ArgoCon

Mastering Argo Workflows at Scale: A Practical Guide to Scalability Excellence

Tim Collins - Pipekit | Alec Stansell - Fetch Analytics

INTROS

Tim Collins

Senior Infrastructure Engineer @ Pipekit.io

- Argo Maintainer. Lives in the CNCF Argo Slack.
- Member of the Pipekit Services team.
- Growing a moustache to annoy his wife.

Alec Stansell

Data Scientist @ FetchAnalytics.ai

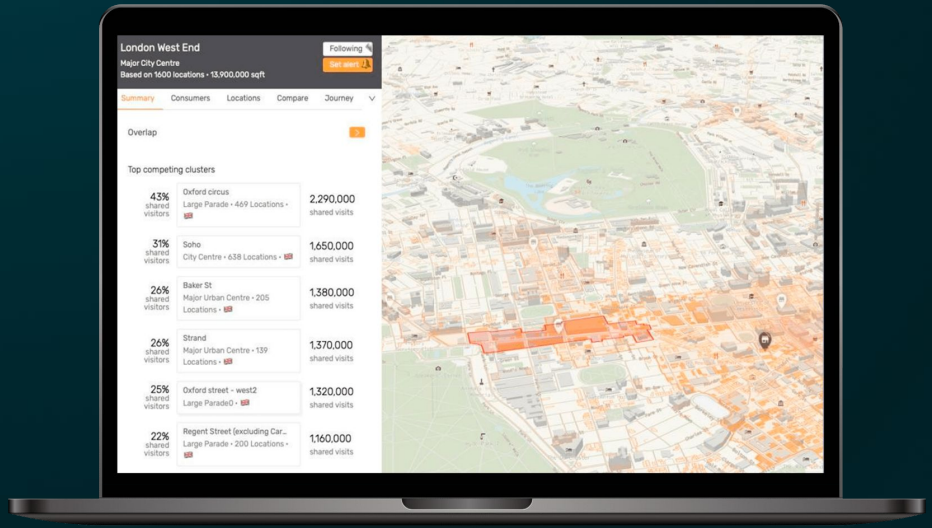
- Optimising Argo Workflows past 6 months.
- Water industry, HPC, Data Engineering
- Painting, Free Diving, Gypsy Jazz

PIPEKIT

- Argo experts & maintainers
- Save engineering time and up to 60% on compute costs
- Add a team of 3 Argo maintainers & 5 Argo contributors to your Slack
- Serving startups & Fortune 500 enterprises since 2021:
  - Enterprise Support for Argo -> Ideal for Platform Eng teams scaling with Argo
  - Control Plane for Argo Workflows -> Ideal for Data teams who don't speak K8s OR multi-cluster setups

FETCH ANALYTICS

- How people interact with the physical world.
- Metrics: journeys, dwell time, popular locations.
- Coffee shop.
- UK, Sweden, Spain, Netherlands, South Africa.
- Scaling

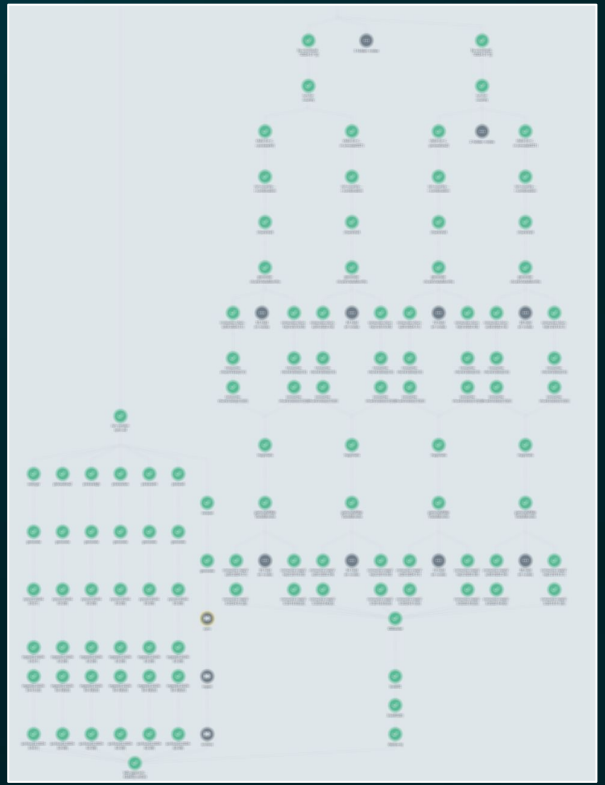


ARGO WORKFLOWS AT FETCH ANALYTICS

- Core of our business
  - > 500 billion records twice a week.
  - Algorithms deriving mobility patterns.
  - Long running 16 hours.

- Problem:
  - Unreliable.
  - Feeling that it could be faster.
  - Limited transparency of what's going on.

- Share practical insights when scaling your pipeline.

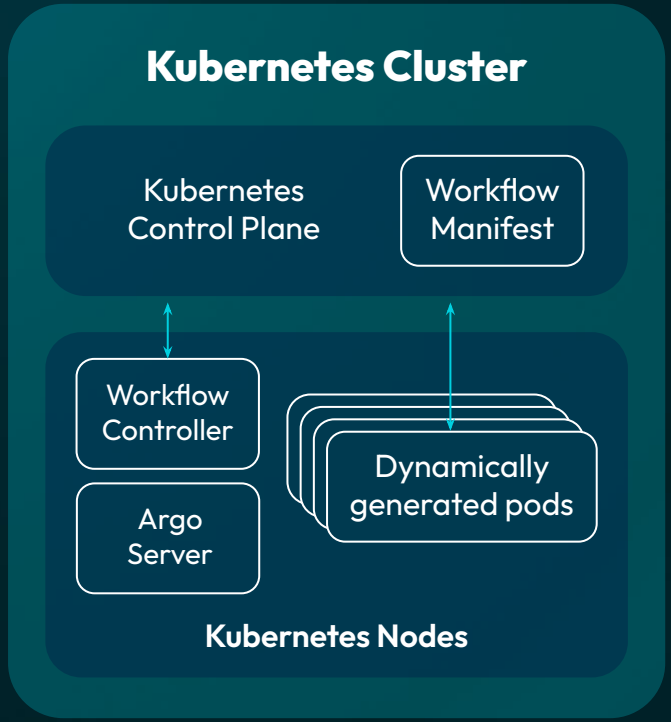


GUIDED ARGO PARAMETER GRID SEARCH

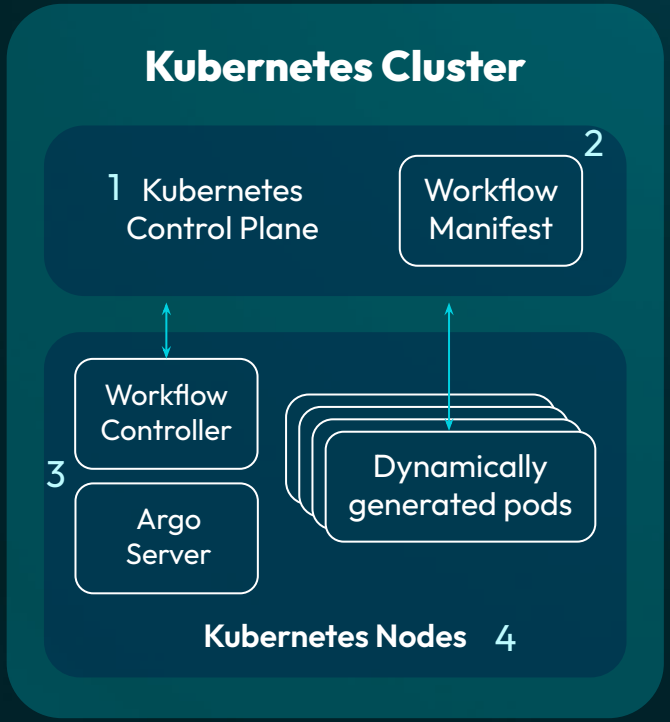
- Search for optimal setup.
- 66 experiments
- 15 Regressors
- Including:
  - Thread usage.
  - Resources per pod, step, node:
  - Network File Store vs Buckets (GCS).
  - Data chunk size and number.
  - Machine specs and type.
- Outputs
  - **Pipeline run time**
  - Reliability
  - Cost
- Results
  - Reliable, consistent, deterministic.
  - Reduced run time from 4 to 1 hour for our biggest market run.
  - “Sleep easy on Sundays” - CTO

HOW ARGO WORKFLOWS WORKS

- User creates a Workflow manifest. This is stored in etcd.
- Workflow Controller starts working when it finds a workflow manifest.
- Controller asks the K8s API to create pod(s).
- Controller continually asks the k8s api for the status of the pod(s).
- Controller writes the status and parameter values of each workflow step back to the Workflow manifest (via k8s API).
- Users viewing the UI or using the API will cause the Argo Server to query the Kubernetes API for Workflows information.



WHAT THINGS COULD BREAK AT SCALE?



- 1 - Kubernetes Control Plane could get overwhelmed.
- 2 - Workflow manifest could get too large for etcd.
- 3 - Workflow Controller/Server could run out of resources.
- 4 - Cluster could run out of Kubernetes nodes (or other resources) to run the work.

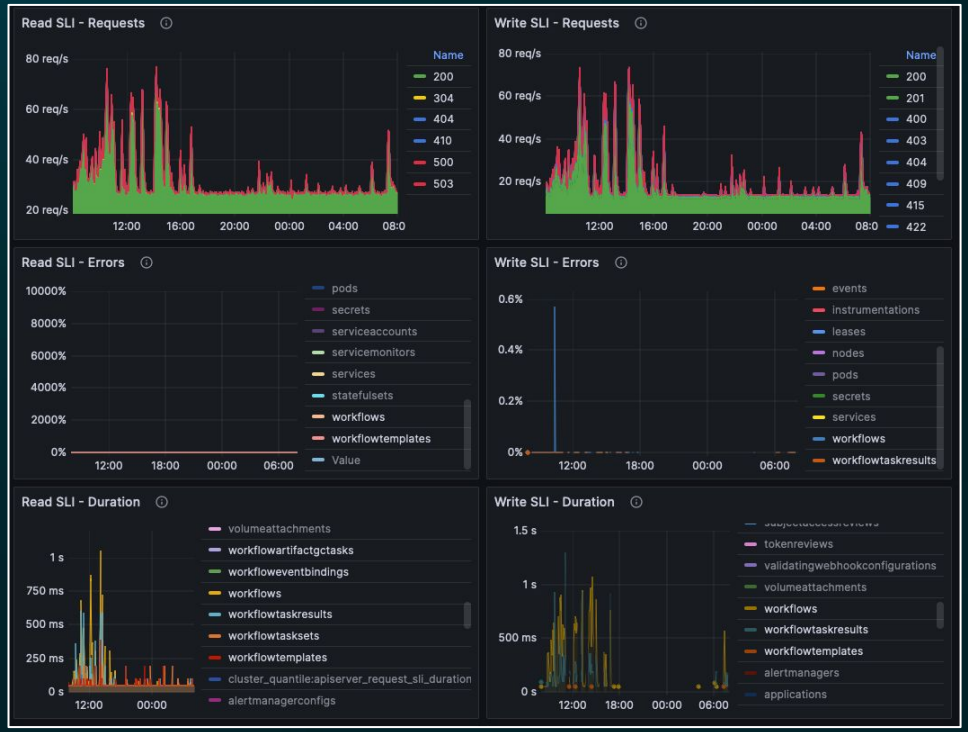
1 - THE KUBERNETES API

Monitor the Kubernetes API Health

- Kube-prometheus-stack comes with a Grafana dashboard for this.
- Alternatively can use the Workflow Controller logs to get some insight.

Looking after the Kubernetes API

- `DEFAULT_REQUEUE_TIME`.
- Workflow Parallelism.
- Limit how often the controller creates k8s resources: `resourceRateLimit`
- Use Kubernetes 1.27+.
- Spread the work across more Clusters.
- Consider what else the cluster is used for.



2 - LARGE WORKFLOW MANIFEST

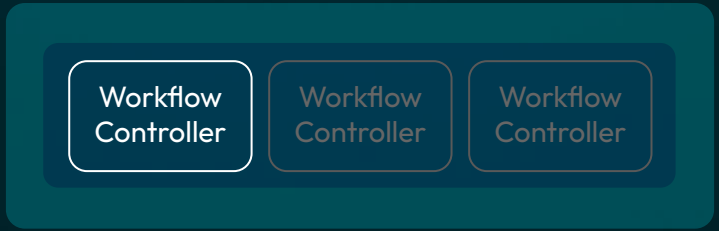
Parameters, steps and statuses - everything written back to the Workflow manifest.

- Are you putting too much data into parameters?
  - Consider using a shared (RWX) disk or artifacts instead
- Are you running too many pods in one workflow?
  - Consider splitting into smaller workflows
- Still > 3mb
  - Consider workflow offloading to a Database

```
Status:               Error
Message:              Request entity too large: limit is 3145728
Conditions:
 PodRunning           True
 Completed            True
Created:              Mon Oct 23 23:48:52 +0200 (8 hours ago)
Started:              Mon Oct 23 23:48:52 +0200 (8 hours ago)
Finished:             Tue Oct 24 01:12:20 +0200 (6 hours ago)
Duration:             1 hour 23 minutes
Progress:             4483/5205
```

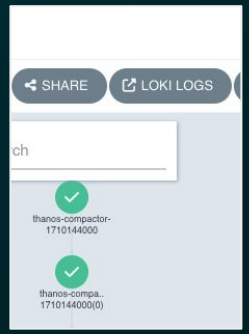
3 - WORKFLOW CONTROLLER RESOURCES

- Resource requests/limits on the Controller are not set by either the official release manifest or the Helm chart.
- The types of workflow you execute will determine the resource usage of the controller.
- You can only have one running Workflow Controller replica at a time.
  - Make use of `PriorityClasses`.
  - `LEADER_ELECTION_DISABLE` is `FALSE` by default, even if you have one workflow controller.



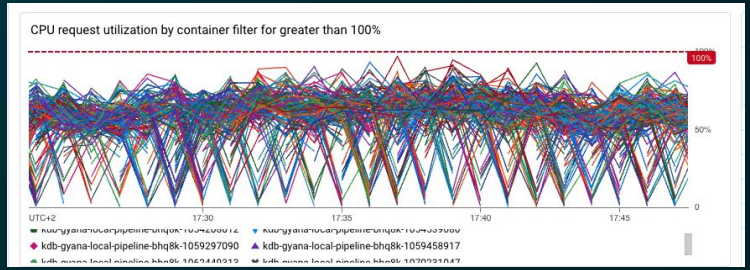
3 - WORKFLOW SERVER RESOURCES

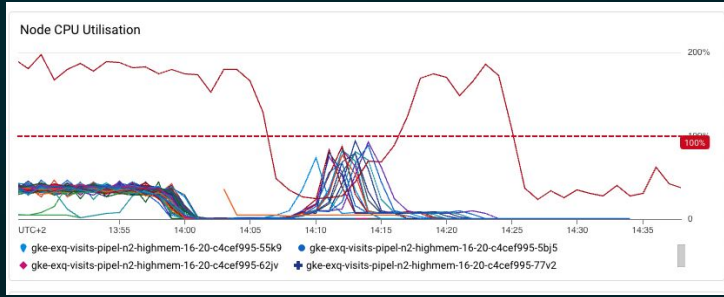
- Server - CLI and UI so not vital for running workflows.
- View approximately 1000 workflows before things get too slow.
  - Depending on size
- Delete old workflows (use `ttlStrategy`) from your cluster.
  - `argo delete -older 10d`
  - If you need workflows, consider archiving to a bucket.
- Use a dedicated log aggregation tool to view Workflow logs
  - Link to UI via the controller configmap.
- Use direct kubectl/CLI commands.
  - `argo get @latest —watch`
- Resource requests/limits on the server are not set by either the official release manifest or the Helm chart.



TUNING NODES AND POD RESOURCES

- Monitoring.
- 80% Roughly node and pod resource utilisation.
- Split out steps with different requirements.
- Requests to ensure other pods don’t steal your resources.
- Mindful of other processes leading to performance degradation sidecars, metrics server.
- Tune your workflow controller resources.





4 - RUNNING OUT OF KUBERNETES NODES

Look for pending pods

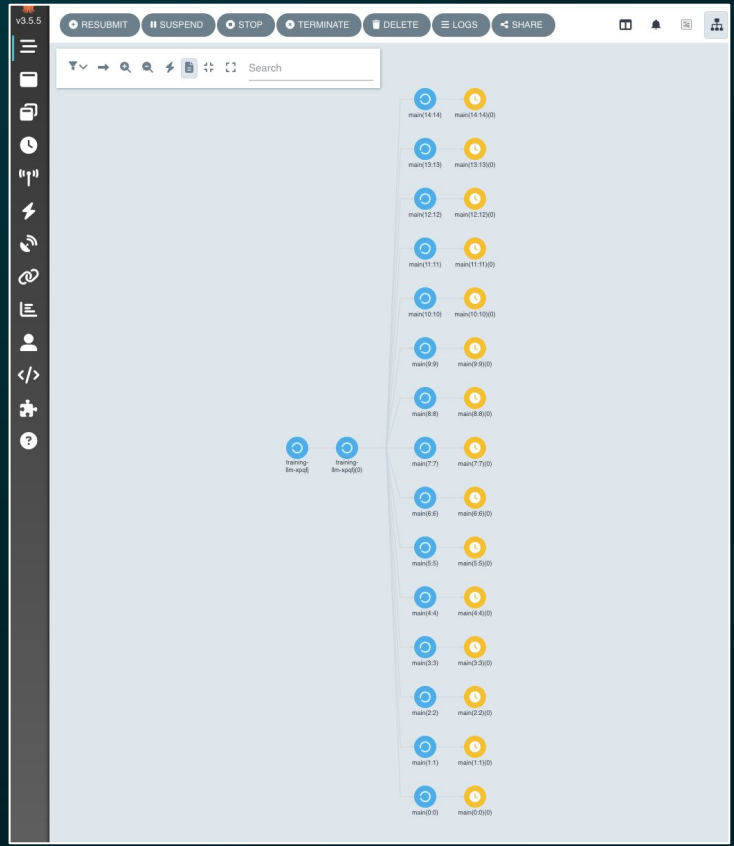
- Pods stuck in pending may indicate that you don't have the Kubernetes nodes at hand.

Autoscaling

- If a node is connected to your cluster, you're already paying for it.
- Scale down when you're not doing things. Consider scaling to 0 at night/weekends (if applicable).

Consider ARM and Spot

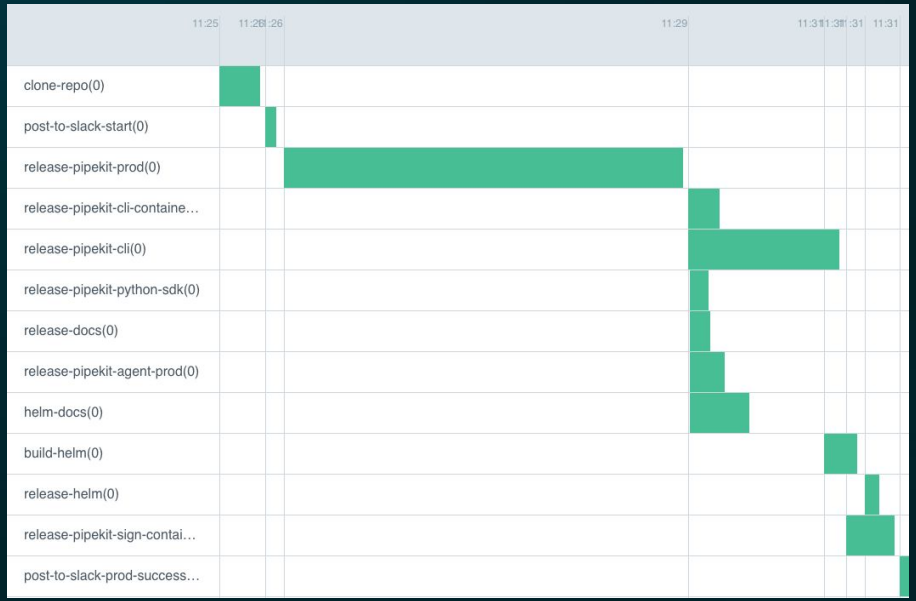
- Cost-savings.
- For Spot, you need to be able to handle sudden node-eviction in your Workflow steps.



WHY IS MY WORKFLOW SLOW?

If you don't have observability, look at the gaps between steps in the Timeline view:

- Pod creation/init time
  - Image size
    - Optimise your image size
    - Image caching
      - https://github.com/XenitAB/spegel
    - Image prefetching
    - Custom Kubernetes node images
  - Many different images (lots of fresh pulls)
    - Can you combine similar images into one?
    - Use a good image tagging methodology (or better yet use the image digest)
  - Container registry rate limiting
  - Do you have enough Kubernetes nodes?
  - Waiting for volumes to mount



WHY IS MY WORKFLOW SLOW?

Workflow Design

As a rough rule of thumb, assume the startup time of a pod is at least 30s:

- If a step is not likely to be parallelised, consider combining it with other steps that won't be run in parallel.
- If a step requires the output of a previous step and both steps are not going to be parallelised, run them in the same pod.
- If a job is reasonably short (2 minutes or less?) and the speed of the execution is critical, consider not using Workflows for the job.
- Consider putting many short-lived steps into one containerset. This results in a single pod.

Large output artifacts

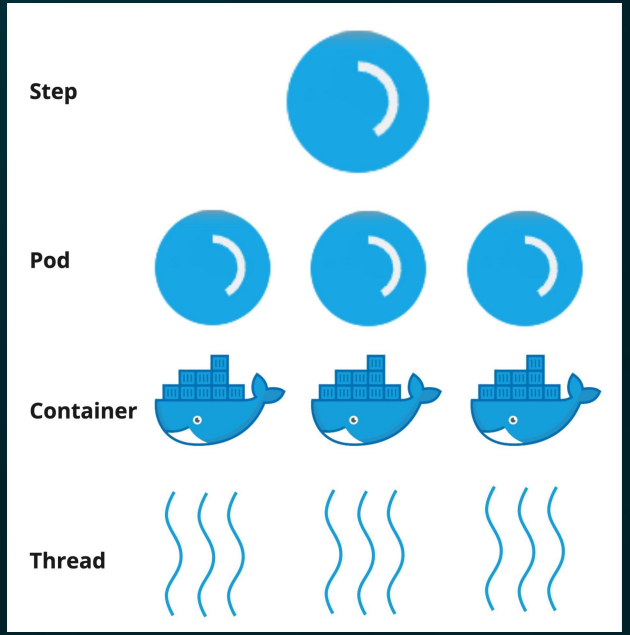
- Takes time to (un)compress and upload/download the files
- You can measure the time it takes to fetch/push artifacts by looking at the logs of the init container.

Resource requests for workflow steps. Remember the init/wait containers too.

GC pods after completion

WHERE SHOULD PARALLELISM OCCUR?

- How do you break up your algorithms to scale horizontally?
- Thread, container, pod, node parallelism:
- High Pods Greater load on controller
    - Background processes + metrics + side cars
- Right number of pods a node / run time of a pod couple of minutes.
- Small vs large workflows - cluster utilisation.



OBSERVABILITY

Open Source Grafana dashboard

- grafana.com/grafana/dashboards/20348-argo-workflows-metrics/
- Import ID: 20348

IDEAL IF:

- You have Prometheus/Grafana set up already.
- You tried the existing one and found it no longer works.
- You want to have a base dashboard to work your own metrics into.

OBSERVABILITY

Observability Enhancements to Argo Workflows Controller (expected in v3.6)

- Large number of new metrics and fixes to old metrics.
- Helping you answer these questions:
  - How long does workflowTemplate `foo` take to run?
  - When did cronWorkflow `bar` last run?
  - How many workflows Failed in the last week?
  - What's the reason my pods are pending?

Top 5 Pending Pods by reason in the last 1d	
prometheus/runner-prometheus : argo : PodInitializing	1391
prometheus/runner-prometheus : argo : Unschedulable	1242
prometheus/runner-prometheus : argo : ErrImagePull	82
prometheus/runner-prometheus : argo : ImagePullBackOff	50
prometheus/runner-prometheus : argo : ErrImagePull: pull QPS exceeded	40

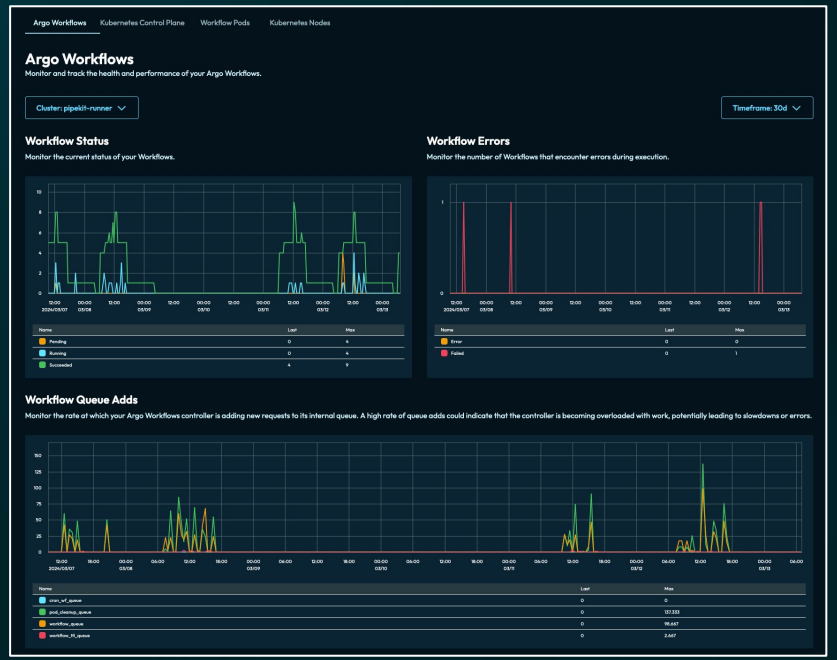
- Read and upvote the proposal: github.com/argoproj/argo-workflows/issues/12589

FREE WORKFLOW METRICS BY PIPEKIT

"79% of organizations with observability have saved time or money"

Uncover deep insights into your Argo Workflows and Kubernetes environments.
Gain real-time insights into your systems' health.

- Open source metrics collector (OTEL).
- We show you all the data we collect.



GET STARTED:

- Register your interest at pipekit.io/metrics-signup.

IDEAL IF:

- You don't have an existing observability stack.
- You don't have time to learn how to compose dashboards.
- You want to take your Argo Workflows scaling to the next level with minimal effort.

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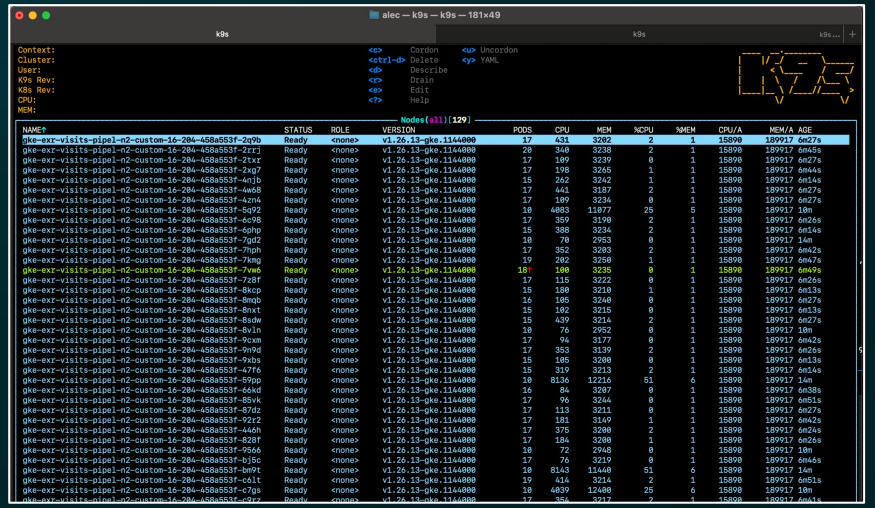
FETCH'S FINDINGS

- Monitoring
  - Prometheus + Kube State Metrics + Argo Metrics.
- NFS in production (see Tims talk).
- No container lifecycle hooks.
- New tools:
  - Kustomize - DRY YAML and cost savings.
  - K9S - CLI for cluster management.
  - Argo v3.5.x - observability and performance.
- Optimisations:
  - Performant reliable pod and node
  - ¼ the time.
  - Deterministic.



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FREE STUFF

GITHUB REPO

- github.com/pipekit/talk-demos

GRAFANA DASHBOARD

- grafana.com/grafana/dashboards/20348-argo-workflows-metrics/
- Import ID: 20348

FREE WORKFLOW METRICS BY PIPEKIT

- Register your interest at pipekit.io/metrics-signup

FREE ARGO/INFRASTRUCTURE HELP & ADVICE

- Booth E34
- Regular Office Hours (pipekit.io/office-hours)

FETCH ANALYTICS

- Contact alec@fetchanalytics.ai for more information on access to the Fetch Analytics platform.