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Welcome

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Federated Kubernetes with Geo-Distributed IRIS IAM

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Agenda

1 Overview of IRIS IAM

2 Geo-Distributed/Multi-cluster HA-IAM technical overview

3 Performance testing findings for Multi-cluster IAM

4 Multi-cluster Setup beyond IAM

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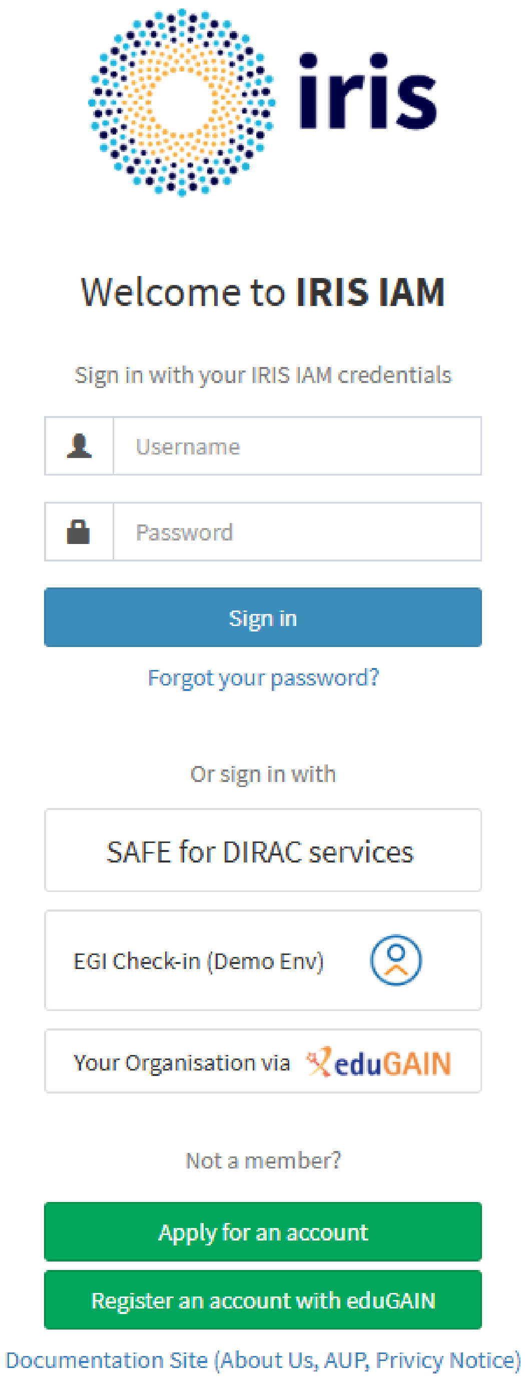
Overview of IAM

What is IRIS IAM?

- IAM (Identity and Access Manager) provides an Authentication and Authorization Infrastructure (AAI) solution to IRIS.
- The IAM acts as a proxy service, allowing IRIS collaborators access to other IRIS services.
  - SCD Cloud
  - IRIS indico
  - SAFE for Dirac
  - FTS & Rucio
  - Many more…



iris

Welcome to **IRIS IAM**

Sign in with your IRIS IAM credentials

Username

Password

Forgot your password?

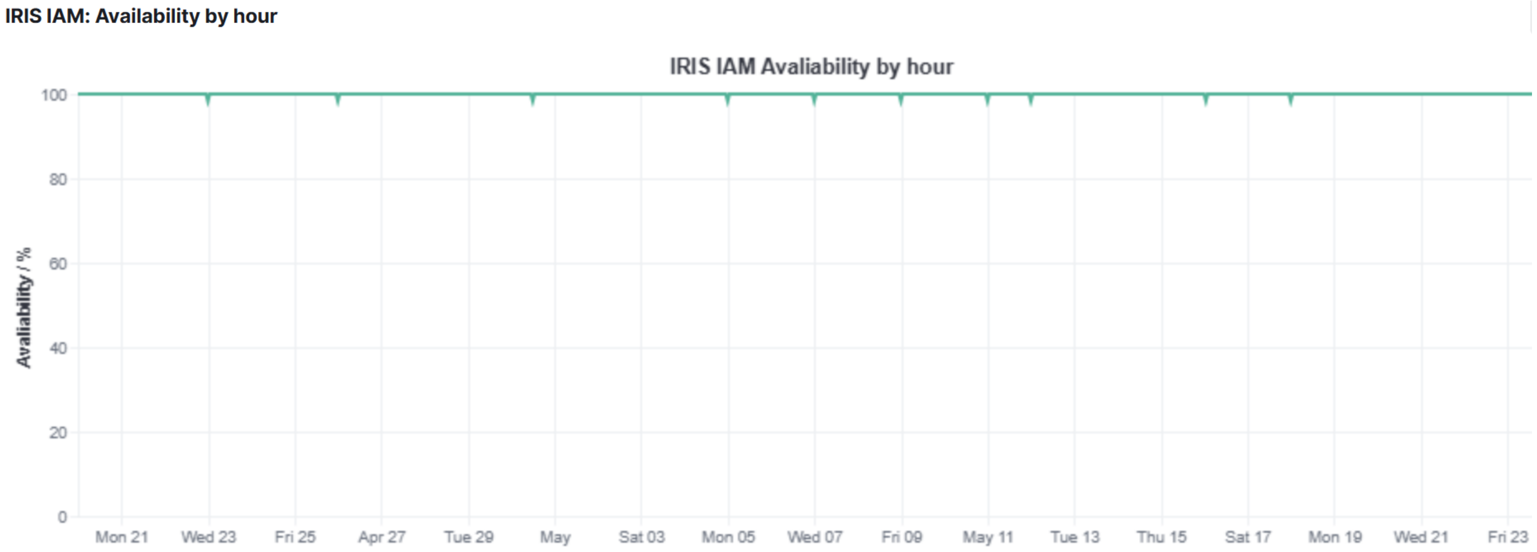
Or sign in with

Not a member?

Documentation Site (About Us, AUP, Privacy Notice)

IRIS IAM – Why HA

- Provide IAM for entire UK
- Good availability
- Reduce risk of
  - Loss of service
  - Provide better grantee for downstream services
- Geographically distributed IAM service



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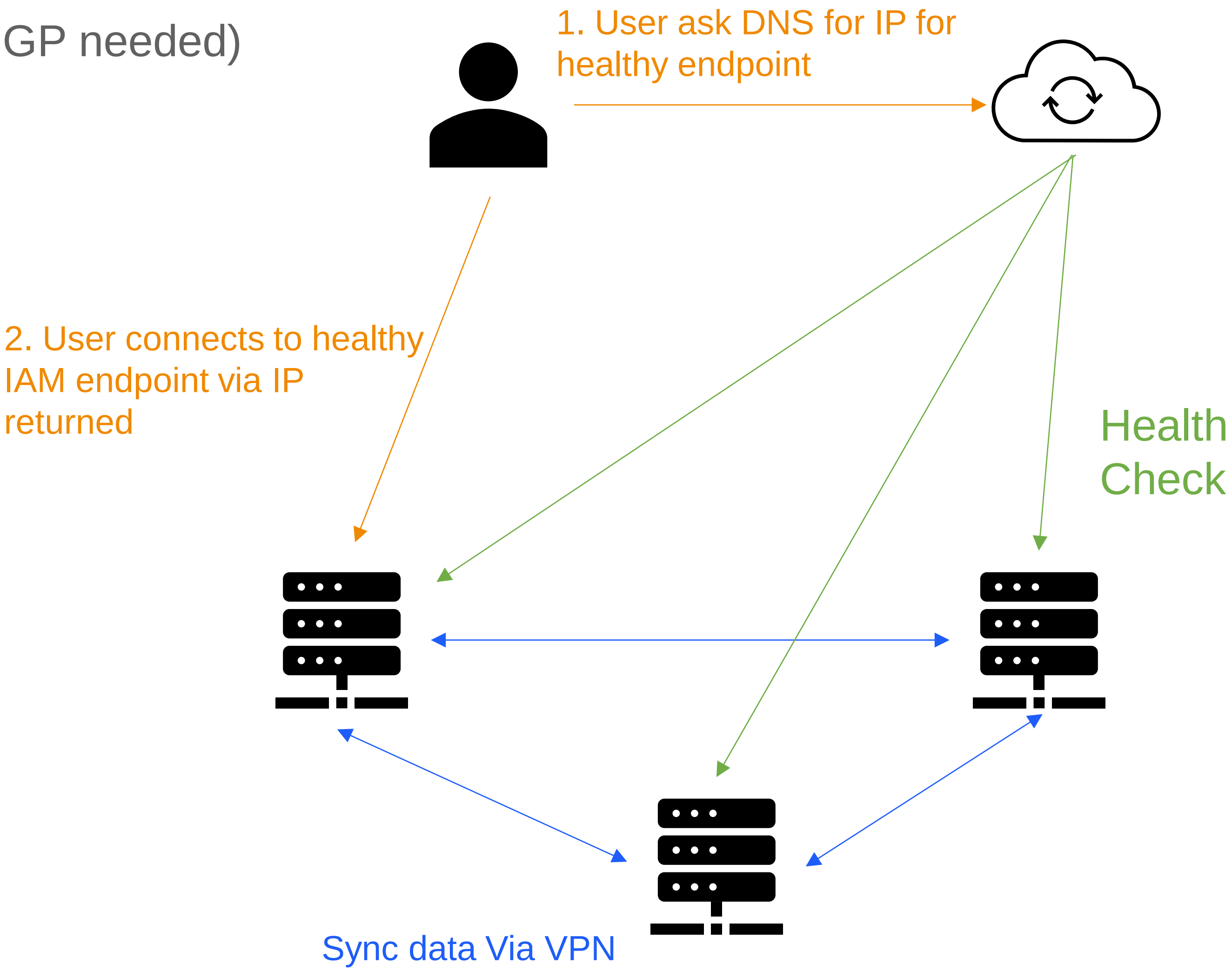
Geo-Distributed HA-IAM technical overview

Architecture

- DNS load balancer
  - Low infrastructure requirement (No BGP needed)
- Kubernetes
  - Running
    - IAM
    - Database
    - Session Storage
  - Performance advantage
- VPN services
  - Allow synchronization of data
- Needed
  - Data synchronization
  - Orchestration


1. User ask DNS for IP for healthy endpoint
2. User connects to healthy IAM endpoint via IP returned
Health Check
Sync data Via VPN

Liqo

- liqotech/liqo: Enable dynamic and seamless Kubernetes multi-cluster topologies
- Self-negotiated resource and service consumption relationships between cluster
  - VPN configurations
  - Certification authorities
- Workload offloading to remote clusters
  - No modification to K8s
  - Status transparent
- Network Fabric: Native Pod-to-Pod and Pod-to-Service
  - VPN tunnel for secure communication
  - Synchronisation of State
- Storage Fabric:
  - Auto configuration of storage class
  - Storing that data closer to workload

Liqo

- Setup
  - Helm
  - Build-in CLI application
- Peering between cluster
  - Made aware of each other’s configuration
    - E.g. pods and service CIDR
  - Propagation of pod affinity/anti-affinity
  - Reflecting resource
  - Automatic offloading namespace
  - CA
  - Setting up control plane
    - Communication with kubeapi can be done within VPN or outside of VPN

Liqo

- Install with Helm or liqoctl on both cluster
  - Set parameters such as: Pod/Service CIDR, amount of resource to share, resources not to share, gateway network
- Peering the cluster
  - Negotiate Network
  - Create relevant resources such as resources slice, network pods
- Foreign cluster represented as worker virtual nodes ready to schedule workloads from master node

Master
Foreign Worker

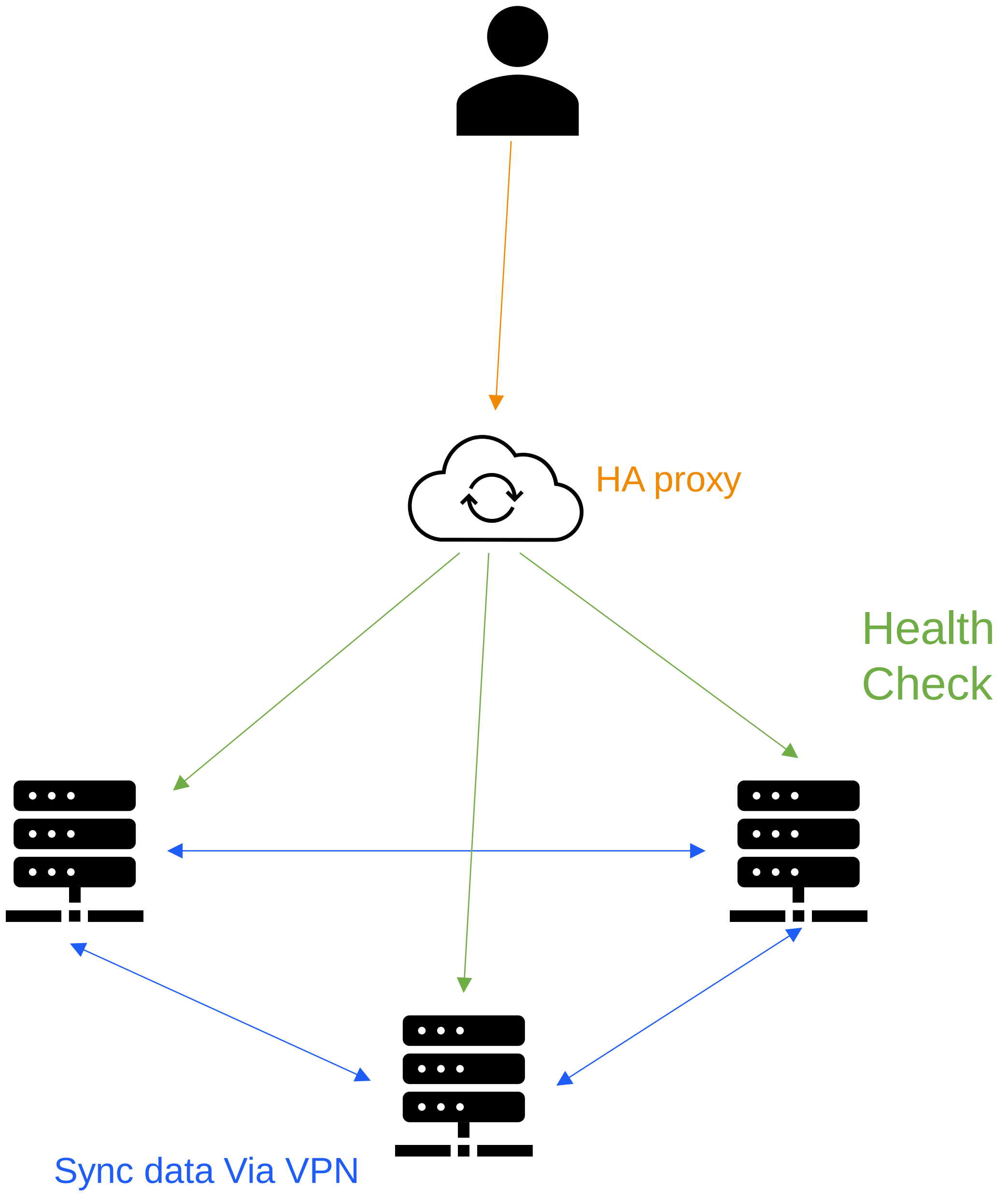
Testing Scopes

- Mainly testing service reachability and performance in the IAM Context
  - With combination of
    - Container Engine
    - Network Environment
    - Backend DB

- Kubernetes Engine performance is out of scope of this investigation
  - Benchmarking Liqo: Kubernetes Multi-Cluster Performance | by Marco Iorio | The Liqo Blog | Medium
  - Minimal at lost at 10k pods and 100ms latency between cluster

Testing Architecture

- HA Proxy load balancer
  - 4x Core 16GB RAM
  - Round Robin
- Kubernetes
  - RKE2
  - Testing Local Cluster
    - 3x 8 Core + 30GB RAM (HA masters)
  - Testing Remote Cluster
    - 2x 8 Core + 30GB RAM (1x Master, 1x Worker)
  - 30ms latency introduced with Linux traffic command, queuing discipline applied on all remote cluster nodes IP
- IAM Setup
  - One container per node
  - Nginx
  - INDIGO IAM
  - Redis Sentinel
  - Persistence Database
    - SCD Galera
    - MariaDB Replication
    - Galera



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Testing

- Locust - A modern load testing framework
    - Python based
- Tests
    - Access Token
        - Issue Access Token
    - Refresh Token
        - Issue Access Token → Issue Refresh Token
    - Workflow
        - Issue Access Token → Issue Refresh Token → Token Exchange
- Hardware Setup
    - 10 min x 3 Trial / Setup
    - 8 Worker
        - 500 simulated User
        - 10 users/s ramp up

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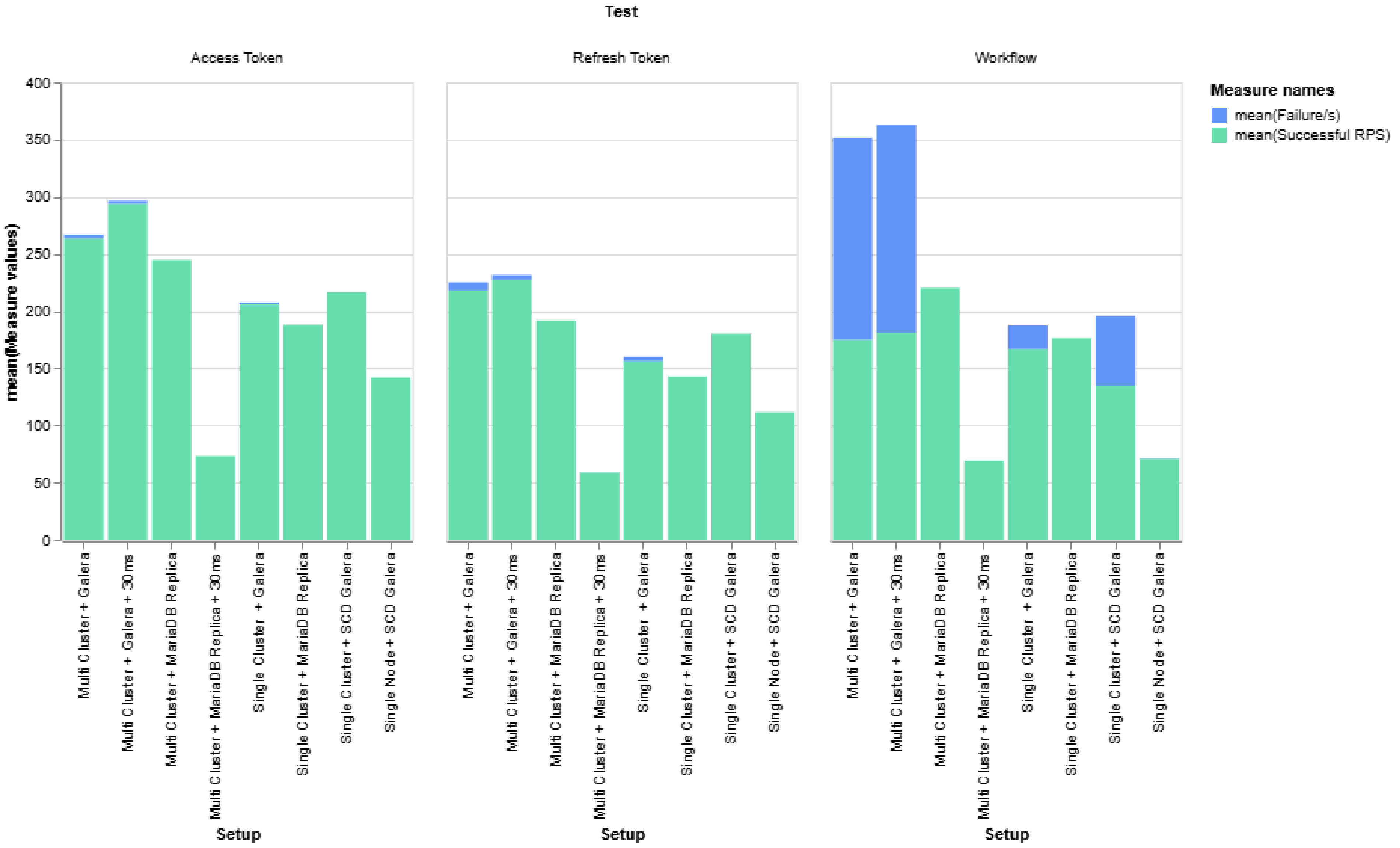
Findings

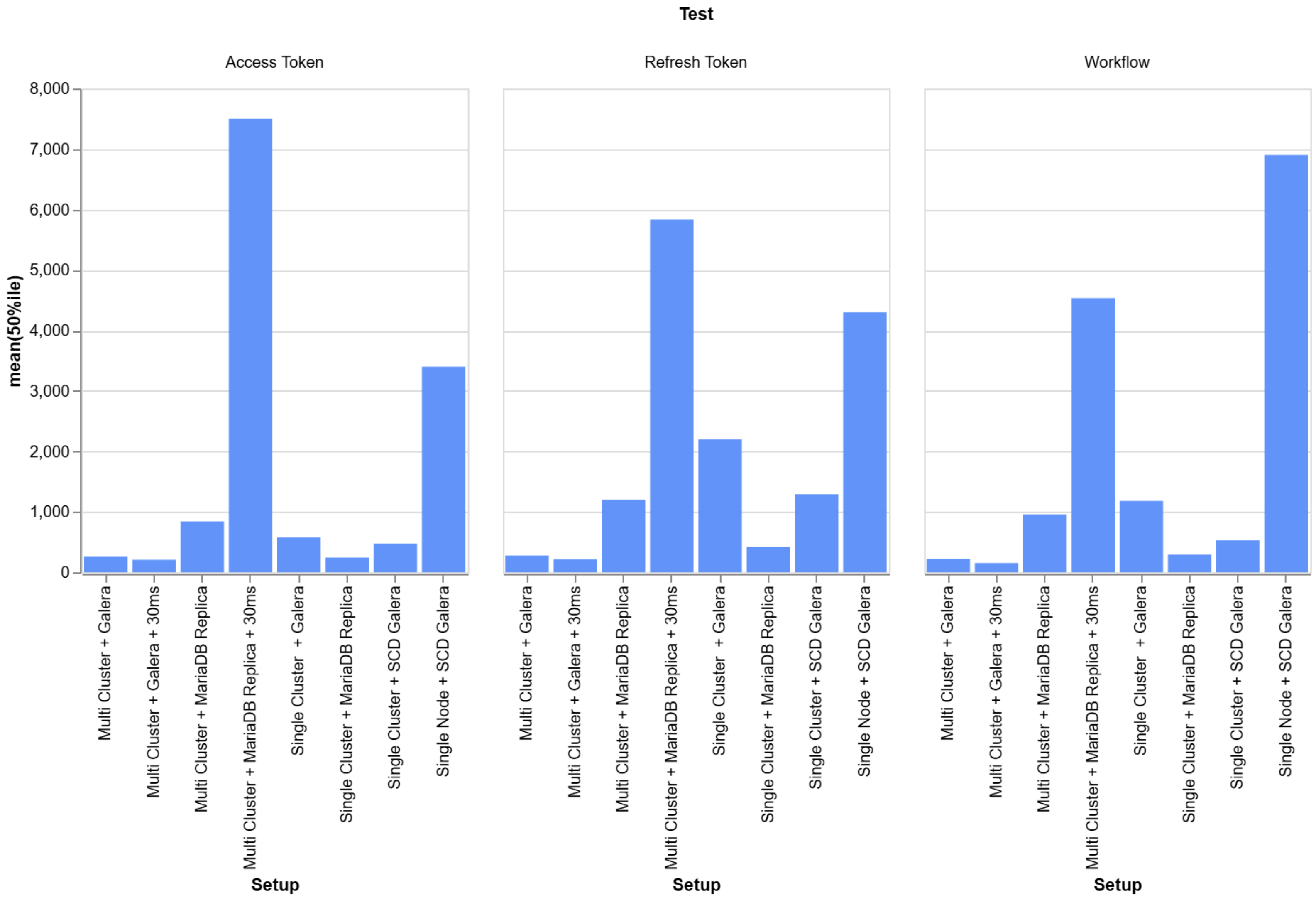
Current IAM

- Usage Level
  - IRIS IAM
    - 10-20 tokens / hr
    - 20-30 logins / hr
    - ~850 users in total
    - ~330 clients in total
  - SKA IAM
    - 1000 – 2000 tokens/ hr
    - 1000 – 2000 logins/ hr
    - ~200 users in total
    - ~ 620 clients in total

Request per Second (Throughput)



Response Time (50 percentile)



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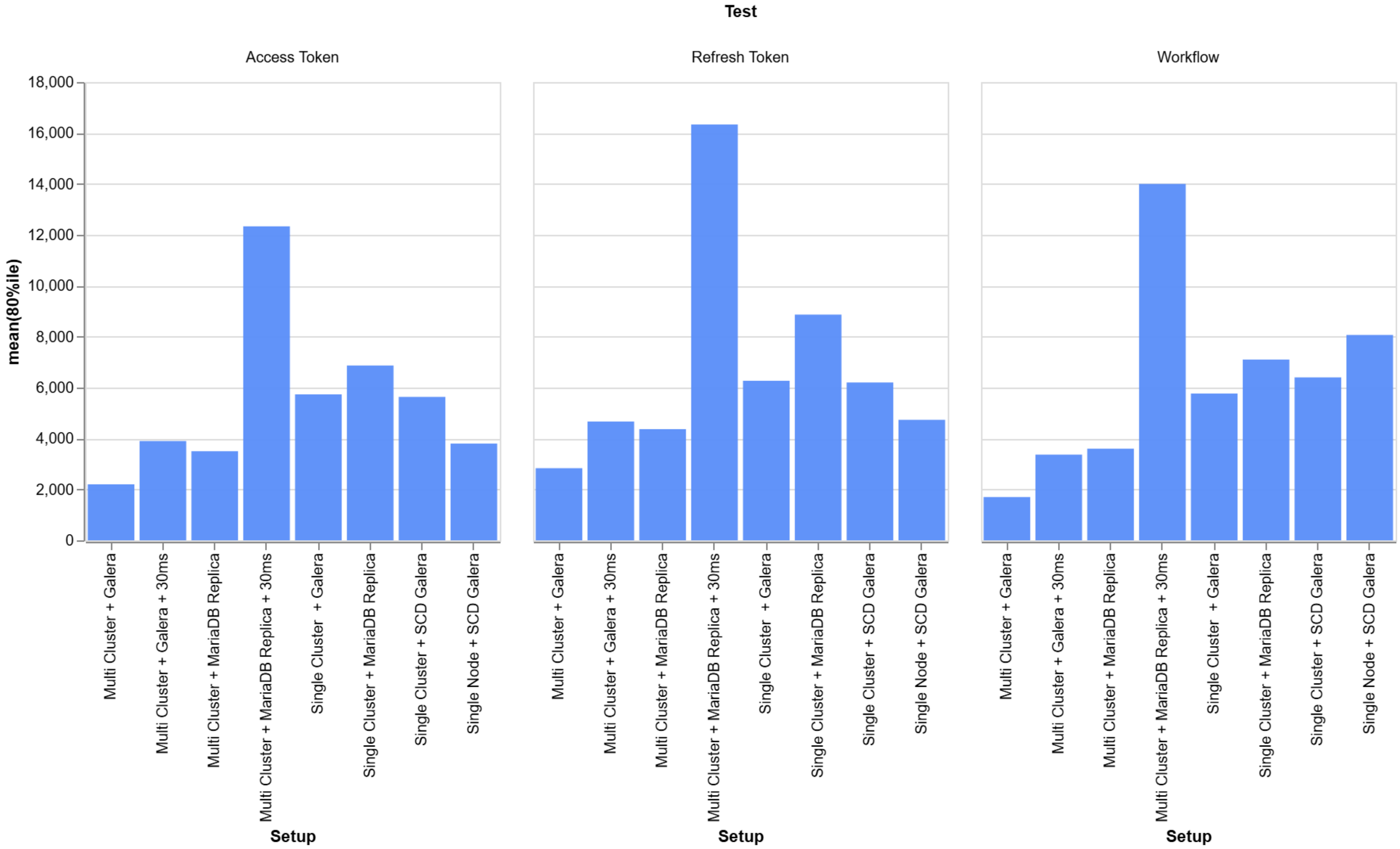
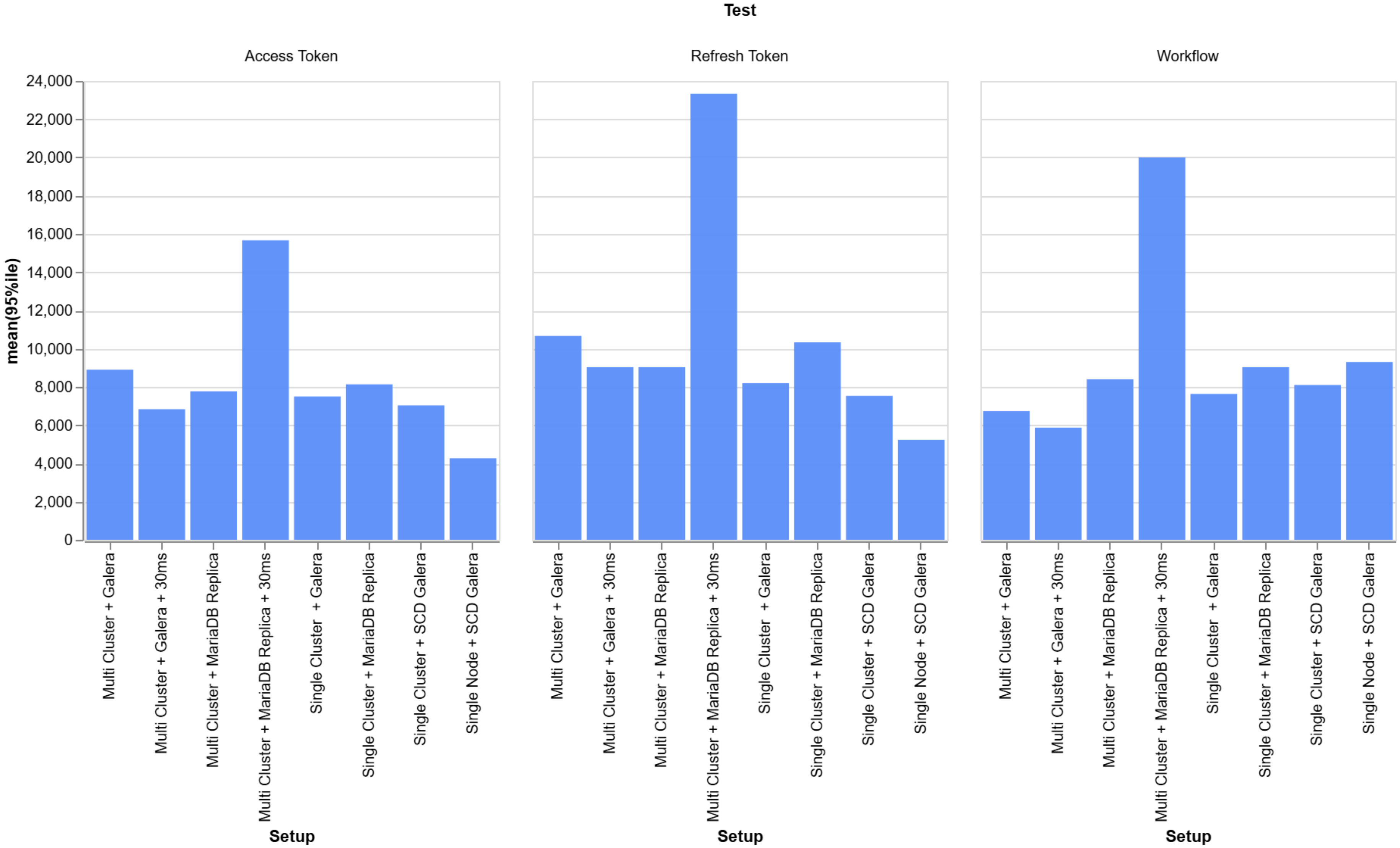
Response Time (80 percentile)



Response Time (95 percentile)



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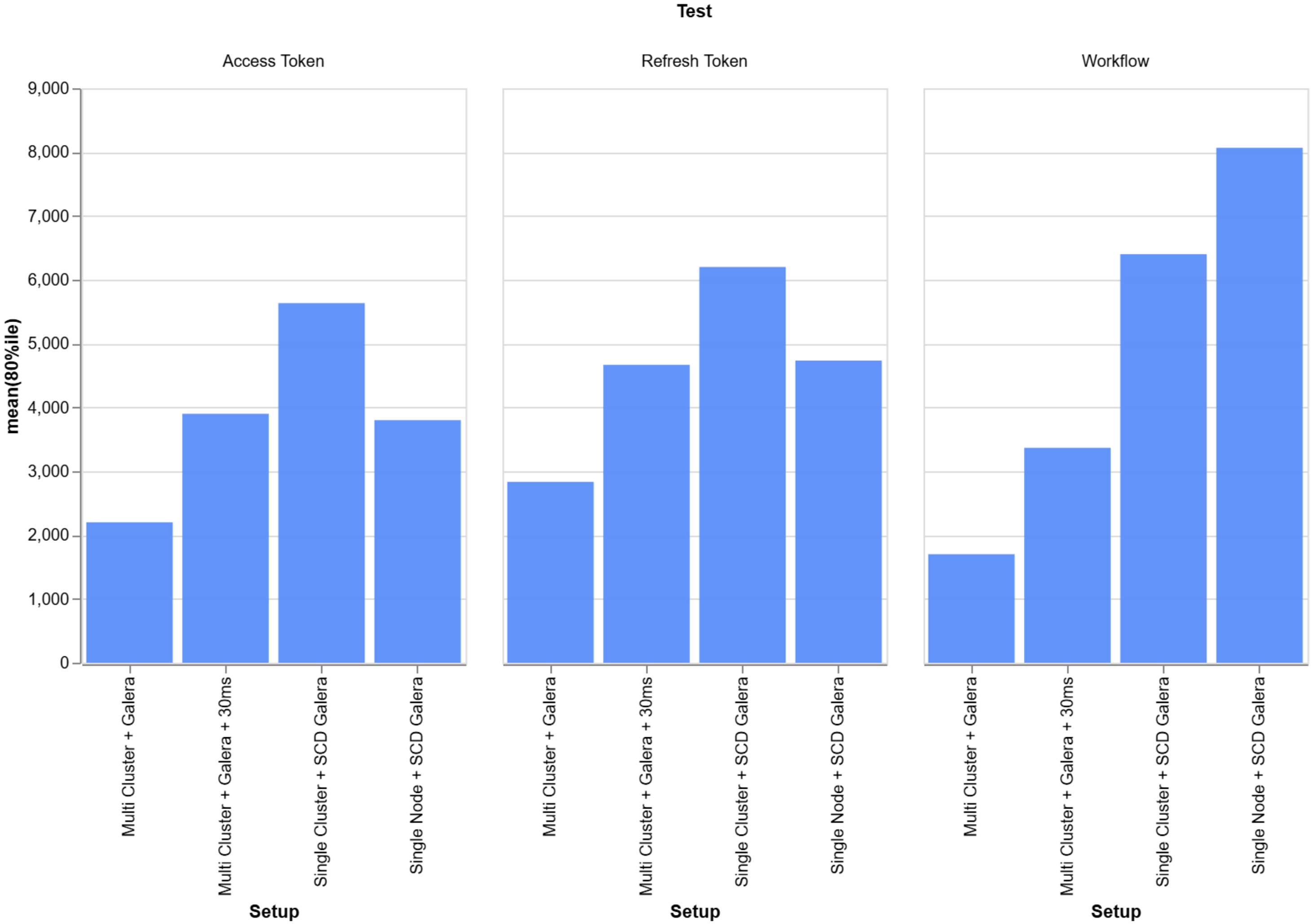
Findings

- More container = Better performance
  - Single node Docker < Single cluster (3x Frontend) < Multi cluster (5x Frontend)



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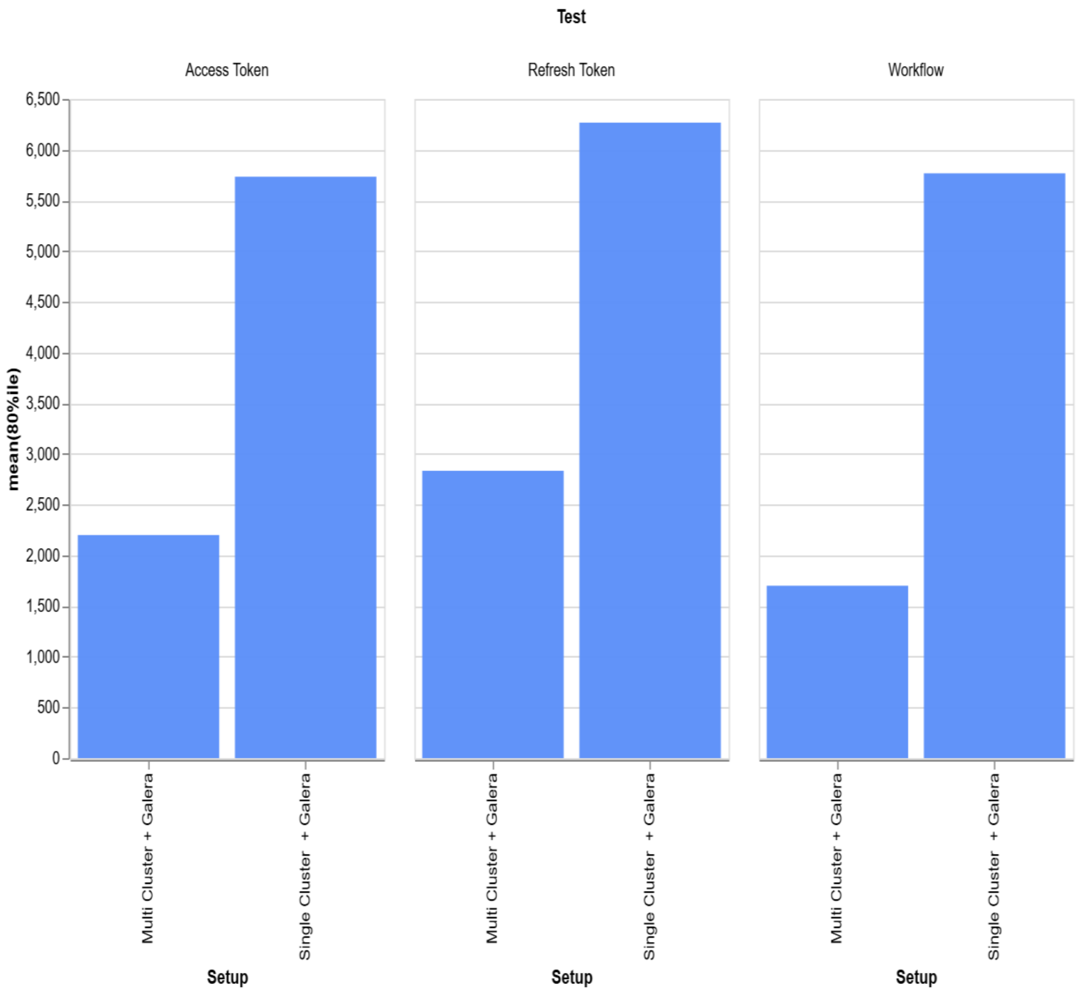
Findings

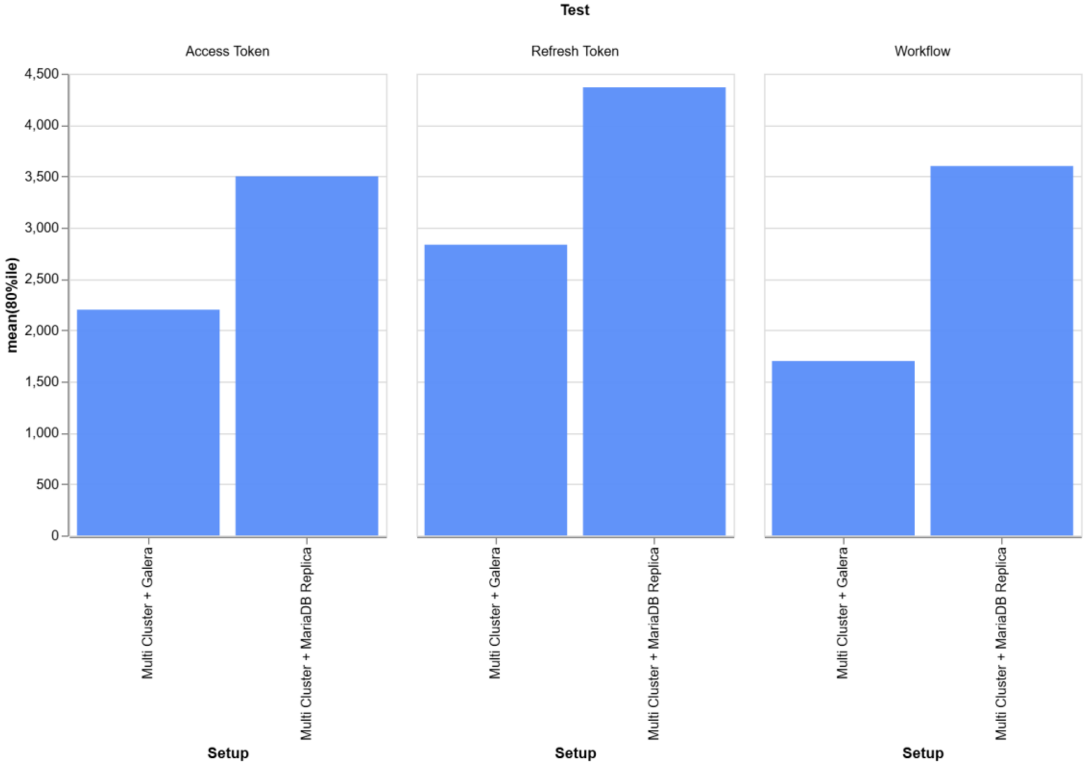
Minimal overhead with the network fabric

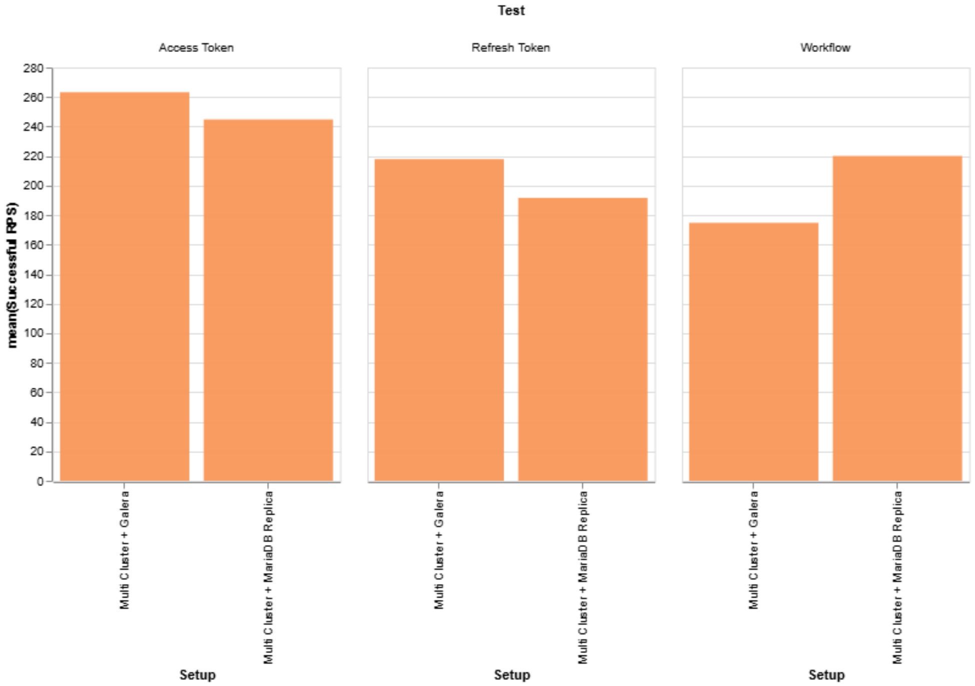
- VPN wireguard, additional overhead for remote monitoring



Findings

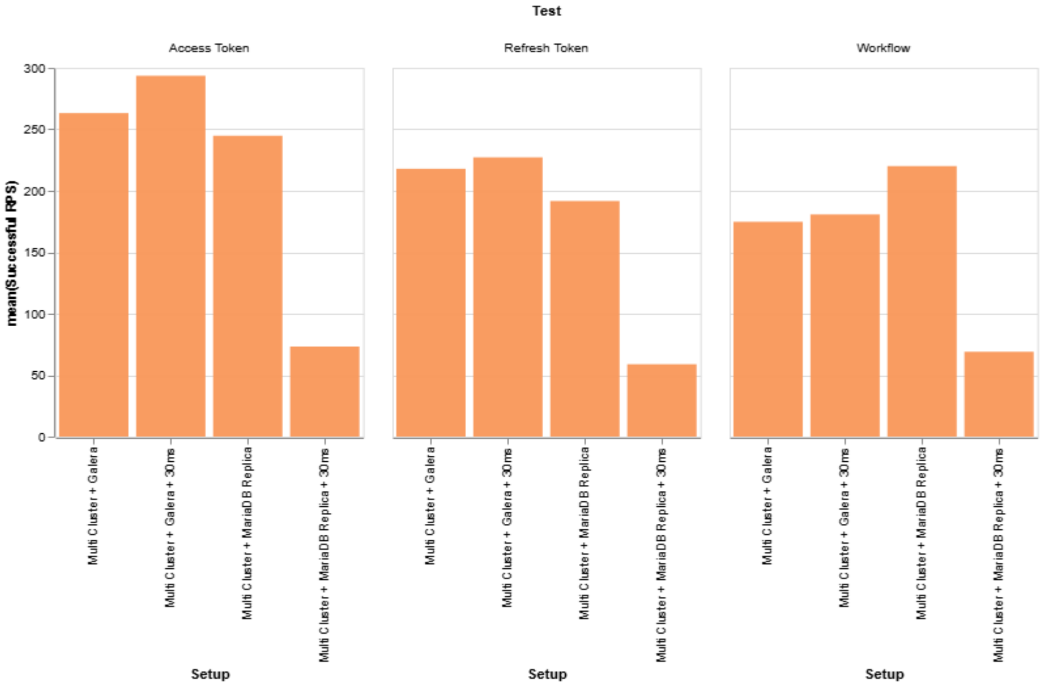
- Galera yields better Throughput and response time
  - Especially for workloads involves higher proportion of DB read





Findings

- Performance drop significantly when
  - Higher latency between DB and INDIGO IAM
    - Replica maria DB ensure worse case scenario most of the time at latency
    - Minimum difference when no latency between cluster, performance degraded significantly when latency is introduced



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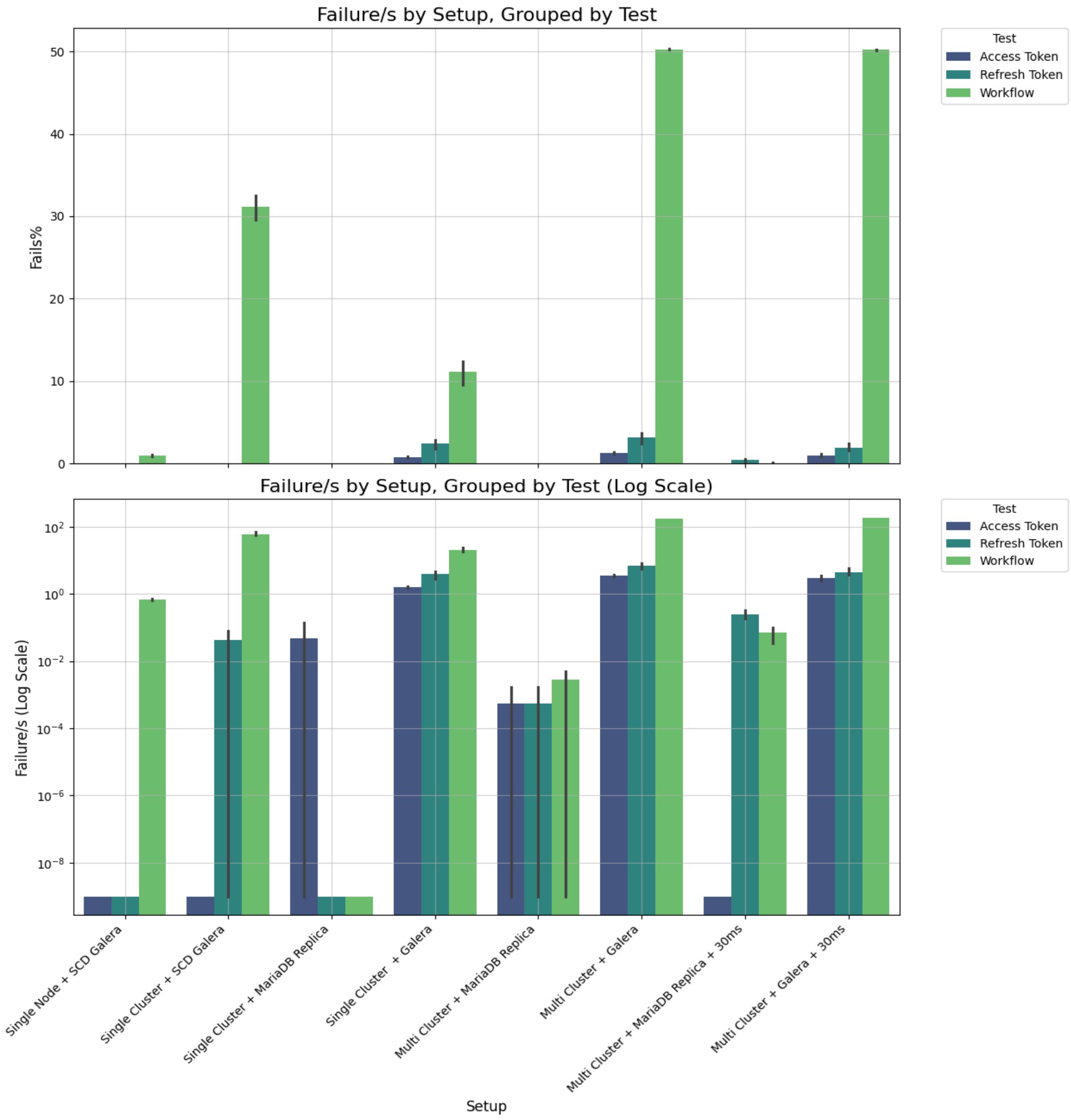
Findings

- Failure rate Galera backend
  - Proportional to
    - number of member galera
    - Number of frontend
  - Potential causes
    - Lack of Global lock for cluster (Error 500)
      - Forcing rollback when conflicting write happens
    - INDIGO IAM no critical read support (Error 400, Error 401)
      - IAM read from a node that is not synced up with the latest write
  - Inconsistency with DB cluster
  - Depends on workload
    - Issuing access token only involve static read + insert
    - Workflow involves additional referencing of data written immediately after



Findings

- Delay in web response when 30ms latency introduced
  - Sentinel is a master replica structure
  - Highly likely that any query is subjected to cross data centre

Conclusion

- Using K8s
    - Improve performance
    - Ease of management
        - Recovery
        - Upgrading
- Multi-cluster geo distributed setup
    - Done securely
    - No performance degradation compared to existing baseline
    - Improve availability
- Request hosting of foreign cluster for IAM.

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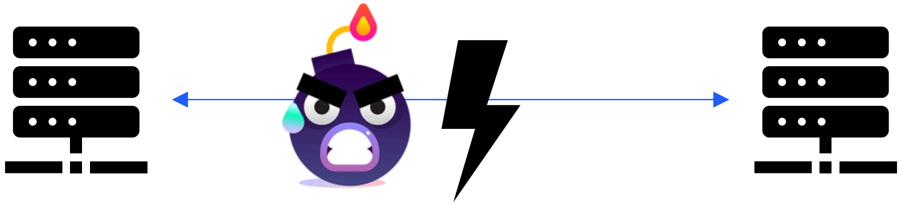
Multi-cluster Setup beyond IAM

Managing edge cluster

- K8s cluster on edge, placed near field equipment (detector)
- Normal Kubernetes extension
  - Network resources (high latency, low bandwidth)
    - Not plentiful
  - Security
    - Not strictly on site
    - Field equipment may be listened or tampered if communication not encrypted
  - Non uniform cluster setup
    - Different routing and CIDR for pods and services
    - Different storage implementation



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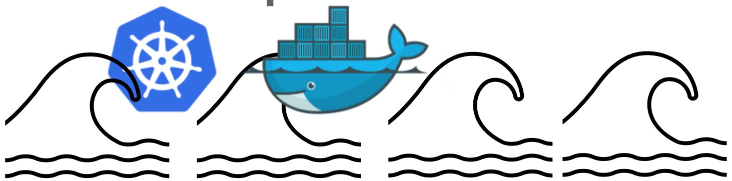
Managing edge cluster

- Mult cluster setup mitigates these issue
  - Communication are subject to environmental Hazzard
    - Allows ad-hoc joining of edge cluster
    - Up to 200ms latency between clusters
  - Re-establish communication amongst each other
  - Member cluster are made aware of each others configuration
    - Auto routing or NAT for pods and services between cluster CIDR (*)
      - Some applications don’t work with NAT
    - Mirrored storage class that follows the pods on a cluster
      - Casted to local cluster preferred storage class
      - No need to be aware of all storage engine downstream

Focus on resource-efficiency

- Leverage resources across research partners and public cloud providers



- Focus on higher value-added activity
  - GPU compute which has a high mark-up on GPU but lower mark up for CPU
  - Bursting of CPU workload into public cloud maybe cost efficient
- Not tied to specific vendors
  - Liqo is installed via helm and compatible with K8s compliant cluster
  - In the event of vendor switch, service can be migrated with lower disruption

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Questions?

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