Airflow CI/CD: Github to Composer (easy as 1, 2, 3)

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Source:
https://github.com/jaketf/ci-cd-for-data-processing-workflow
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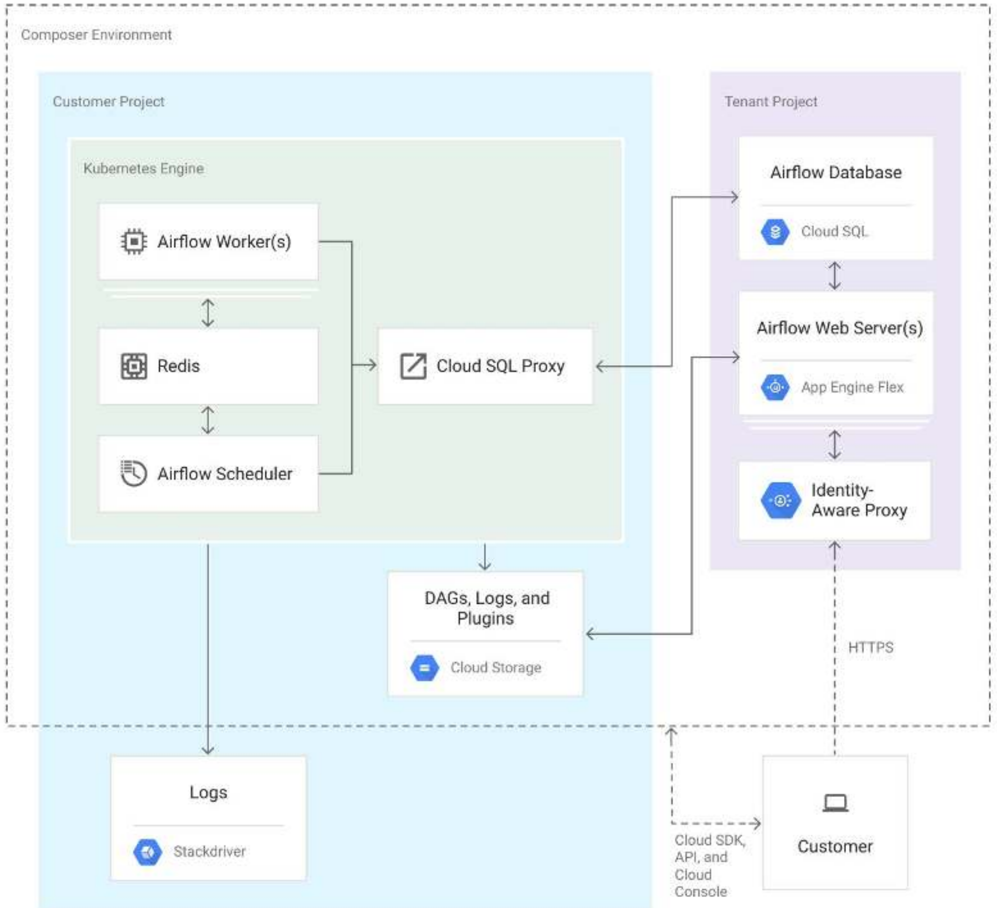
Composer Basics

Airflow Architecture

- Storage (GCS)
  - Code artifacts
- Kubernetes (GKE)
  - Workers
  - Scheduler
  - Redis (Celery Queue)
- AppEngine (GAE)
  - Webserver / UI
- Cloud SQL
  - Airflow Metadata Database



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GCS Directory mappings

GCS “folder”	Mapped Local Directory	Usage	Sync type
gs://{composer-bucket}/dags	/home/airflow/gcs/dags	DAGs (SQL Queries)	Periodic 1-way rsync (workers / web-server)
gs://{composer-bucket}/plugins	/home/airflow/gcs/plugins	Airflow plugins (Custom Operators / Hooks etc.)	Periodic 1-way rsync (workers / web-server)
gs://{composer-bucket}/data	/home/airflow/gcs/data	Workflow-related data	GCSFUSE (workers only)
gs://{composer-bucket}/logs	/home/airflow/gcs/logs	Airflow task logs (should only read)	GCSFUSE (workers only)

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Testing Pipelines

1

CI/CD for Composer == CI/CD for everything it Orchestrates

- Often Airflow is used to manage a series of tasks that themselves need a CI/CD Process
    - ELT Jobs: BigQuery
        - dry run your SQL, unit test your UDFs
        - deploy SQL to dags folder so parseable by workers and webserver
    - ETL Jobs: Dataflow / Dataproc Jobs
        - run unit tests and integration tests with a build tool like maven.
        - deploy artifacts (JARs) to GCS

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DAG Sanity Checks

- Python Static Analysis (flake8)
- Unit / Integration tests on custom operators
- Unit test that runs on all DAGs to assert best practices / auditability across your team.
- Example Source `test_dag_validation.py`:
    - DAGs parse w/o errors
        - catches a plethora of common “referencing things that don’t exist errors” e.g. files, Variables, Connections, modules, etc.
    - DAG Parsing < threshold (2 seconds)
    - No dags in running_dags.txt missing or ignored
    - (opinion) Filename == Dag ID for tracability
    - (opinion) All DAGs have an owners email with your domain name.

Inspired by: “Testing in Airflow Part 1 — DAG Validation Tests, DAG Definition Tests and Unit Tests” - Chandu Kavar

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Integration Testing with Composer

- A popular failure mode for a DAG is referring to something in the target environment that does not exist:
  - Airflow Variable
  - Environment Variable
  - Connection ID
  - Airflow Plugin
  - pip dependency
  - SQL / config file expected on workers' / webserver's filesystem
- Most of these can be caught by staging DAGs in some directory and running `list_dags`
  - In Composer we can leverage the fact that the `data/` path on GCS is synced to the workers' local file system

```
$ gsutil -m cp ./dags \
    gs://<composer-bucket>/data/test-dags/<build-id>


$ gcloud composer environments run \
    <environment> \
    list_dags -- -sd \
    /home/airflow/gcs/data/test-dags/<build-id>/
```

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Deploying DAGs to Composer

2

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Deploying a DAG to Composer: High-Level

1. Stage all artifacts required by the DAG
   a. JARs for Dataflow jobs to known location GCS
   b. SQL queries for BigQuery jobs (somewhere under `dags/` folder and ignored by `.airflowignore`)
   c. Set Airflow Variables referenced by your DAG
2. (Optional) delete old (versions of) DAGs
   a. This should be less of a problem in an airflow 2.0 world with DAG versioning!
3. Copy DAG(s) to GCS `dags/` folder
4. Unpause DAG(s) (assuming best practice of `dags_paused_on_creation=True`)
   a. New Challenge: But now I have to unpause each DAG which sounds exhausting if deploying many DAGs at once
   b. This may require a few retries during the GCS -> GKE worker sync. Enter `deploydags` application...

Deploying a DAG to Composer: deploydags app

A simple golang application to orchestrate the deployment and sunsetting of DAGs by taking the following steps:

= airflow CLI
* = Need for concurrency

1. list_dags
2. compare to a running_dags.txt config file of what "should be running"
   a. Allows you to keep a DAG in VCS you don't wish to
3. validate that running DAGs match source code in VCS
   a. GCS filehash comparison
   b. (Optional) -replace Stop and redeploy new DAG with same name
4. * Stop DAGs
   a. pause
   b. delete source code from GCS
   c. * delete_dag
5. * Start DAGs
   a. Copy DAG definition file to GCS
   b. * unpause

Need to concurrency to stop / deploy many DAGs quickly

Need to be retried (for minutes not seconds) until successful due to GCS -> worker rsync process

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Stitching it all together with Cloud Build

3

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Cloud Build is not perfect!

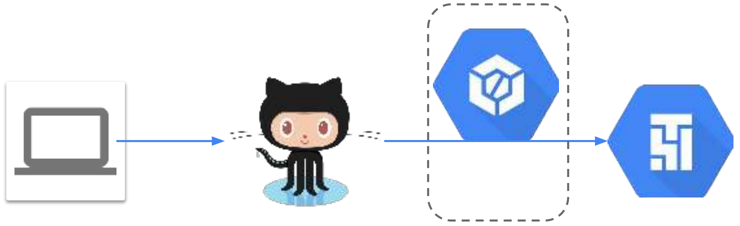
- Most of the tooling built for this talk is not Cloud Build specific :) bring it into your favorite CI tooling

- Cloud Build is great
  - Managed / no-ops / serverless (easy to get started / maintain compared to more advanced tooling like Jenkins / Spinnaker etc.)
  - Better than nothing
  - No need to contract w/ another vendor

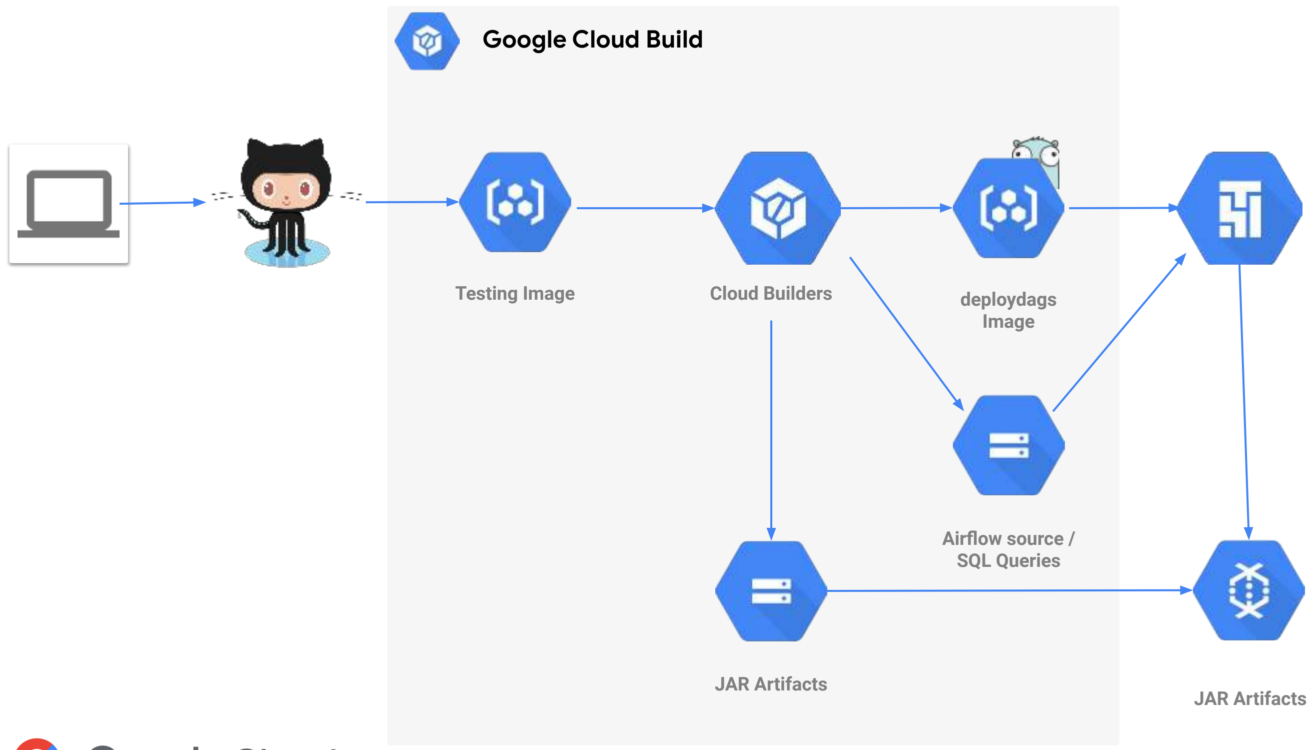
- Cloud Build has painful limitations for being a full CI solution:
  - Only /gcbrun triggers
    - not easy to have multiple test suites gated on different reviewer commands
  - No out of the box advanced queueing mechanics for preventing parallel builds
  - Does not have advanced features around “rolling back” (though you can always revert to old commit and run the build again)
  - Does not run in your network so need some public access to Airflow infrastructure (e.g. public GKE master or through bastion host)

Cloud Build with Github Triggers

- Github Triggers allow you to easily run integration tests on a PR branch
  - Optionally gated with “/gcbrun” comment from a maintainer.
    - Pre-commit automatically runs
    - Post-commit comment gated
- Cloud Build has convenient Cloud Builders for
  - Building artifacts
    - Running mvn commands
    - Building Docker containers
  - Publishing Artifacts to GCS / GCR
    - JARs, SQL files, DAGs, config files
  - Running gcloud commands
  - Running tests or applications like deploydags in containers



Cloud Build with Github Triggers for CI



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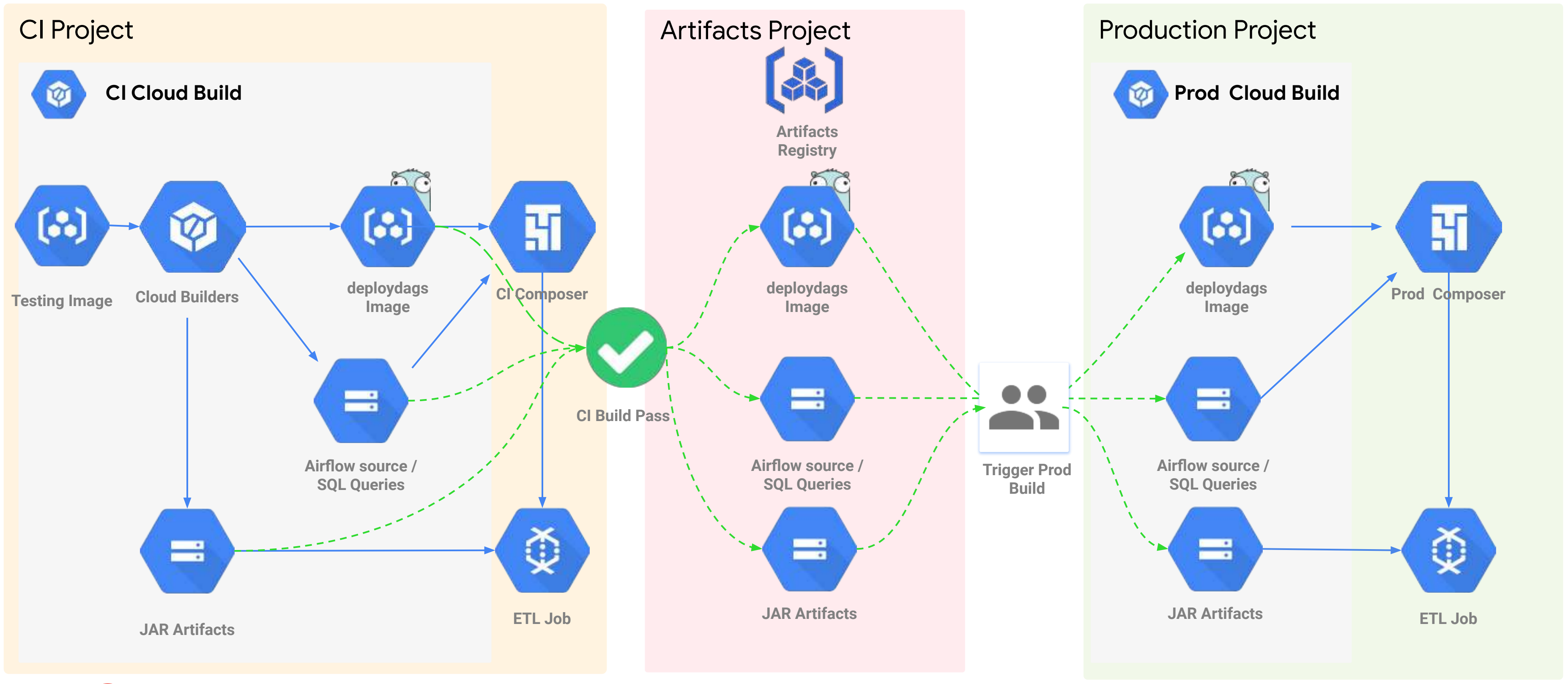
Isolating Artifacts and Push to Prod



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Cloud Build Demo

- Let’s validate a PR to Deploy N new DAGs that orchestrate BigQuery jobs and Dataflow jobs
  - Static Checks (runs over whole repo)
  - Unit tests (defined in precommit_cloudbuild.yaml in each dir which is run by `run_relevant_cloudbuilds.sh` if any files in this dir were touched)
  - Deploy necessary artifacts to GCS / GCR
  - DAG parsing tests (w/o error and speed)
  - Integration tests against target Composer Environment
  - Deploy to CI Composer Environment
- This similar cloudbuild.yaml could be invoked with substitutions for the production environment values for deploy to prod (pulling the artifacts from the artifact registry project).
- Source: https://github.com/jaketf/ci-cd-for-data-processing-workflow

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Future Work

3+

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Future Work

- CI Composer shouldn't cost this much and we need to Isolate CI tests
  - Ephemeral composer CI environments per test (SLOW)
    - Working hours CI environments though… :)
  - Acquire a "Lock" on the CI environment and queue ITs so they don't stomp on each other
    - Require a "wipeout CI environment" automation to reset the CI environment
- Security
  - Support deployments with only Private IP
  - Add support for managing airflow connections with CI/CD
- Portability
  - Generalize deploydags to run airflow cli commands with go client k8s exec to make this useful for non-composer deployments
- Examples
  - Different DAGs in different environments w/ multiple running_dags.txt configs (or one yaml)
  - Support "DAGs to Trigger" for DAGs that run system tests and poll to assert success
  - BigQuery EDW DAGs
  - Publish Solutions Page & Migrate repo to Google Cloud Platform GitHub Org

Contributions and Suggestions Welcome! Join the conversation in GitHub Issues
And join the community conversation on the new #airflow-ci-cd Slack Channel!

Thank you!

Special thanks to:

1. Google Cloud Professional Services for enabling me to work on cool things like this
2. Ben White for requirements and initial feedback
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