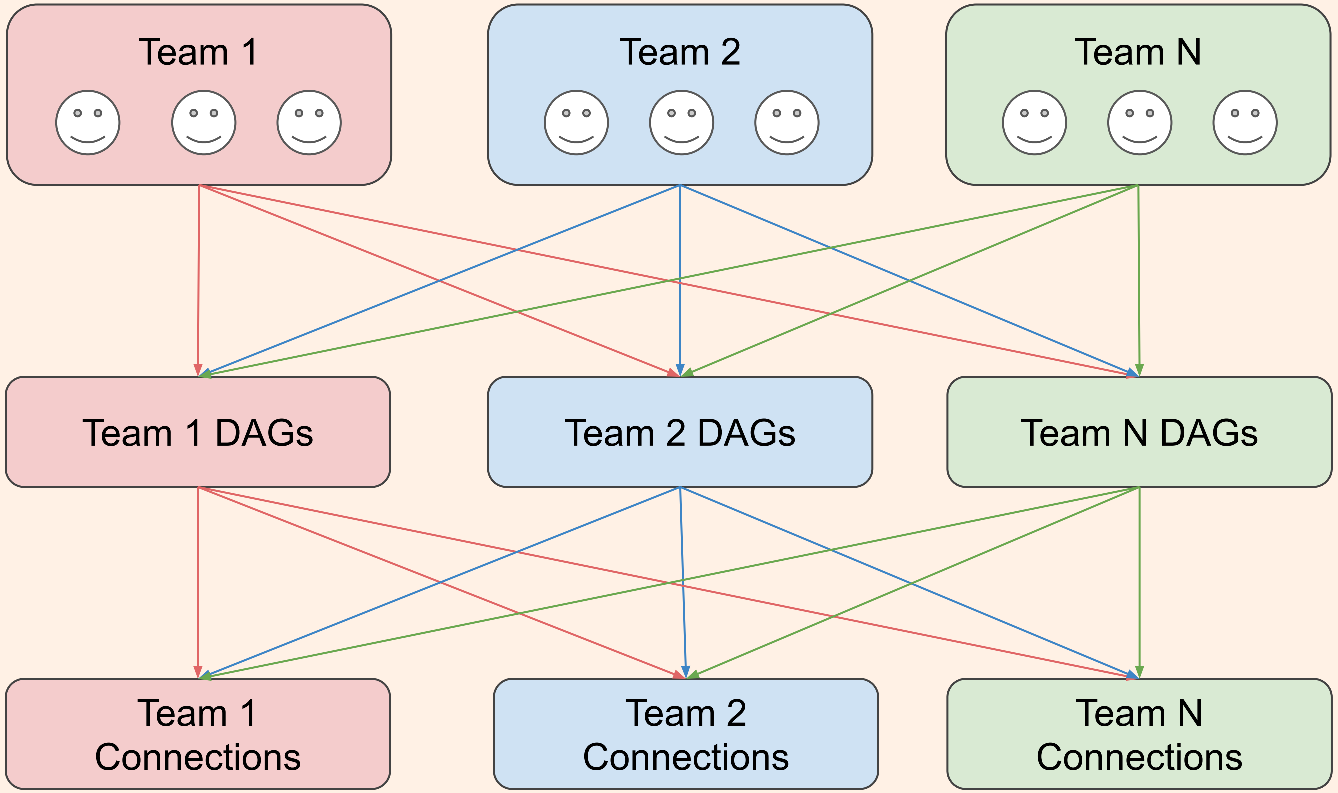
Airflow requirements





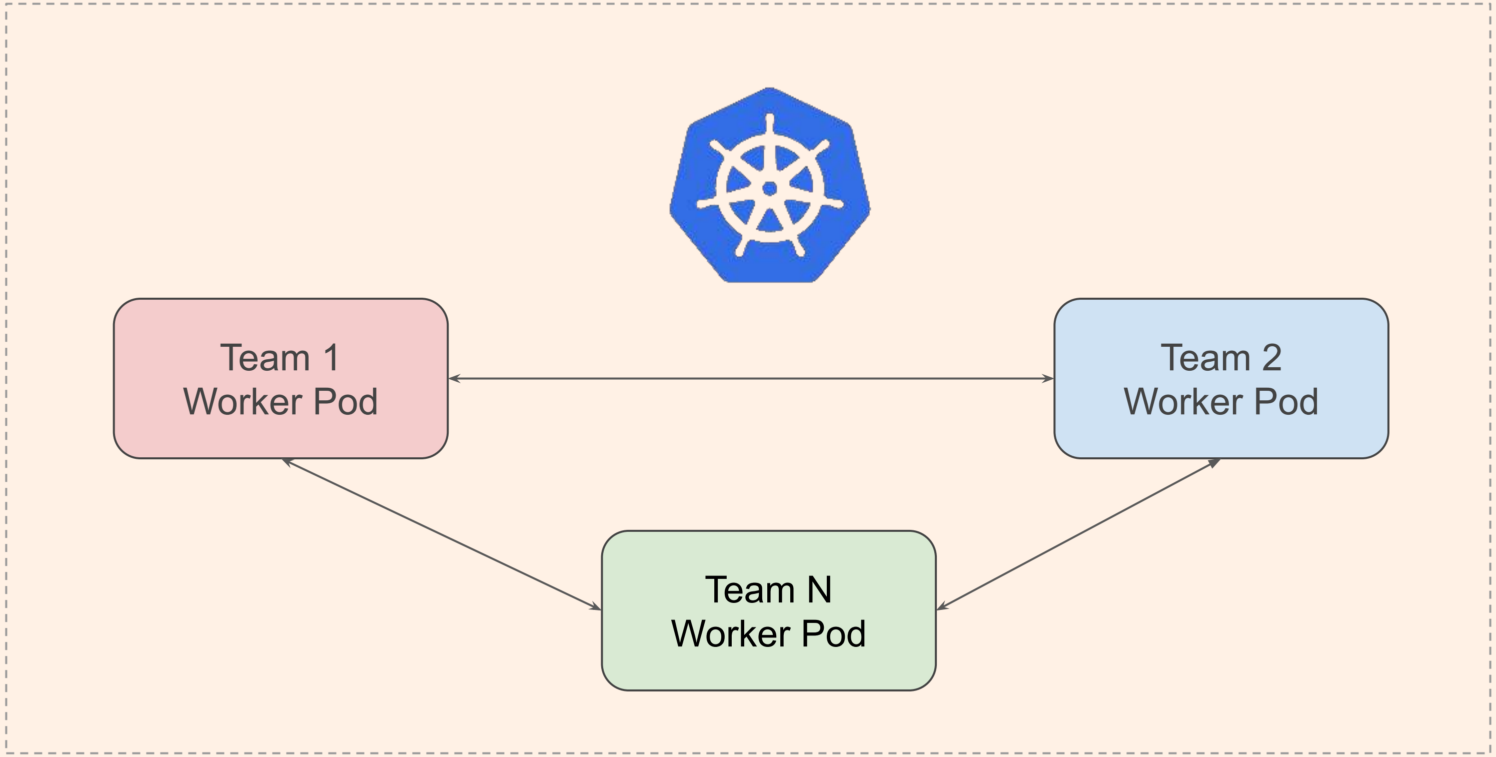
Teams will share **Airflow resources**

Airflow shared components



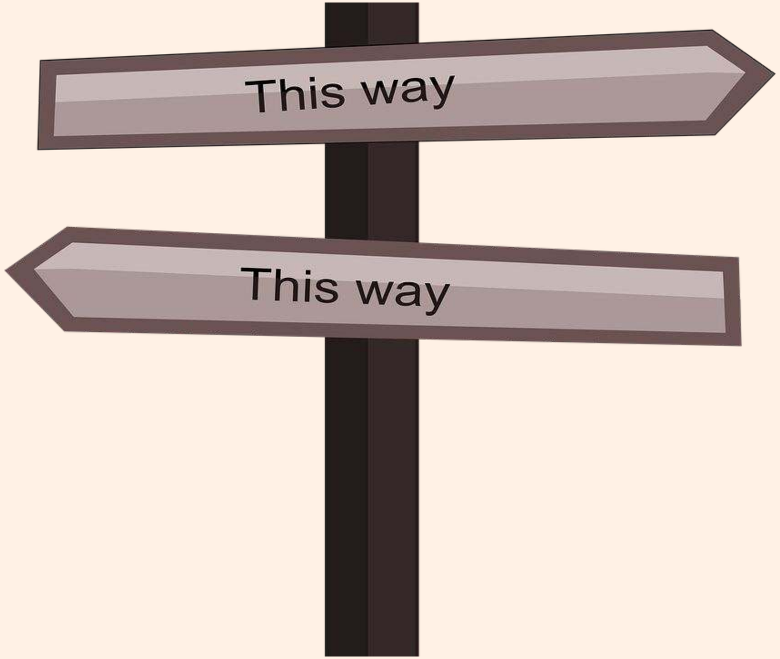
Teams will share Kubernetes resources

Kubernetes shared components



ISSUE
SECURITY • SECURITY

How to evolve this architecture?


This way
This way

Airflow instance per team

One instance components

Instance per team problems

- Adding new team is **hard**
- Maintaining environment per team is **difficult**
- Releasing new features is **slow**
- Resources are **not fully utilised**
- Total **cost increase**

Another way?

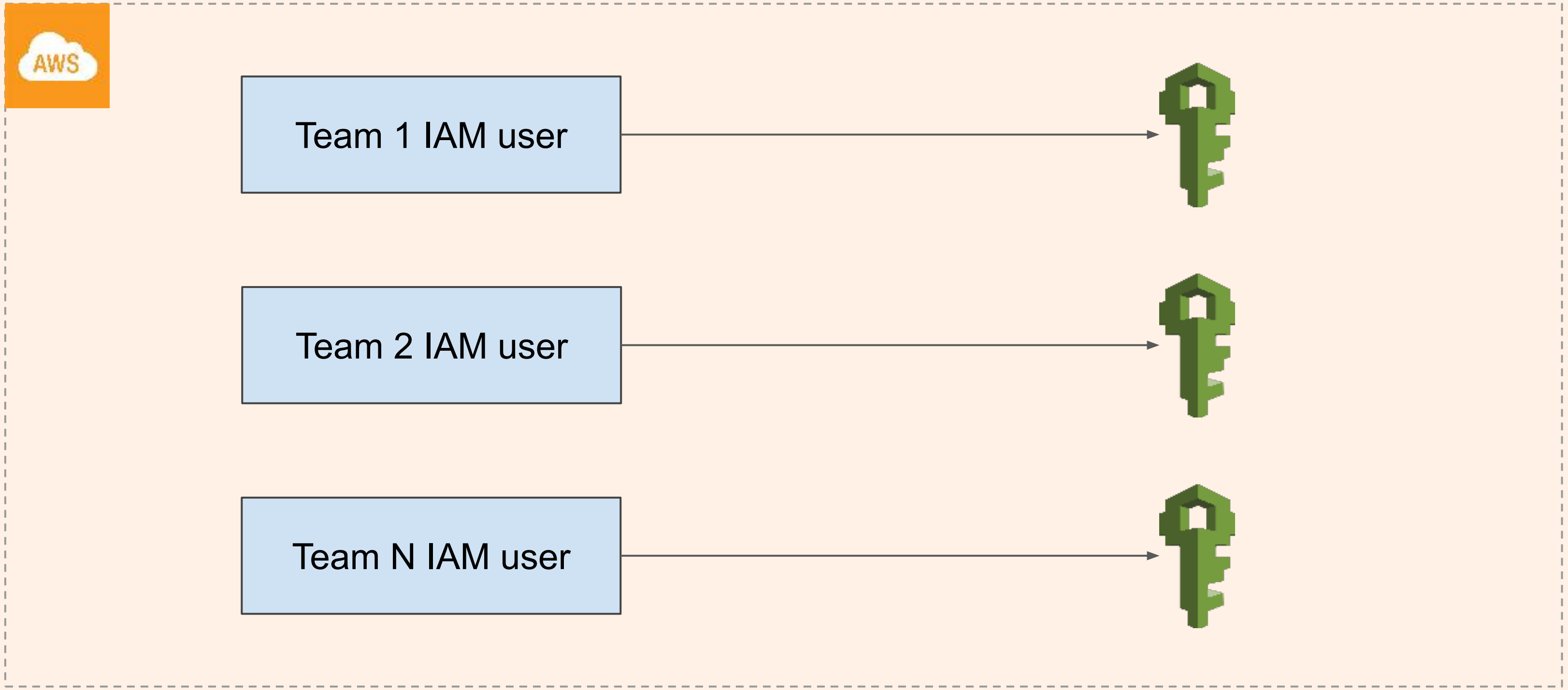
Multitenancy

Multiple independent instances in a shared environment

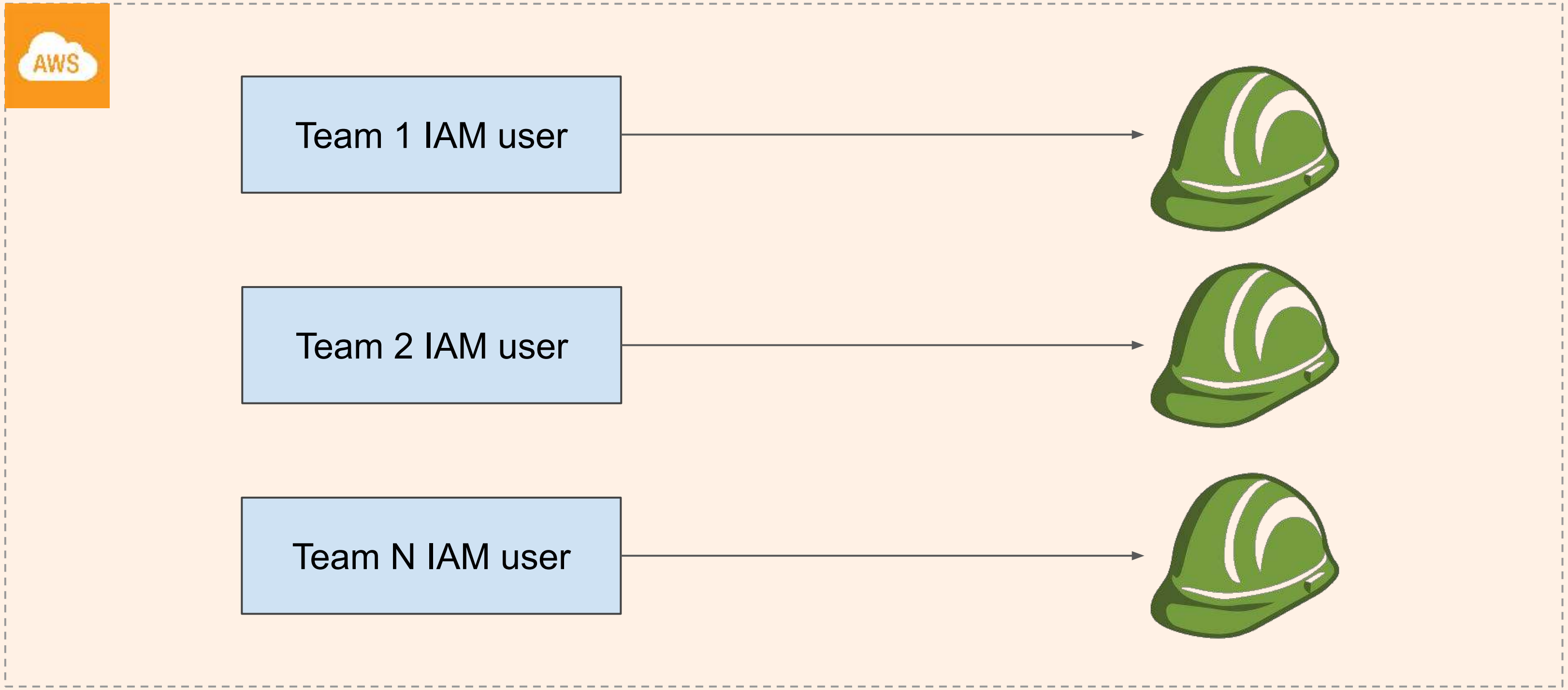
Multi-tenant components

How to make AWS multi-tenant?

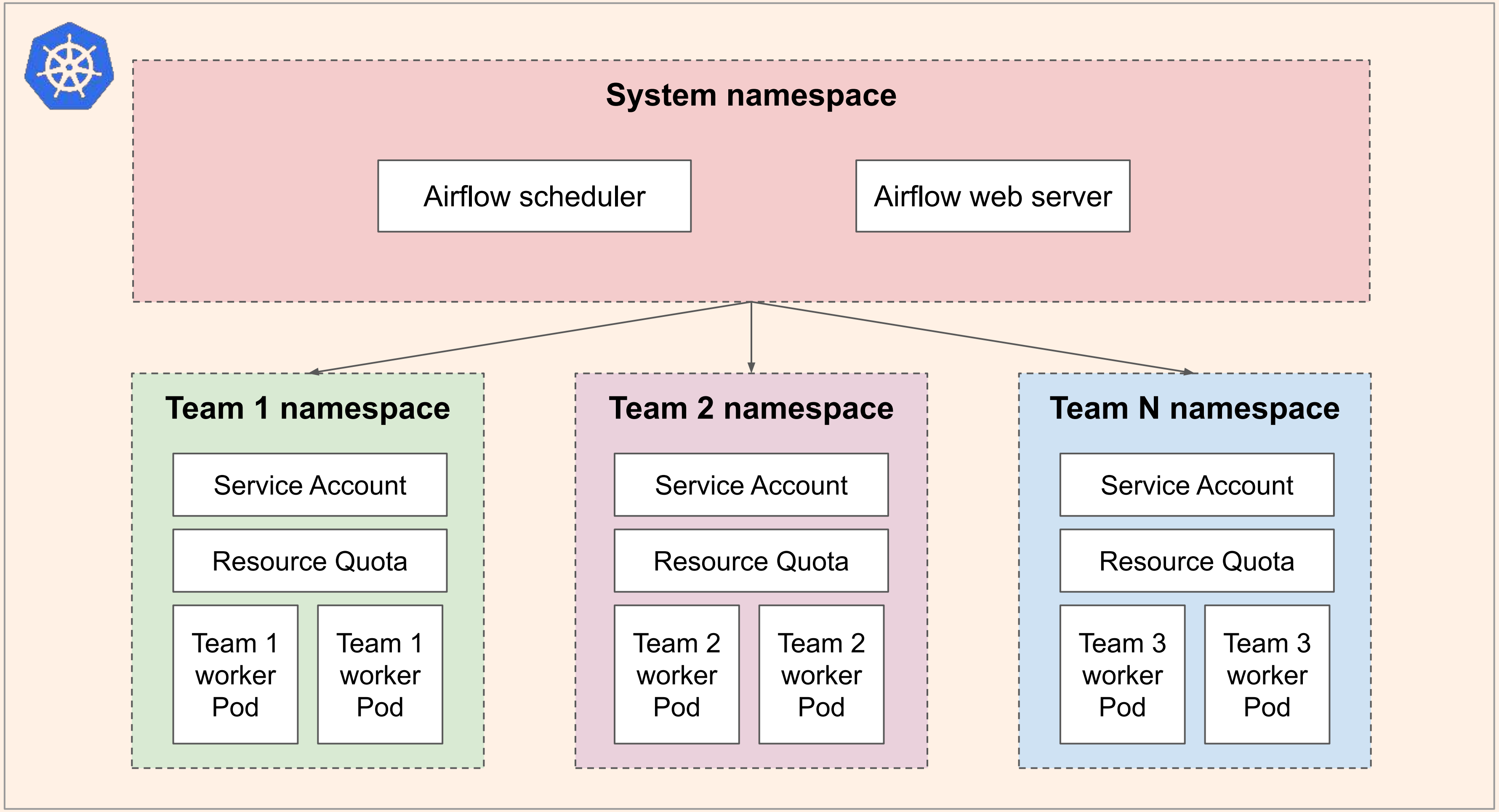
IAM Security



IAM Security



How to enhance Kubernetes?


System namespace
Airflow scheduler
Airflow web server
Team 1 namespace
Service Account
Resource Quota
Team 1 worker Pod
Team 1 worker Pod
Team 2 namespace
Service Account
Resource Quota
Team 2 worker Pod
Team 2 worker Pod
Team N namespace
Service Account
Resource Quota
Team 3 worker Pod
Team 3 worker Pod

How to improve PostgreSQL?

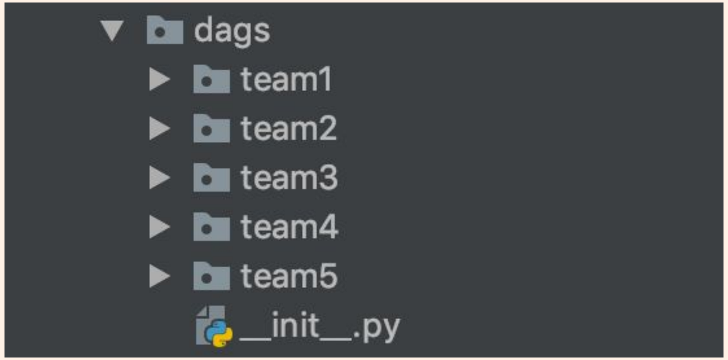
CHANGES

How to extend Airflow?

Redesign Airflow source code

Redesign Airflow source code

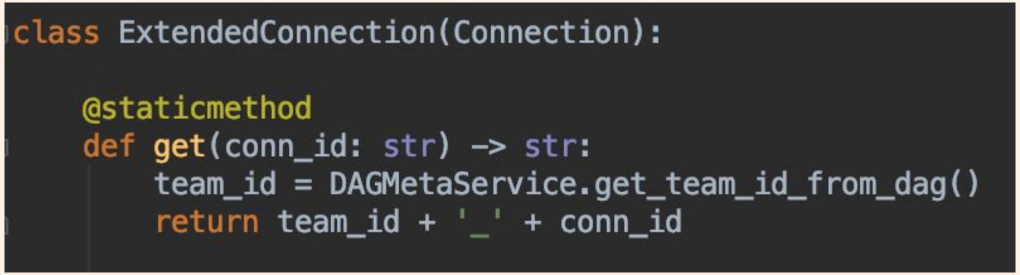
- Module per team



```
▼ dags
    ▶ team1
    ▶ team2
    ▶ team3
    ▶ team4
    ▶ team5
      __init__.py
```

Redesign Airflow source code

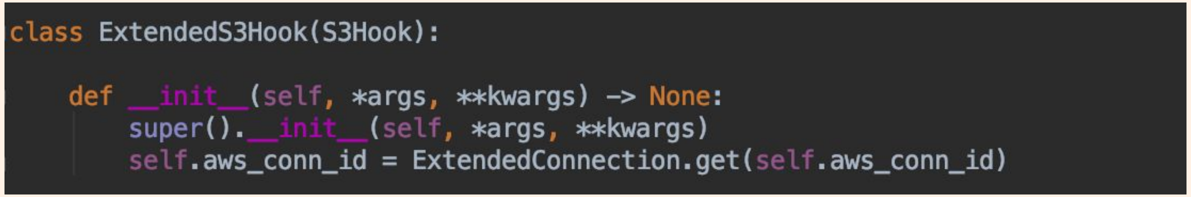
- Module per team
- Connections per team



```
class ExtendedConnection(Connection):

    @staticmethod
    def get(conn_id: str) -> str:
        team_id = DAGMetaService.get_team_id_from_dag()
        return team_id + '_' + conn_id
```

Redesign Airflow source code

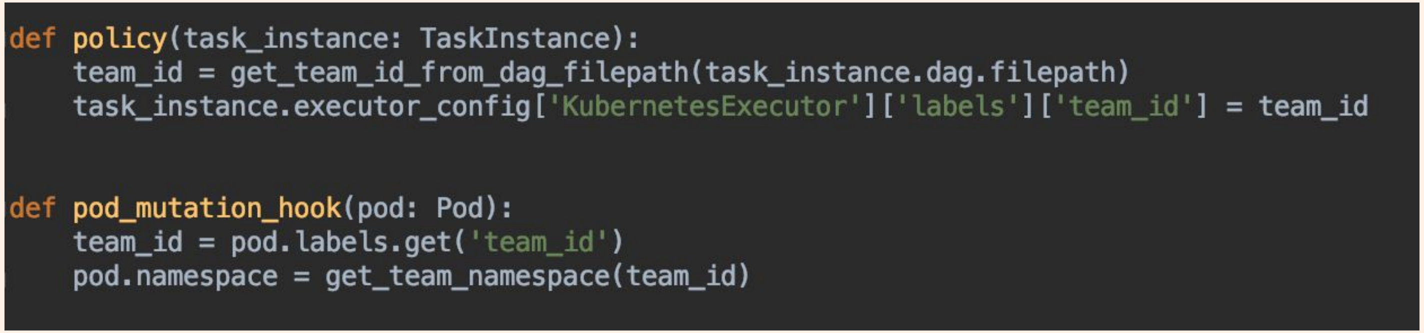
- Module per team
- Connections per team
- Extend hooks, operators and sensors



```
class ExtendedS3Hook(S3Hook):

    def __init__(self, *args, **kwargs) -> None:
        super().__init__(self, *args, **kwargs)
        self.aws_conn_id = ExtendedConnection.get(self.aws_conn_id)
```

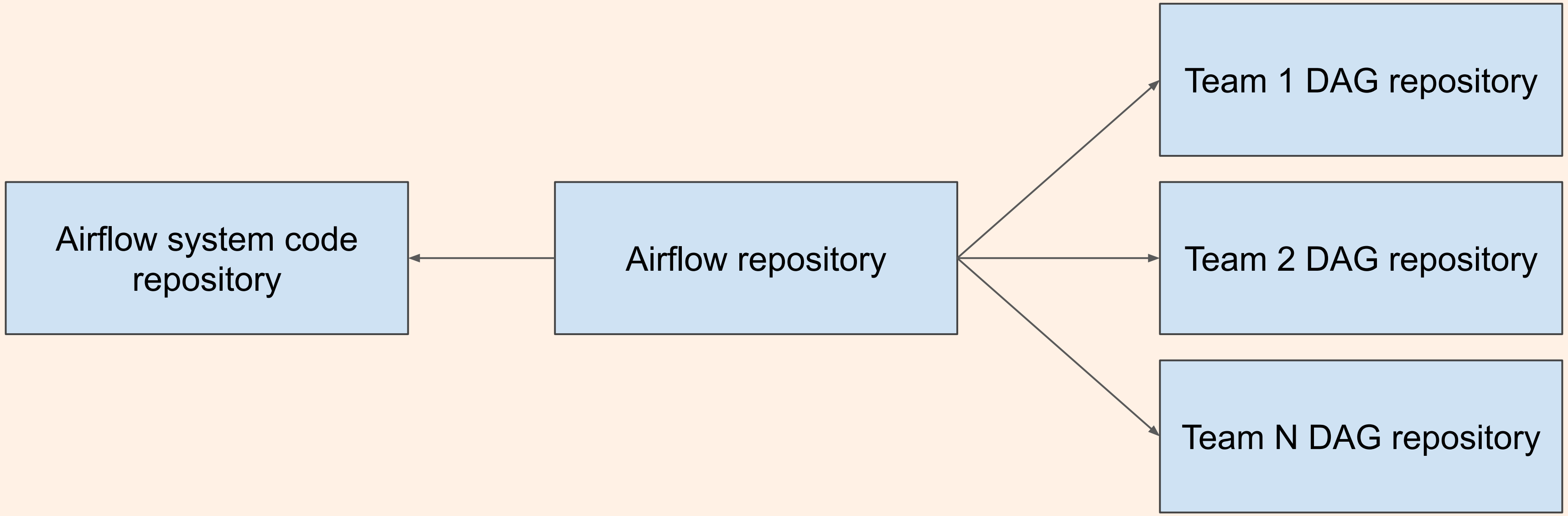
Redesign Airflow source code

- Module per team
- Connections per team
- Extend hooks, operators and sensors
- Use **airflow_local_settings.py**



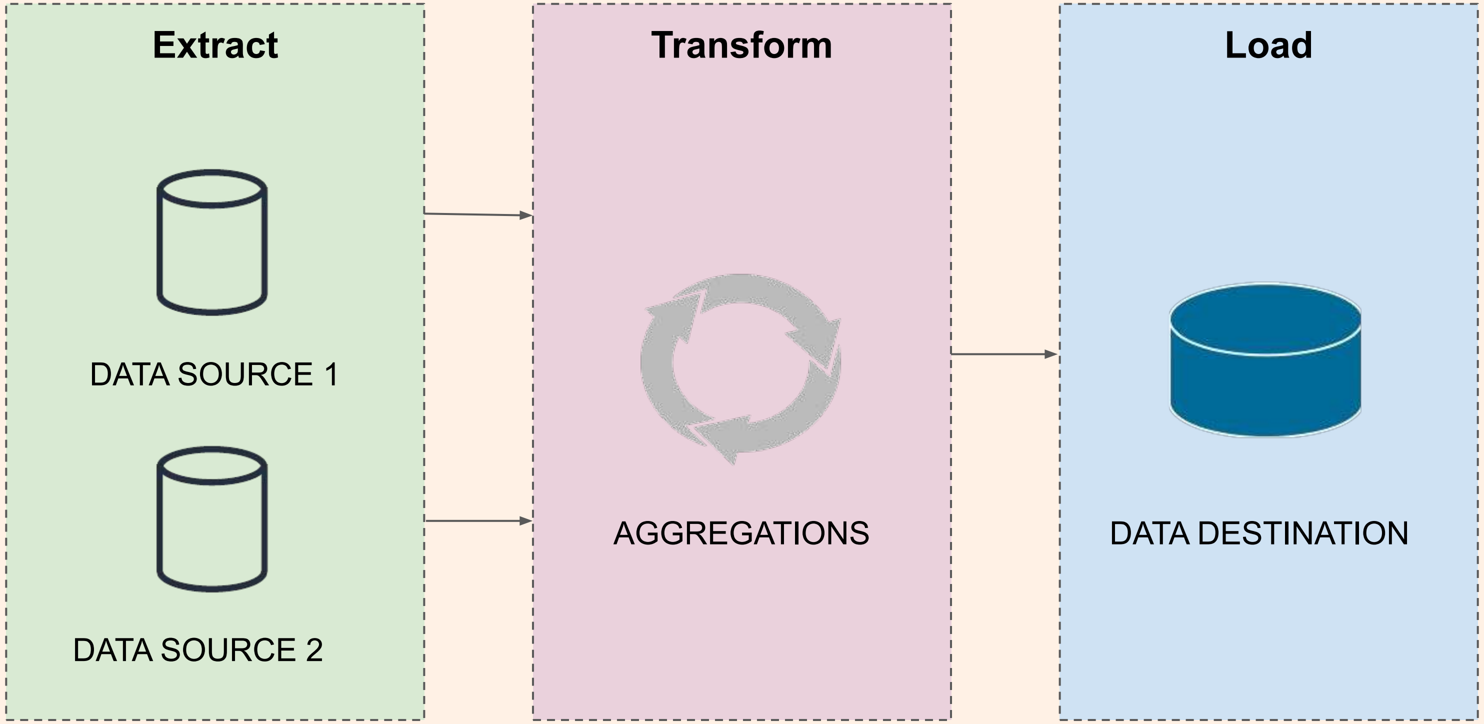
```
def policy(task_instance: TaskInstance):
    team_id = get_team_id_from_dag_filepath(task_instance.dag.filepath)
    task_instance.executor_config['KubernetesExecutor']['labels']['team_id'] = team_id


def pod_mutation_hook(pod: Pod):
    team_id = pod.labels.get('team_id')
    pod.namespace = get_team_namespace(team_id)
```

Redesign repository structure

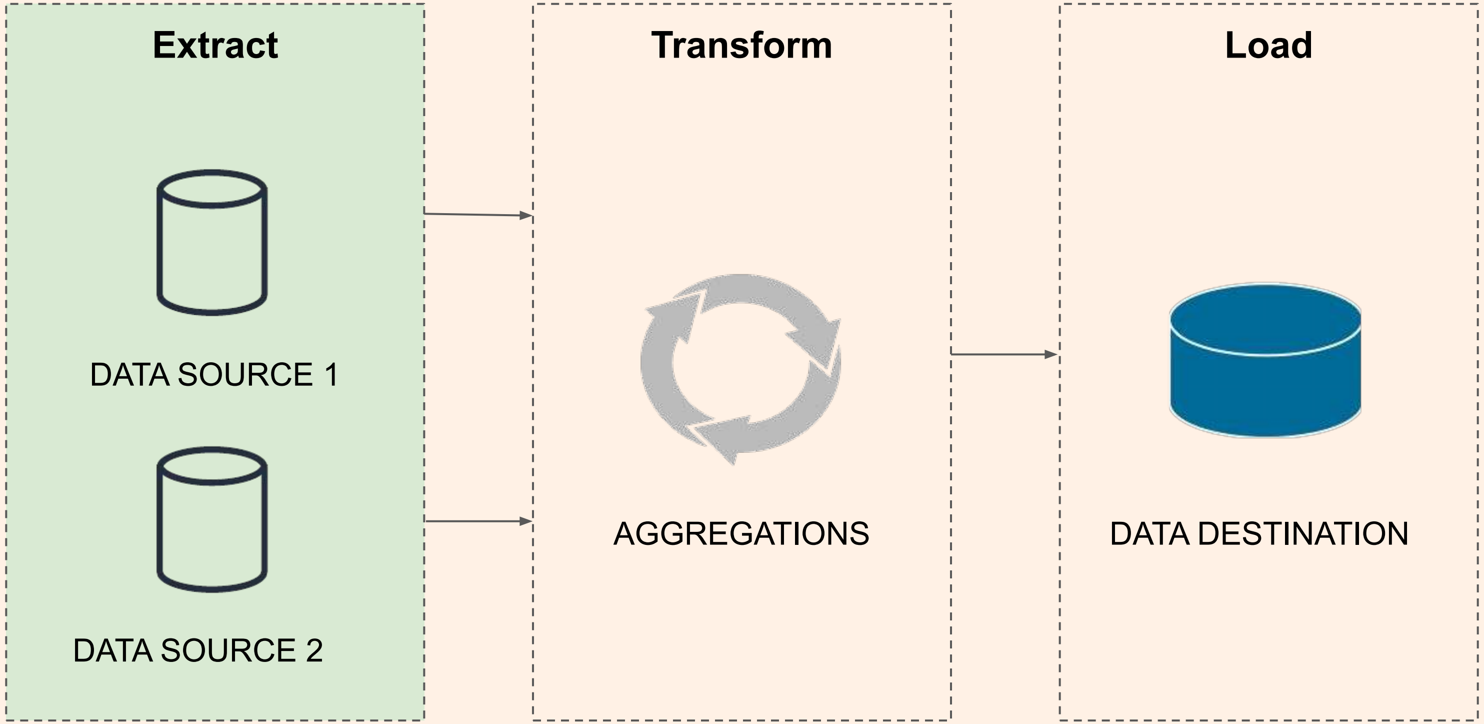


Execution environment in Kubernetes

ETL


Extract
DATA SOURCE 1
DATA SOURCE 2
Transform
AGGREGATIONS
Load
DATA DESTINATION

Extract


Extract
Transform
Load
DATA SOURCE 1
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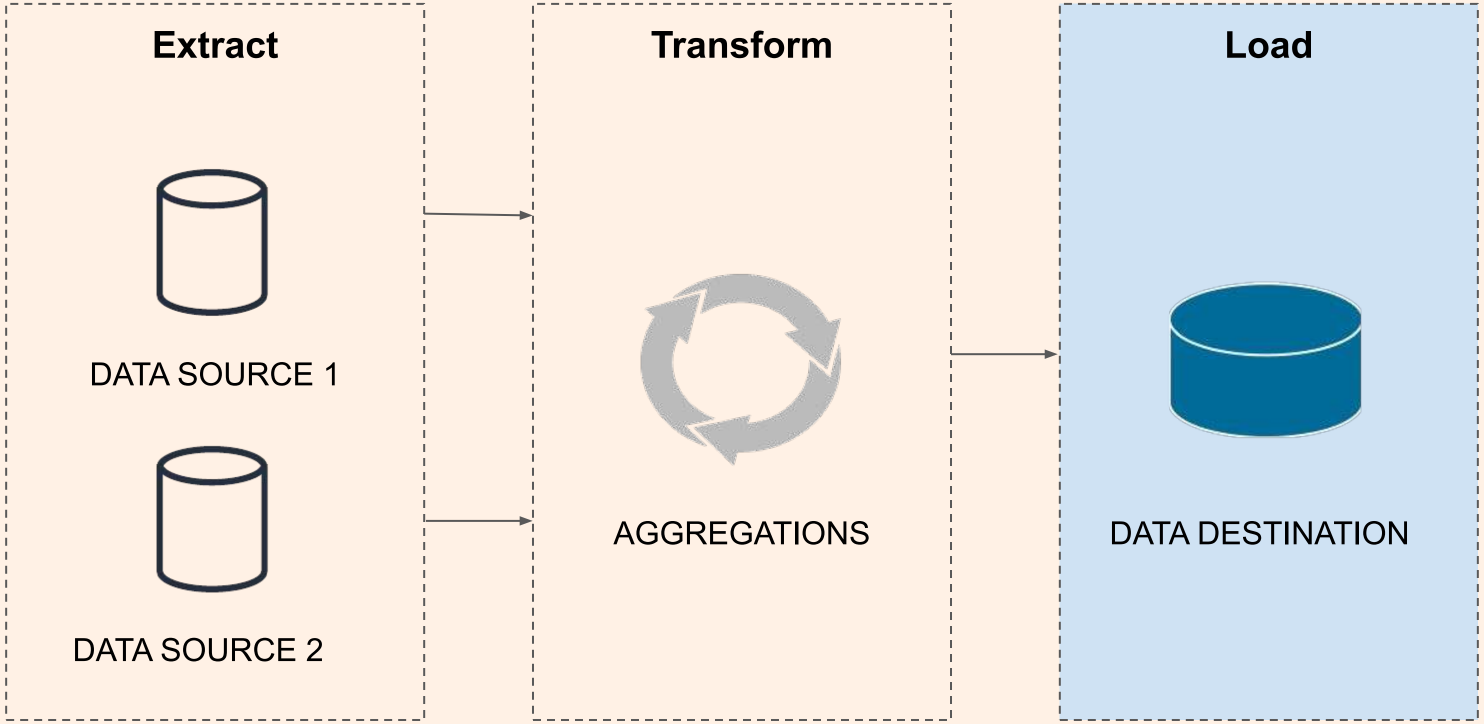
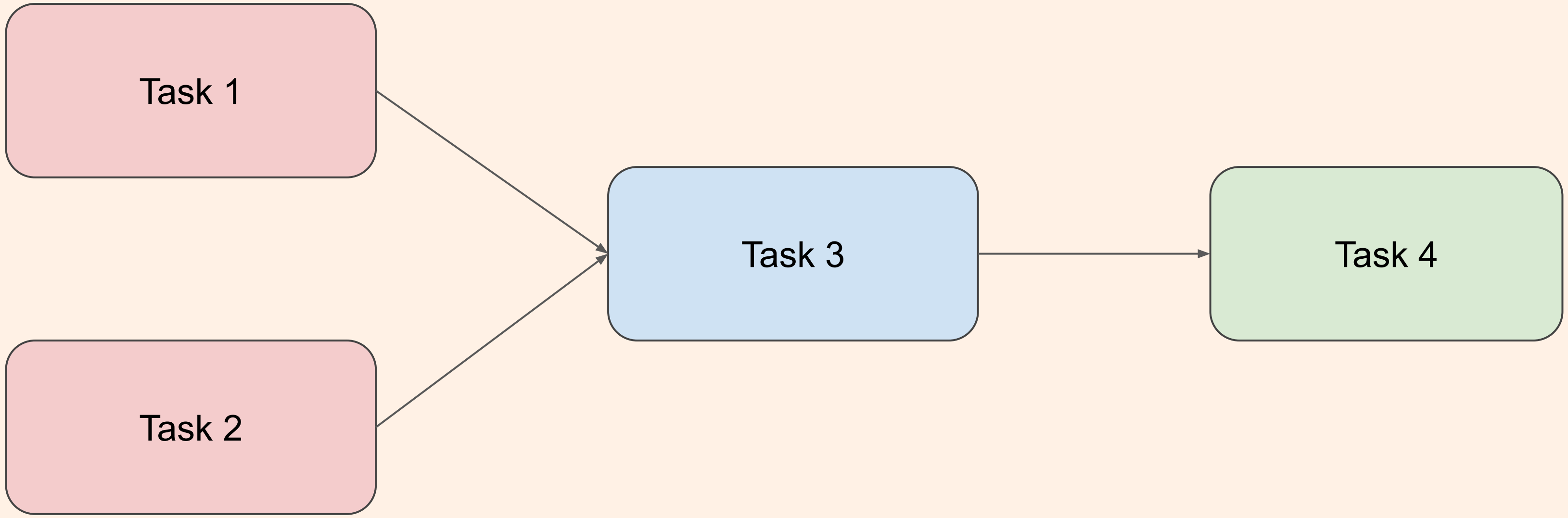
DATA DESTINATION

Load


Extract
DATA SOURCE 1
DATA SOURCE 2
Transform
AGGREGATIONS
Load
DATA DESTINATION

Transform?

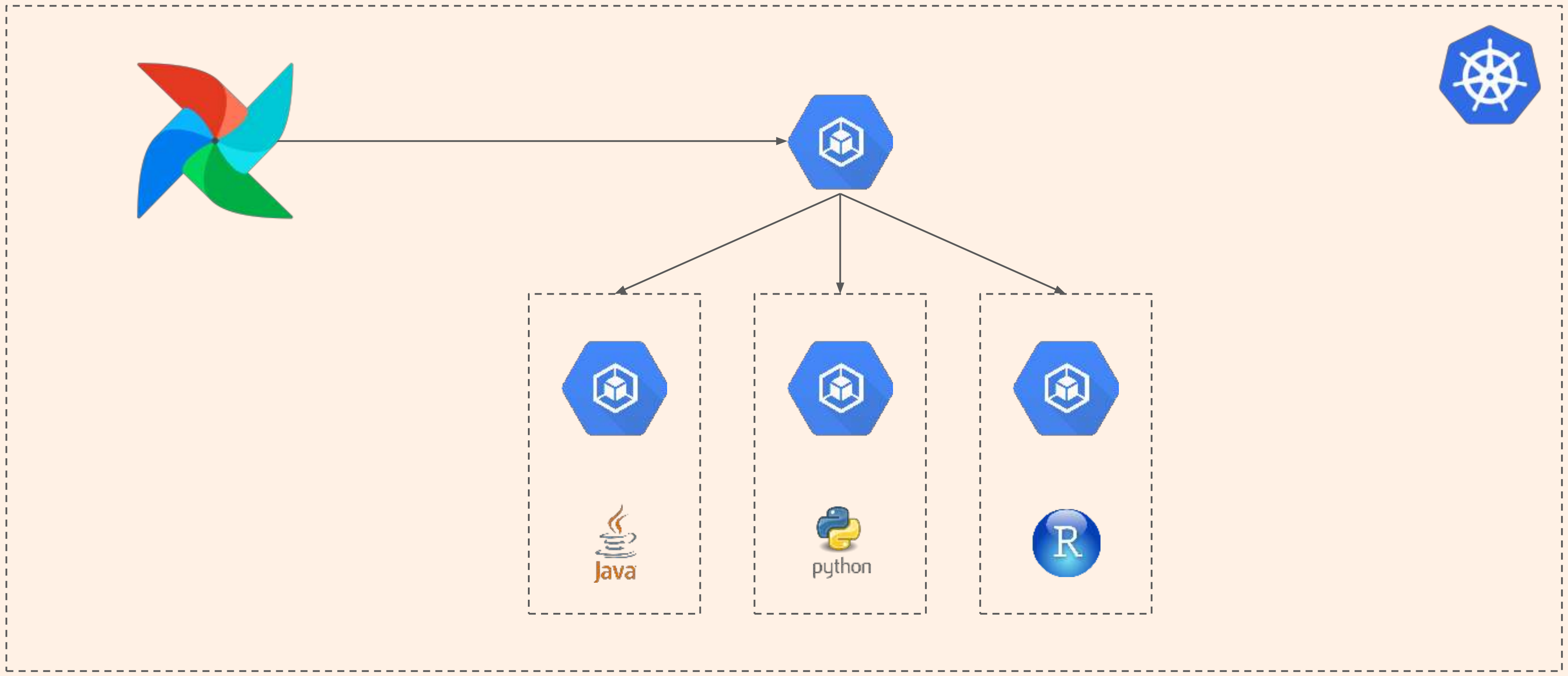
Example workflow



Our goals

- Language agnostic jobs
- Cross task data access

KubernetesPodOperator



Our goals

- ✓ Language agnostic jobs
- Cross task data access

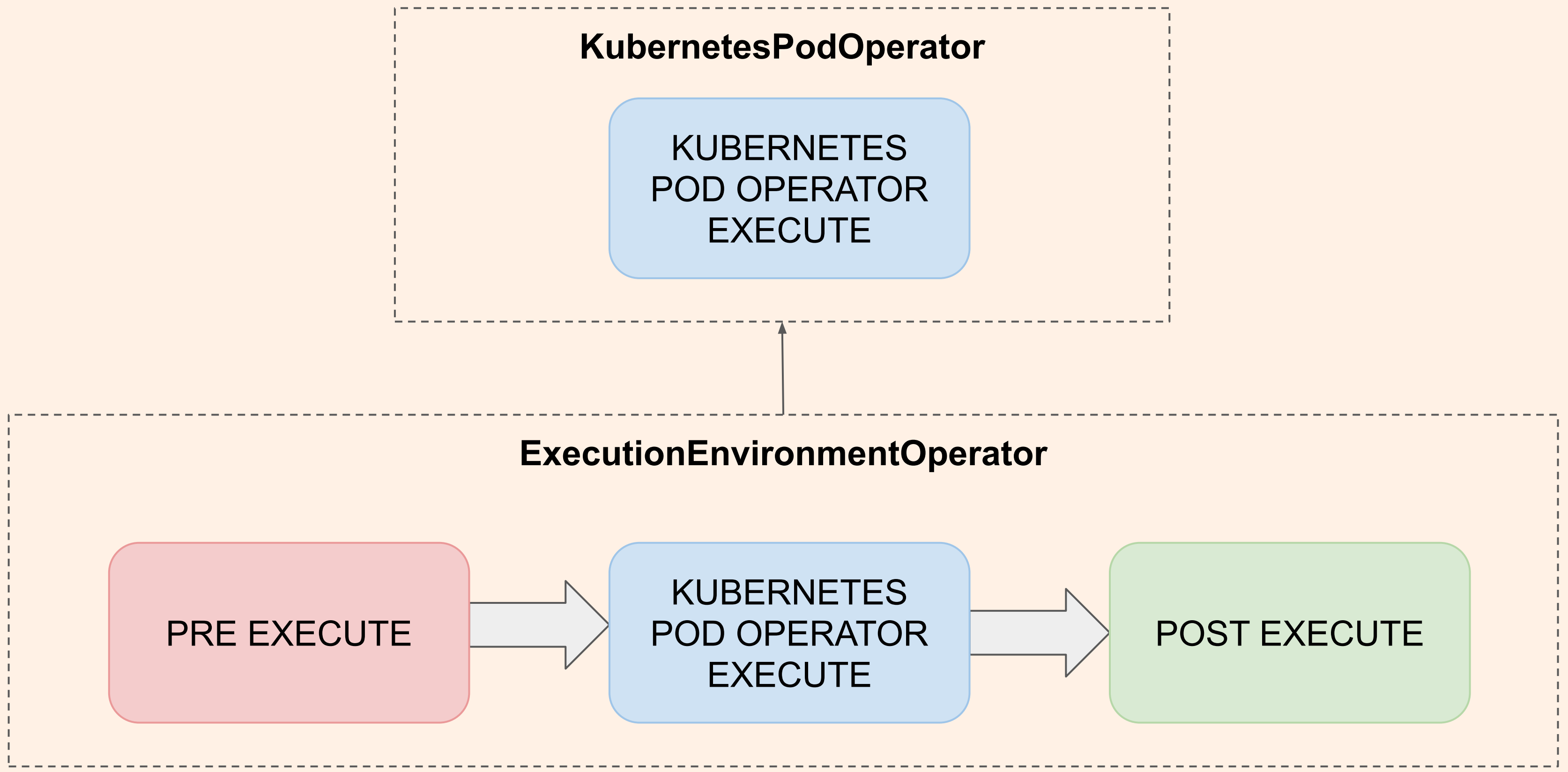
Unique storage pattern

- Unique team name from the multitenancy
- Unique DAG id
- Unique task id per DAG
- Unique execution date per DAG run

/{team}/{dag_id}/{task_id}/{execution_date}

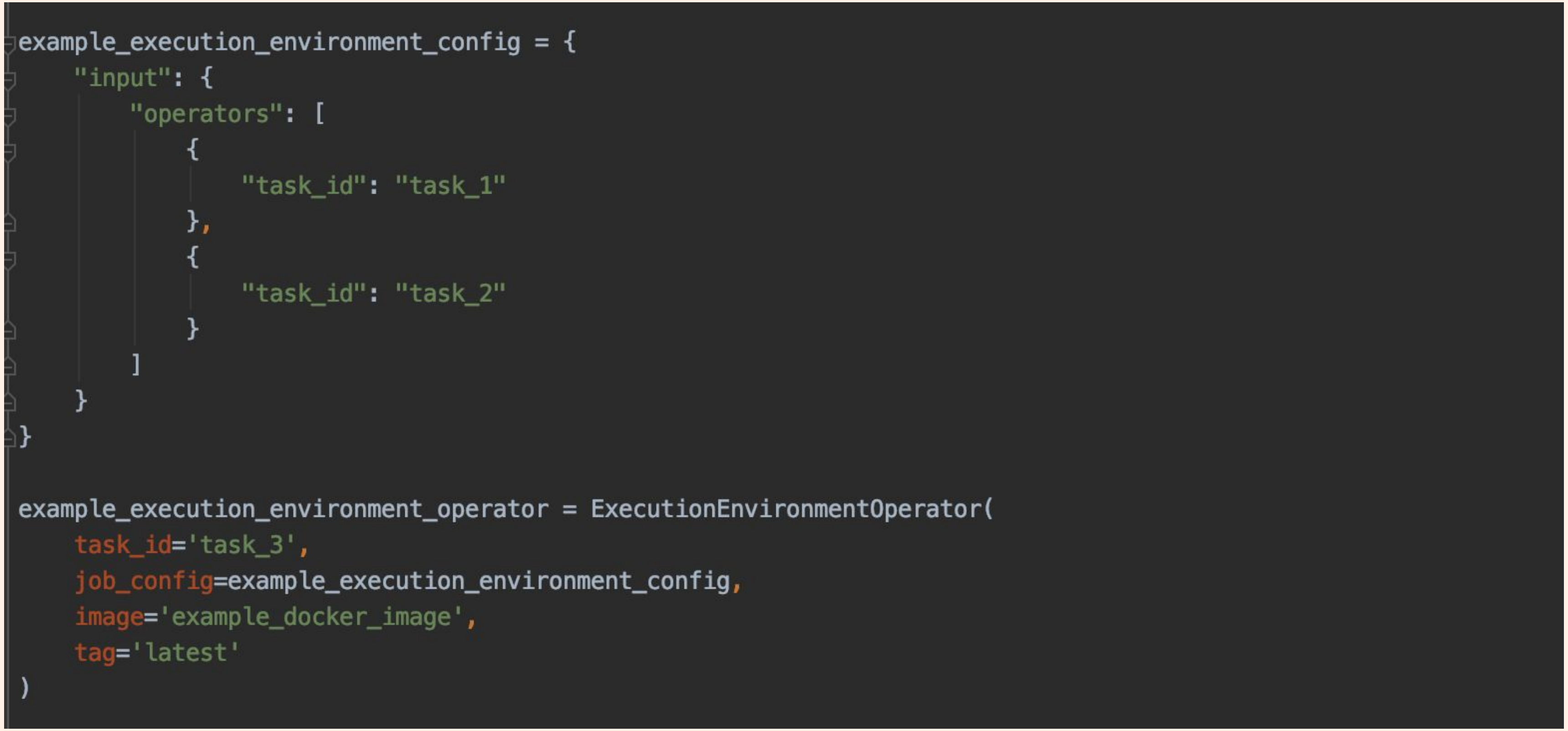
The power of extensibility

ExecutionEnvironmentOperator


KubernetesPodOperator
KUBERNETES POD OPERATOR EXECUTE
ExecutionEnvironmentOperator
PRE EXECUTE
KUBERNETES POD OPERATOR EXECUTE
POST EXECUTE

Configurable cross task data dependencies

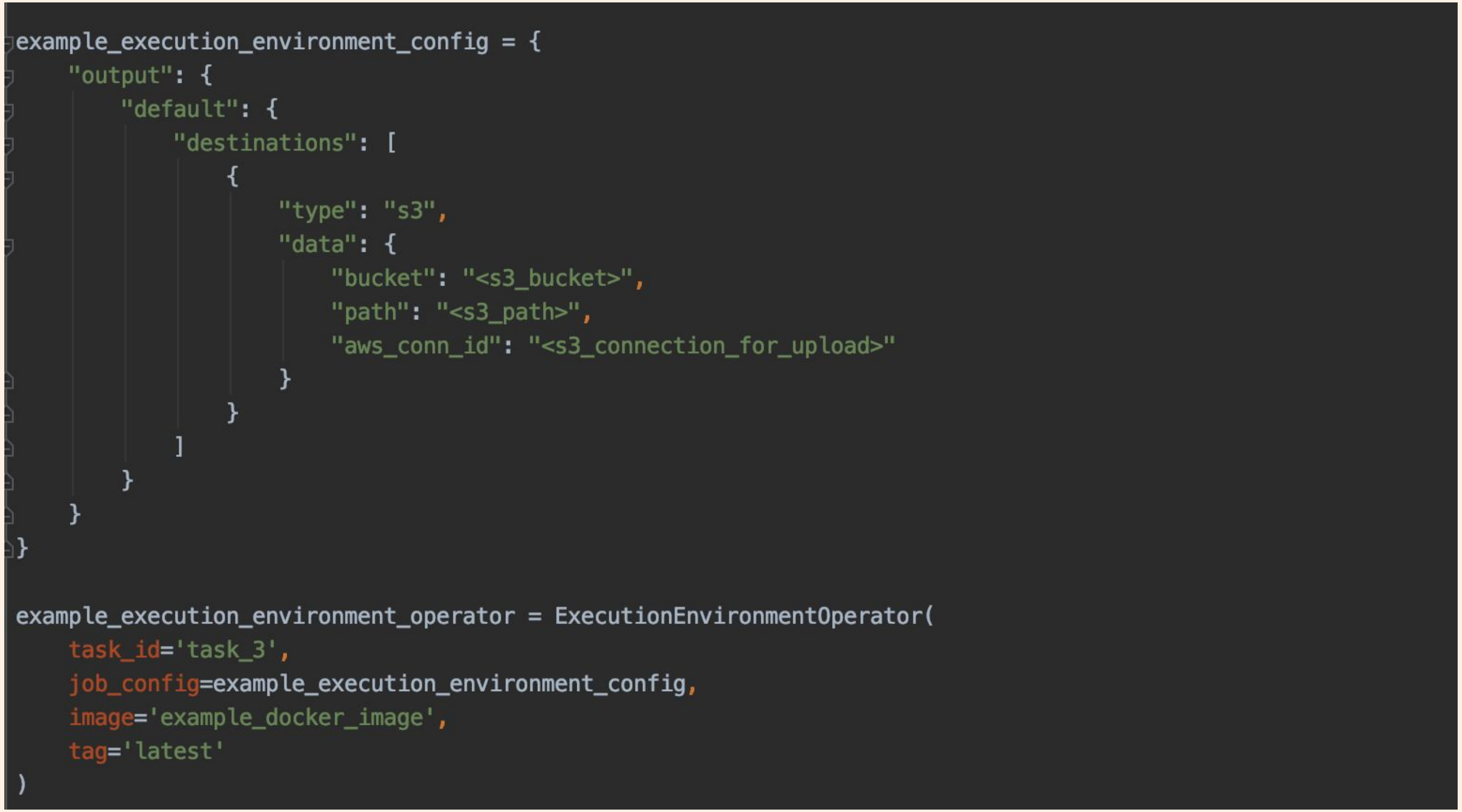
Example input configuration



```python
example_execution_environment_config = {
    "input": {
        "operators": [
            {
                "task_id": "task_1"
            },
            {
                "task_id": "task_2"
            }
        ]
    }
}

example_execution_environment_operator = ExecutionEnvironmentOperator(
    task_id='task_3',
    job_config=example_execution_environment_config,
    image='example_docker_image',
    tag='latest'
)
```

Example output configuration

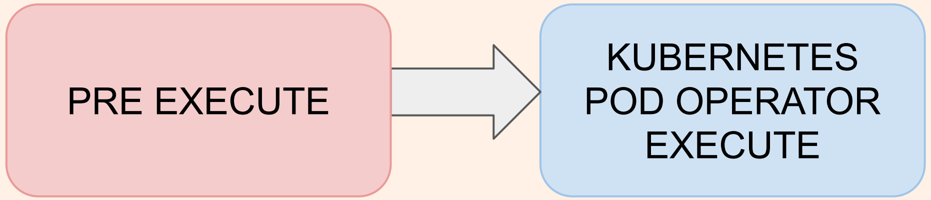


```
example_execution_environment_config = {
    "output": {
        "default": {
            "destinations": [
                {
                    "type": "s3",
                    "data": {
                        "bucket": "<s3_bucket>",
                        "path": "<s3_path>",
                        "aws_conn_id": "<s3_connection_for_upload>"
                    }
                }
            ]
        }
    }
}

example_execution_environment_operator = ExecutionEnvironmentOperator(
    task_id='task_3',
    job_config=example_execution_environment_config,
    image='example_docker_image',
    tag='latest'
)
```

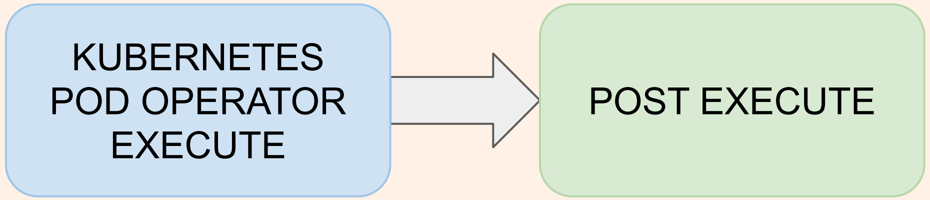
Pre-execute

- Bootstrap the environment
- Enrich the configuration
- Export the configuration to the execution environment pod

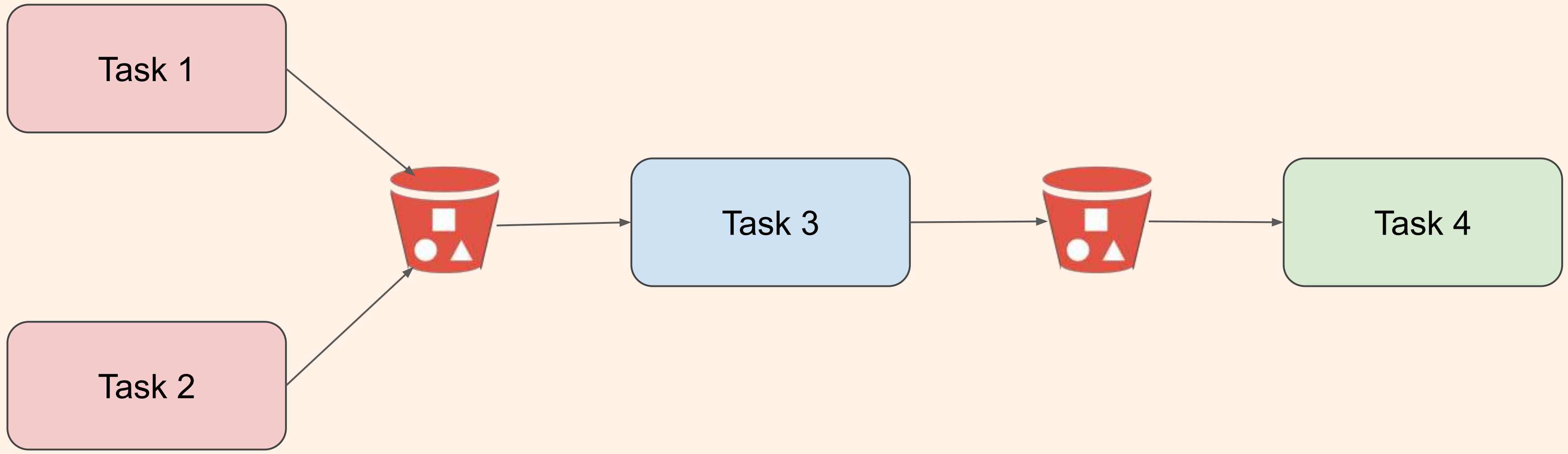


Post-execute

- Handle the execution
- Clear all bootstraps
- Deal with the output



POC with AWS S3 as intermediate storage



Is this efficient?

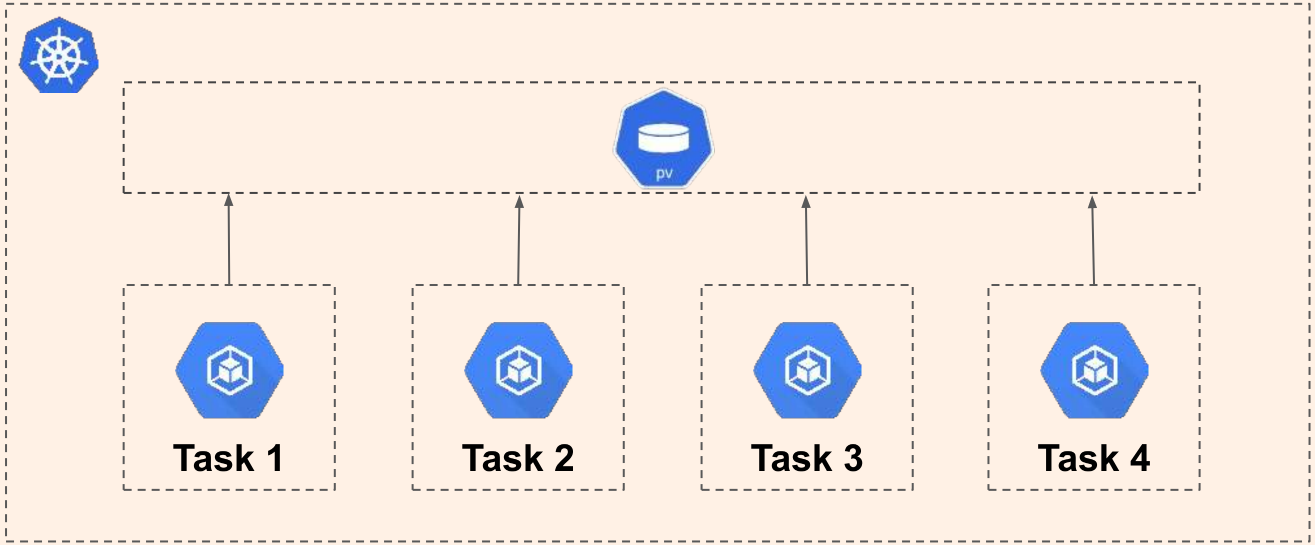
- ✗ Multiple downloads and uploads
- ✗ Single processing power
- ✗ Always loading the data in memory

How to evolve the execution environment?

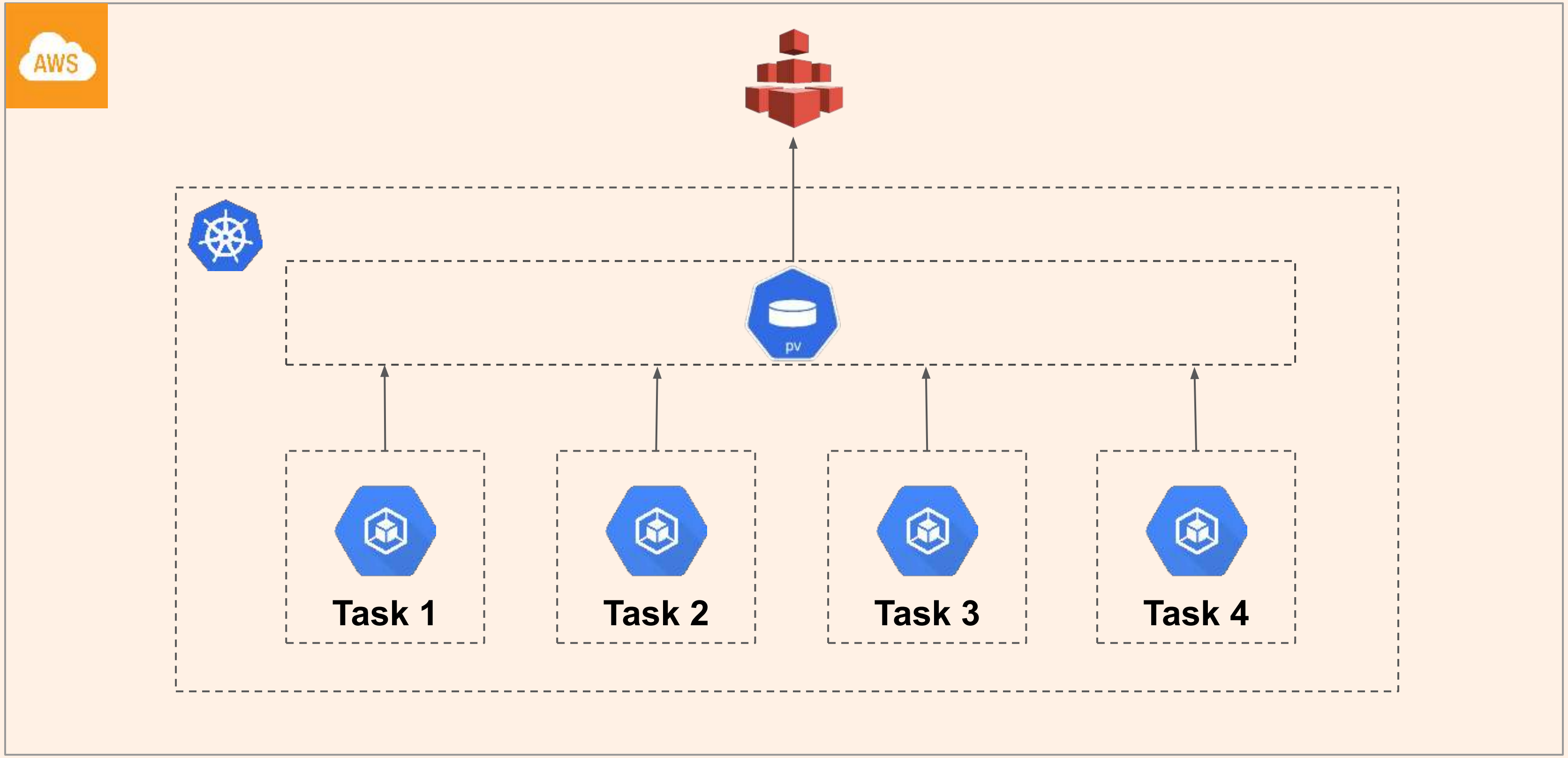
- Remove unnecessary data transfers
- Parallelize the processing
- Provide hot data access

Shared file system

Kubernetes persistent volume



Kubernetes persistent volume with EFS



So far so good

- ✓ Remove unnecessary data transfers
- Parallelize the processing
- Provide hot data access

One worker?

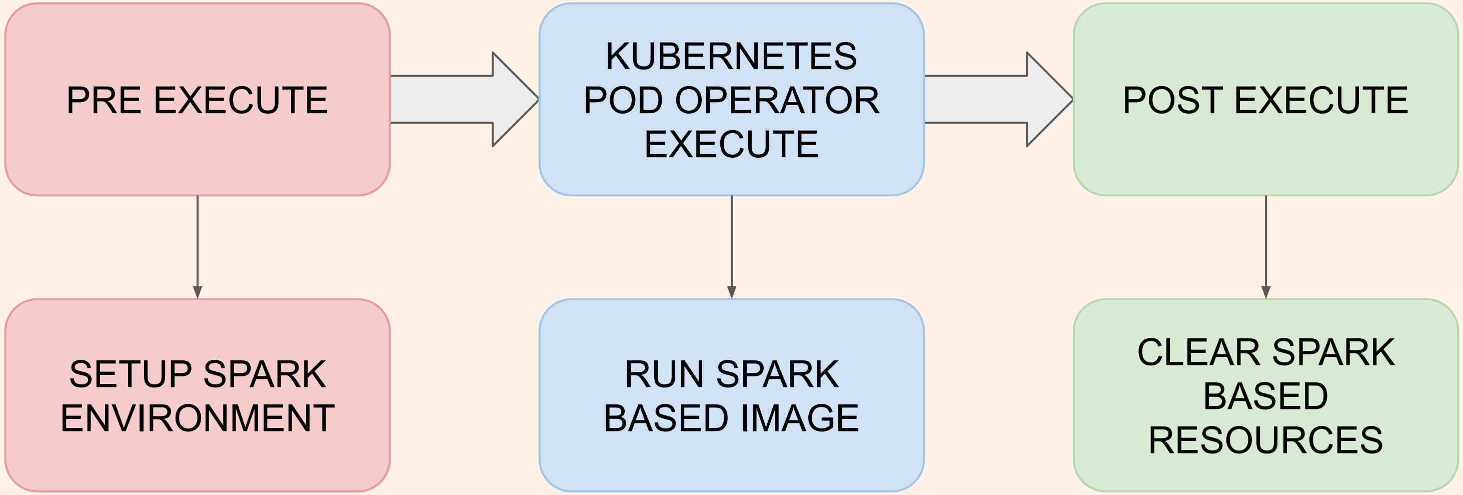
APACHE

Spark™

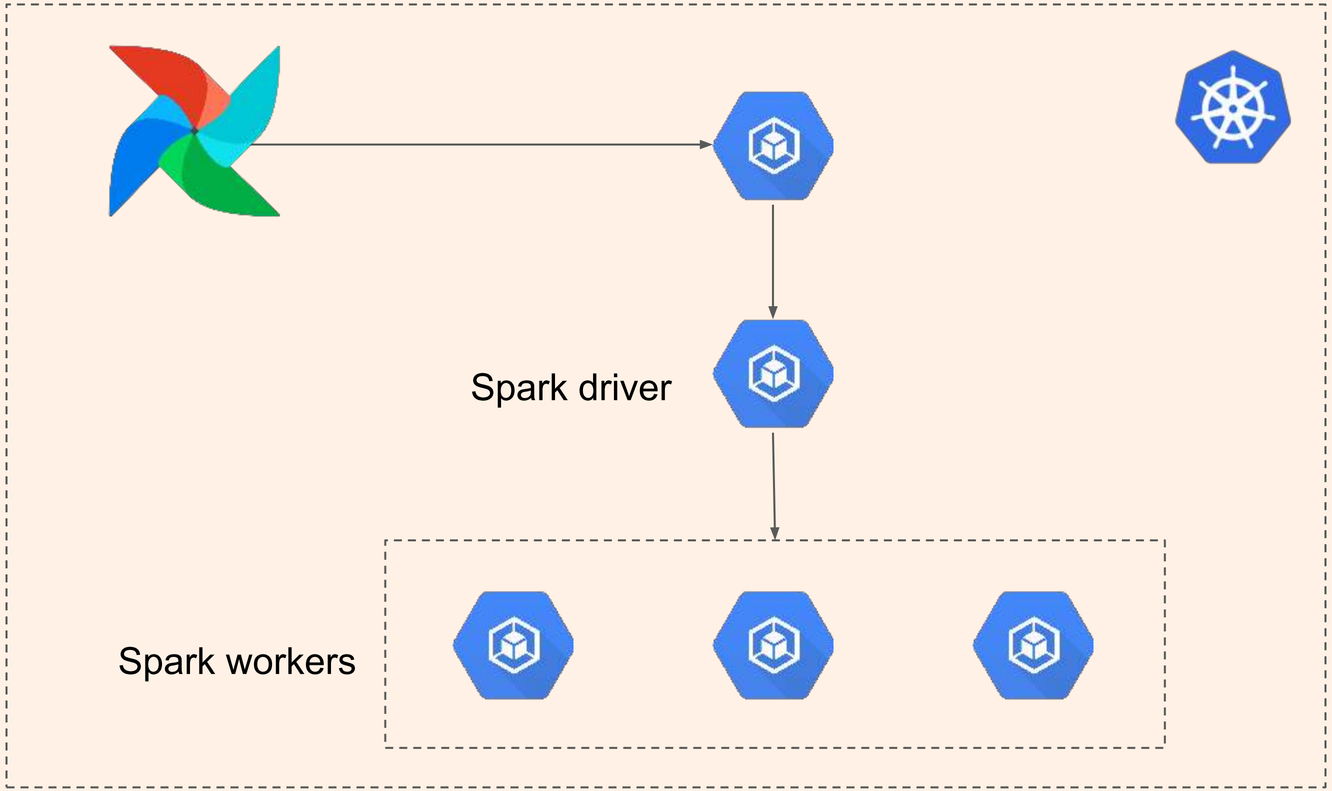
Benefits from Spark

- Runs perfectly in Kubernetes
- Supports many distributed storages
- Allows faster data processing
- Supports multiple languages
- Easy to use

SparkExecutionEnvironmentOperator



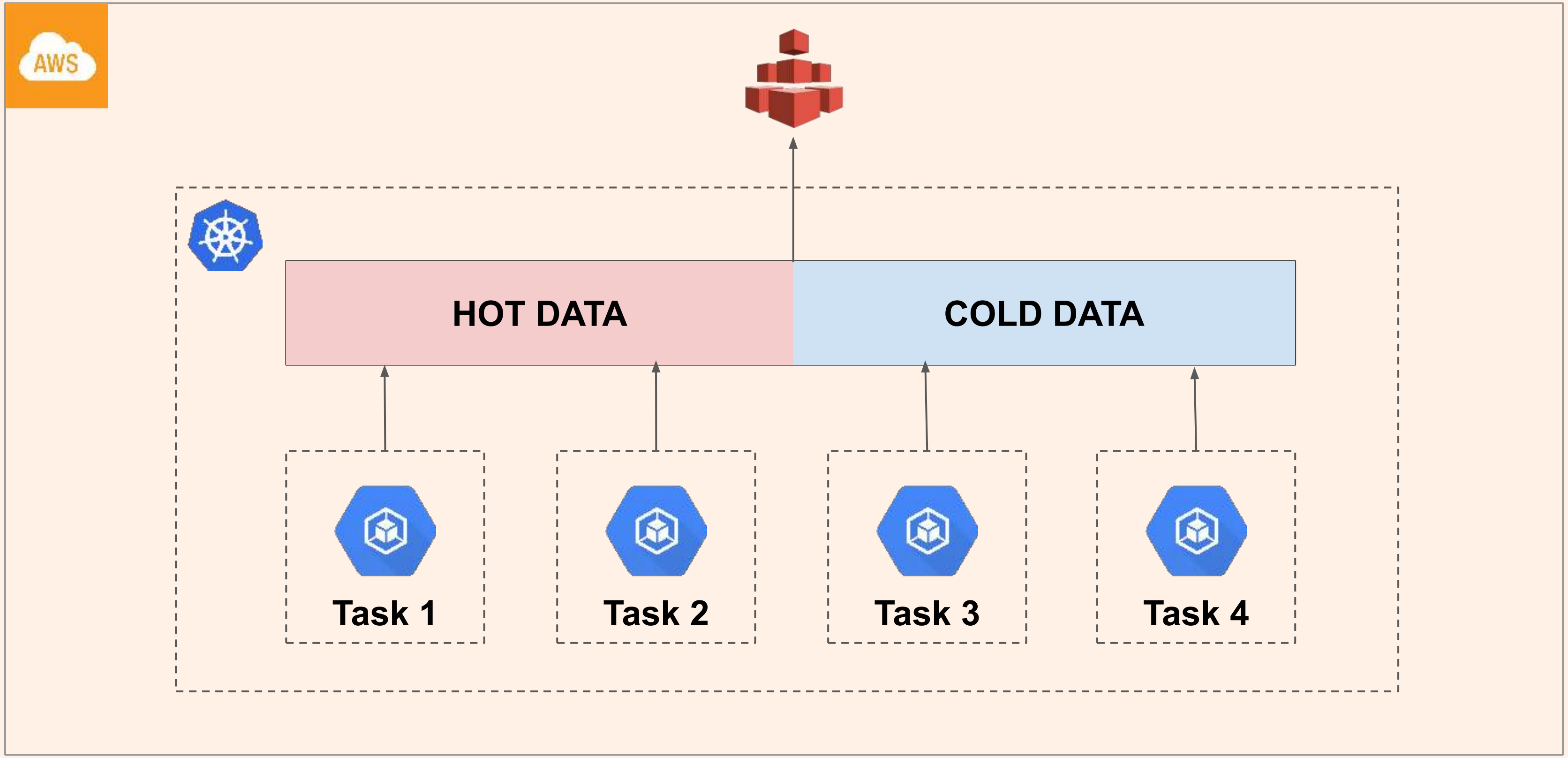
Spark execution environment



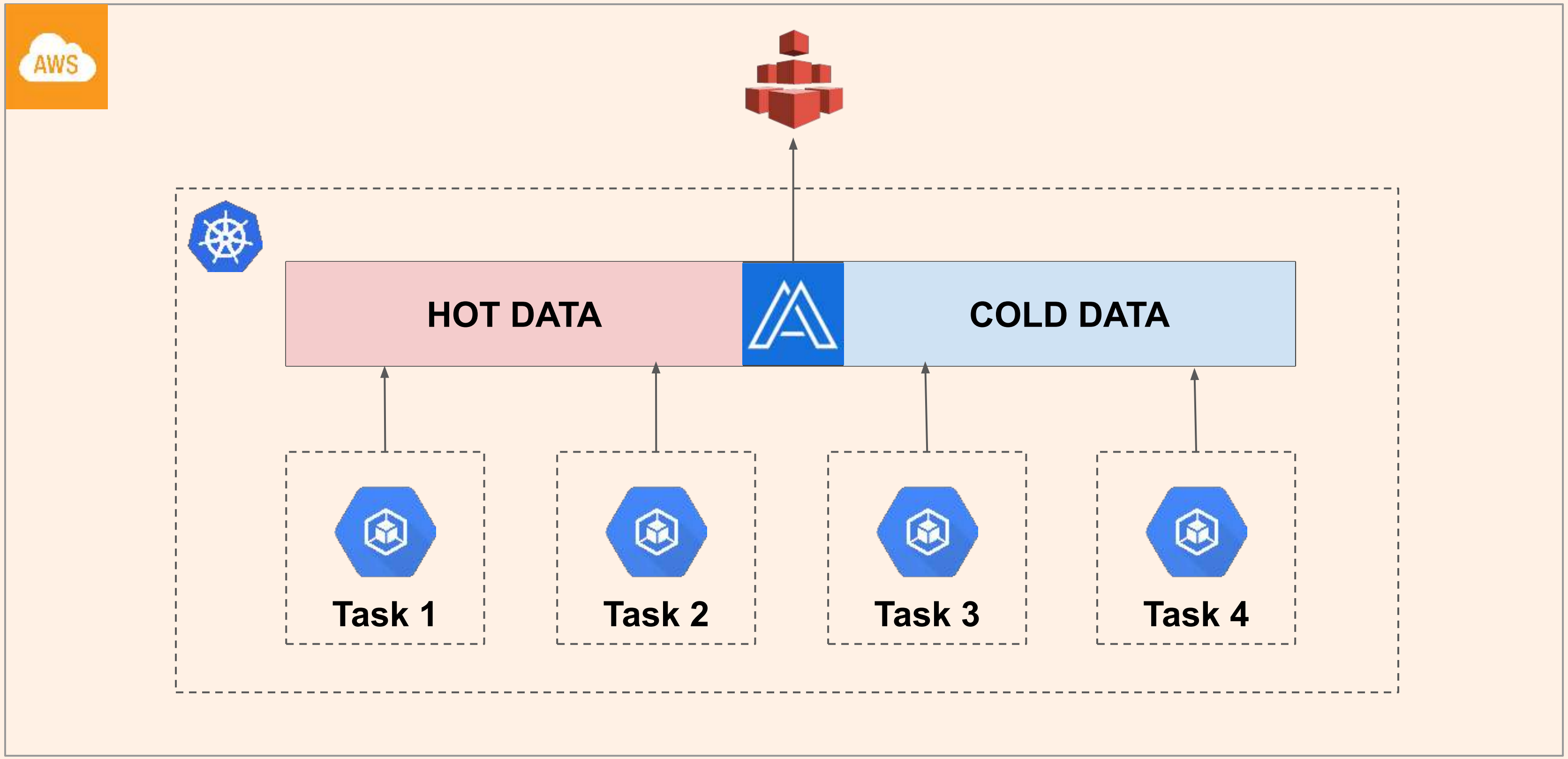
Our current state

- ✓ Remove unnecessary data transfers
- ✓ Parallelize the processing
- Provide hot data access

Hot & cold data



Alluxio



Thank you!

#apacheairflow