Kubernetes HA Cluster Deployment Report (Proof of Concept)

1. Introduction

This report outlines the deployment of a **Proof of Concept (PoC)** highly available Kubernetes cluster on a bare-metal hypervisor environment. The goal is to validate core architectural components for security, high availability, and observability in a controlled lab setting.

2. Deployment Environment

- **Platform:** Proxmox VE hypervisor cluster
- **Virtual Machines:** 5 VMs total
  - 3 Control-plane (master) nodes
  - 2 Worker nodes
- Each VM is provisioned with sufficient CPU, RAM, and storage to simulate production-like workloads and storage replication.

3. Kubernetes Cluster Setup

- **Kubernetes Distribution:** RKE2 (Rancher Kubernetes Engine 2)
  - Hardened Kubernetes distribution with embedded etcd for HA control plane.
  - Uses containerd runtime.
- **Control Plane Load Balancing:**
  - HAProxy load balances traffic to the 3 master nodes.
  - Ports:
    - **6443**: Kubernetes API server.
    - **9345**: etcd peer communication.

4. Networking & Ingress

- **CNI Plugin:**
  - **Calico** selected due to hardware limitations preventing Cilium usage.
- **Load Balancer:** MetalLB in Layer 2 mode assigns static IPs for LoadBalancer services.
- **Ingress Controller:** Istio service mesh used as ingress gateway.
  - Manages ingress traffic via VirtualServices and Gateways.
  - TLS termination managed by cert-manager.
- **DNS & TLS:**
  - DNS managed externally via Cloudflare.
  - cert-manager automates TLS certificate issuance using Cloudflare DNS-01 challenge.

5. Storage

- **Persistent Storage:** Longhorn deployed for distributed block storage.
  - Supports volume replication and fault tolerance.
  - Ensures data availability during node failures.

6. Application Deployment & Exposure

- **Keycloak** (Identity Provider) and **ArgoCD** (GitOps) deployed via Helm.
- Exposed through Istio Ingress Gateway using VirtualServices.
- Secured with cert-manager TLS certificates.
- Enables testing of secure access, authentication, and continuous deployment.

7. Monitoring & Observability

- **Prometheus** collects metrics from cluster components and workloads.
- **Grafana** visualizes cluster health and application telemetry.
- Both deployed for PoC monitoring purposes.

8. High Availability & Resilience

- 3-node control plane with embedded etcd maintains quorum under node failure scenarios.
- HAProxy ensures uninterrupted Kubernetes API access.
- Longhorn replication provides storage fault tolerance.
- Istio and MetalLB ensure resilient and secure application ingress.

9. Summary

This PoC environment validates the feasibility of deploying a highly available, secure Kubernetes platform on bare-metal virtualized infrastructure. Key features demonstrated:

- HA control plane with HAProxy load balancing.
- Calico CNI supporting the existing hardware environment.
- Longhorn persistent storage with replication.
- Istio ingress with MetalLB load balancing and automated TLS.
- Secure, Helm-deployed Keycloak and ArgoCD applications.
- Integrated monitoring via Prometheus and Grafana.

```
root@lb:~# kubectl get nodes -o wide
NAME       STATUS   ROLES                       AGE   VERSION          INTERNAL-IP     EXTERNAL-IP   OS-IMAGE             KERNEL-VERSION     CONTAINER-RUNTIME
node01     Ready    control-plane,etcd,master   3d6h  v1.32.6+rke2r1   172.16.25.152   <none>        Ubuntu 24.04.2 LTS   6.8.0-64-generic   containerd://2.0.5-k3s1
node02     Ready    control-plane,etcd,master   3d5h  v1.32.6+rke2r1   172.16.25.153   <none>        Ubuntu 24.04.2 LTS   6.8.0-64-generic   containerd://2.0.5-k3s1
node03     Ready    control-plane,etcd,master   3d5h  v1.32.6+rke2r1   172.16.25.154   <none>        Ubuntu 24.04.2 LTS   6.8.0-64-generic   containerd://2.0.5-k3s1
worker01   Ready    worker                      3d5h  v1.32.6+rke2r1   172.16.25.155   <none>        Ubuntu 24.04.2 LTS   6.8.0-64-generic   containerd://2.0.5-k3s1
worker02   Ready    worker                      3d5h  v1.32.6+rke2r1   172.16.25.156   <none>        Ubuntu 24.04.2 LTS   6.8.0-64-generic   containerd://2.0.5-k3s1
root@lb:~#
```

Figure 1: All Nodes

```
root@lb:~# kubectl -n istio-system get svc istio-ingressgateway
NAME                   TYPE           CLUSTER-IP      EXTERNAL-IP     PORT(S)                                                                      AGE
istio-ingressgateway   LoadBalancer   10.43.248.225   172.16.25.160   15021:30916/TCP,80:32636/TCP,443:31570/TCP,31400:31574/TCP,15443:32239/TCP   3d4h
root@lb:~#
```

Figure 2: istio-ingressgateway

```
root@lb:~# kubectl get pods -o wide
NAME                                                READY   STATUS    RESTARTS        AGE   IP              NODE       NOMINATED NODE   READINESS GATES
csi-attacher-6cc66dfc7-drp56                        1/1     Running   1 (3d5h ago)    3d5h  10.42.140.68    node02     <none>           <none>
csi-attacher-6cc66dfc7-mhrqm                        1/1     Running   0               3d5h  10.42.30.71     worker02   <none>           <none>
csi-attacher-6cc66dfc7-xwmhm                        1/1     Running   5 (3d5h ago)    3d5h  10.42.5.7       worker01   <none>           <none>
csi-provisioner-bf9f5dcf-cnswq                      1/1     Running   5 (3d5h ago)    3d5h  10.42.5.8       worker01   <none>           <none>
csi-provisioner-bf9f5dcf-pz78d                      1/1     Running   0               3d5h  10.42.140.70    node02     <none>           <none>
csi-provisioner-bf9f5dcf-pzcj5                      1/1     Running   0               3d5h  10.42.30.74     worker02   <none>           <none>
csi-resizer-79f94cf664-9hqdv                        1/1     Running   0               3d5h  10.42.140.69    node02     <none>           <none>
csi-resizer-79f94cf664-jltpq                        1/1     Running   5 (3d5h ago)    3d5h  10.42.5.9       worker01   <none>           <none>
csi-resizer-79f94cf664-t566g                        1/1     Running   0               3d5h  10.42.30.72     worker02   <none>           <none>
csi-snapshotter-55f6bf5866-5xkfd                    1/1     Running   0               3d5h  10.42.30.73     worker02   <none>           <none>
csi-snapshotter-55f6bf5866-cwwv2                    1/1     Running   0               3d5h  10.42.140.71    node02     <none>           <none>
csi-snapshotter-55f6bf5866-h7s2r                    1/1     Running   0               3d5h  10.42.5.10      worker01   <none>           <none>
engine-image-ei-b4bcf0a5-7wkrf                      1/1     Running   0               3d5h  10.42.5.4       worker01   <none>           <none>
engine-image-ei-b4bcf0a5-fhk9b                      1/1     Running   0               3d5h  10.42.30.69     worker02   <none>           <none>
engine-image-ei-b4bcf0a5-g4ws4                      1/1     Running   0               3d5h  10.42.140.67    node02     <none>           <none>
engine-image-ei-b4bcf0a5-krpfw                      1/1     Running   0               3d5h  10.42.196.143   node01     <none>           <none>
engine-image-ei-b4bcf0a5-vnfmh                      1/1     Running   0               3d5h  10.42.186.196   node03     <none>           <none>
instance-manager-5c5e30deb5aae00c21267a1ba69e730a   1/1     Running   0               3d5h  10.42.196.144   node01     <none>           <none>
instance-manager-6082f4bff7558b6304bf2ab6f78dfe54   1/1     Running   0               3d5h  10.42.186.197   node03     <none>           <none>
instance-manager-aeacf14c683ebaeed5b0844c2f196446   1/1     Running   0               3d5h  10.42.30.70     worker02   <none>           <none>
instance-manager-bf8074be8c7da594b03daece7d7ac8aa   1/1     Running   0               3d5h  10.42.140.73    node02     <none>           <none>
instance-manager-de5505ac034cffabd831dd638273736e   1/1     Running   0               3d5h  10.42.5.5       worker01   <none>           <none>
longhorn-csi-plugin-4mdsq                           3/3     Running   1 (3d5h ago)    3d5h  10.42.186.198   node03     <none>           <none>
longhorn-csi-plugin-hsd6g                           3/3     Running   1 (3d5h ago)    3d5h  10.42.30.75     worker02   <none>           <none>
longhorn-csi-plugin-pjzbq                           3/3     Running   1 (3d5h ago)    3d5h  10.42.140.72    node02     <none>           <none>
longhorn-csi-plugin-s45s9                           3/3     Running   1 (3d5h ago)    3d5h  10.42.196.145   node01     <none>           <none>
longhorn-csi-plugin-vbs4b                           3/3     Running   1 (3d5h ago)    3d5h  10.42.5.11      worker01   <none>           <none>
longhorn-driver-deployer-74b98bdb6b-2dw7d           1/1     Running   2 (3d5h ago)    3d5h  10.42.30.66     worker02   <none>           <none>
longhorn-manager-b5jr2                              2/2     Running   1 (3d5h ago)    3d5h  10.42.196.142   node01     <none>           <none>
longhorn-manager-dqm44                              2/2     Running   0               3d5h  10.42.30.67     worker02   <none>           <none>
longhorn-manager-fjjmb                              2/2     Running   0               3d5h  10.42.140.66    node02     <none>           <none>
longhorn-manager-wgl7d                              2/2     Running   0               3d5h  10.42.5.2       worker01   <none>           <none>
longhorn-manager-z969m                              2/2     Running   0               3d5h  10.42.186.195   node03     <none>           <none>
longhorn-ui-855f5f5cfb-5cnhh                        1/1     Running   0               3d5h  10.42.5.3       worker01   <none>           <none>
longhorn-ui-855f5f5cfb-x7sl4                        1/1     Running   0               3d5h  10.42.30.68     worker02   <none>           <none>
```

Figure 3: default namespace

```
root@lb:~# kubectl get all -n argocd -o wide
NAME                                                READY   STATUS    RESTARTS   AGE   IP              NODE       NOMINATED NODE   READINESS GATES
pod/argocd-application-controller-0                 1/1     Running   0          3d4h  10.42.5.20      worker01   <none>           <none>
pod/argocd-applicationset-controller-655cc58ff8-wckqd   1/1     Running   0          3d4h  10.42.5.17      worker01   <none>           <none>
pod/argocd-dex-server-7d9dfb4fb8-wmgkm              1/1     Running   0          3d4h  10.42.30.78     worker02   <none>           <none>
pod/argocd-notifications-controller-6c6848bc4c-gjvdt   1/1     Running   0          3d4h  10.42.5.18      worker01   <none>           <none>
pod/argocd-redis-656c79549c-pr2nl                   1/1     Running   0          3d4h  10.42.30.79     worker02   <none>           <none>
pod/argocd-repo-server-856b768fd9-6ll8r             1/1     Running   0          3d4h  10.42.5.19      worker01   <none>           <none>
pod/argocd-server-f45866955-nvgrr                   1/1     Running   0          3d4h  10.42.30.81     worker02   <none>           <none>

NAME                                               TYPE        CLUSTER-IP      EXTERNAL-IP   PORT(S)                      AGE   SELECTOR
service/argocd-applicationset-controller           ClusterIP   10.43.157.136   <none>        7000/TCP,8080/TCP            3d4h  app.kubernetes.io/name=argocd-applicationset-controller
service/argocd-dex-server                          ClusterIP   10.43.67.159    <none>        5556/TCP,5557/TCP,5558/TCP   3d4h  app.kubernetes.io/name=argocd-dex-server
service/argocd-metrics                             ClusterIP   10.43.35.205    <none>        8082/TCP                     3d4h  app.kubernetes.io/name=argocd-application-controller
service/argocd-notifications-controller-metrics    ClusterIP   10.43.124.224   <none>        9001/TCP                     3d4h  app.kubernetes.io/name=argocd-notifications-controller
service/argocd-redis                               ClusterIP   10.43.190.45    <none>        6379/TCP                     3d4h  app.kubernetes.io/name=argocd-redis
service/argocd-repo-server                         ClusterIP   10.43.42.111    <none>        8081/TCP,8084/TCP            3d4h  app.kubernetes.io/name=argocd-repo-server
service/argocd-server                              ClusterIP   10.43.24.253    <none>        80/TCP,443/TCP               3d4h  app.kubernetes.io/name=argocd-server
service/argocd-server-metrics                      ClusterIP   10.43.221.162   <none>        8083/TCP                     3d4h  app.kubernetes.io/name=argocd-server

NAME                                           READY   UP-TO-DATE   AVAILABLE   AGE   CONTAINERS                       IMAGES                                SELECTOR
deployment.apps/argocd-applicationset-controller   1/1     1            1           3d4h  argocd-applicationset-controller   quay.io/argoproj/argocd:v3.0.6   app.kubernetes.io/name=argocd-applicationset-controller
deployment.apps/argocd-dex-server                  1/1     1            1           3d4h  dex                              ghcr.io/dexidp/dex:v2.41.1       app.kubernetes.io/name=argocd-dex-server
deployment.apps/argocd-notifications-controller    1/1     1            1           3d4h  argocd-notifications-controller  quay.io/argoproj/argocd:v3.0.6   app.kubernetes.io/name=argocd-notifications-controller
deployment.apps/argocd-redis                       1/1     1            1           3d4h  redis                            redis:7.2.7-alpine               app.kubernetes.io/name=argocd-redis
deployment.apps/argocd-repo-server                 1/1     1            1           3d4h  argocd-repo-server               quay.io/argoproj/argocd:v3.0.6   app.kubernetes.io/name=argocd-repo-server
deployment.apps/argocd-server                      1/1     1            1           3d4h  argocd-server                    quay.io/argoproj/argocd:v3.0.6   app.kubernetes.io/name=argocd-server

NAME                                                 DESIRED   CURRENT   READY   AGE   CONTAINERS                       IMAGES                                SELECTOR
replicaset.apps/argocd-applicationset-controller-655cc58ff8   1         1         1       3d4h  argocd-applicationset-controller   quay.io/argoproj/argocd:v3.0.6   app.kubernetes.io/name=argocd-applicationset-controller,pod-templat
e-hash=655cc58ff8
replicaset.apps/argocd-dex-server-7d9dfb4fb8                  1         1         1       3d4h  dex                              ghcr.io/dexidp/dex:v2.41.1       app.kubernetes.io/name=argocd-dex-server,pod-template-hash=7d9dfb4f
b8
replicaset.apps/argocd-notifications-controller-6c6848bc4c    1         1         1       3d4h  argocd-notifications-controller  quay.io/argoproj/argocd:v3.0.6   app.kubernetes.io/name=argocd-notifications-controller,pod-template
-hash=6c6848bc4c
replicaset.apps/argocd-redis-656c79549c                       1         1         1       3d4h  redis                            redis:7.2.7-alpine               app.kubernetes.io/name=argocd-redis,pod-template-hash=656c79549c
replicaset.apps/argocd-repo-server-856b768fd9                 1         1         1       3d4h  argocd-repo-server               quay.io/argoproj/argocd:v3.0.6   app.kubernetes.io/name=argocd-repo-server,pod-template-hash=856b768
fd9
replicaset.apps/argocd-server-579f686795                      0         0         0       3d4h  argocd-server                    quay.io/argoproj/argocd:v3.0.6   app.kubernetes.io/name=argocd-server,pod-template-hash=579f686795
replicaset.apps/argocd-server-8686dc946b                      0         0         0       3d4h  argocd-server                    quay.io/argoproj/argocd:v3.0.6   app.kubernetes.io/name=argocd-server,pod-template-hash=8686dc946b
replicaset.apps/argocd-server-90c485944                       0         0         0       3d4h  argocd-server                    quay.io/argoproj/argocd:v3.0.6   app.kubernetes.io/name=argocd-server,pod-template-hash=90c485944
replicaset.apps/argocd-server-f45866955                       1         1         1       3d4h  argocd-server                    quay.io/argoproj/argocd:v3.0.6   app.kubernetes.io/name=argocd-server,pod-template-hash=f45866955

NAME                                          READY   AGE   CONTAINERS                       IMAGES
statefulset.apps/argocd-application-controller   1/1     3d4h  argocd-application-controller   quay.io/argoproj/argocd:v3.0.6
root@lb:~# kubectl get gateway -n argocd -o wide
NAME             AGE
argocd-gateway   3d4h
root@lb:~# kubectl get virtualservice -n argocd -o wide
NAME        GATEWAYS             HOSTS                 AGE
argocd-ui   ["argocd-gateway"]   ["argocd.spantosh.tk"]   3d4h
```

Figure 4: argocd

```
root@lb:~# kubectl get all -n keycloak -o wide
NAME                                READY   STATUS    RESTARTS   AGE   IP              NODE       NOMINATED NODE   READINESS GATES
pod/my-keycloak-0                   2/2     Running   0          12h   10.42.30.108    worker02   <none>           <none>
pod/my-keycloak-postgresql-0        2/2     Running   0          12h   10.42.5.33      worker01   <none>           <none>

NAME                                  TYPE        CLUSTER-IP      EXTERNAL-IP   PORT(S)    AGE   SELECTOR
service/my-keycloak                   ClusterIP   10.43.27.239    <none>        8080/TCP   12h   app.kubernetes.io/component=keycloak,app.kubernetes.io/instance=my-keycloak,app.kubernetes.io/name=keycloak
service/my-keycloak-headless          ClusterIP   None            <none>        8080/TCP   12h   app.kubernetes.io/component=keycloak,app.kubernetes.io/instance=my-keycloak,app.kubernetes.io/name=keycloak
service/my-keycloak-postgresql        ClusterIP   10.43.56.65     <none>        5432/TCP   12h   app.kubernetes.io/component=primary,app.kubernetes.io/instance=my-keycloak,app.kubernetes.io/name=postgresql
service/my-keycloak-postgresql-hl     ClusterIP   None            <none>        5432/TCP   12h   app.kubernetes.io/component=primary,app.kubernetes.io/instance=my-keycloak,app.kubernetes.io/name=postgresql

NAME                                     READY   AGE   CONTAINERS   IMAGES
statefulset.apps/my-keycloak             1/1     12h   keycloak     docker.io/bitnami/keycloak:26.3.2-debian-12-r0
statefulset.apps/my-keycloak-postgresql  1/1     12h   postgresql   docker.io/bitnami/postgresql:17.4.0-debian-12-r17
root@lb:~# kubectl get gateway -n keycloak -o wide
NAME               AGE
keycloak-gateway   12h
root@lb:~# kubectl get virtualservice -n keycloak -o wide
NAME               GATEWAYS               HOSTS                        AGE
keycloak-redirect  ["keycloak-gateway"]   ["keycloak.spantosh.tk"]     12h
keycloak-ui        ["keycloak-gateway"]   ["keycloak.spantosh.tk"]     12h
```

Figure 5: keycloak

```
root@lb:~# kubectl get all -n monitoring -o wide
NAME                                                READY   STATUS    RESTARTS   AGE   IP              NODE       NOMINATED NODE   READINESS GATES
pod/alertmanager-prometheus-alertmanager-0          2/2     Running   0          3d    10.42.5.26      worker01   <none>           <none>
pod/grafana-6b446579b6-nm829                        3/3     Running   0          8h    10.42.5.37      worker01   <none>           <none>
pod/kube-state-metrics-7c4b9f4568-jrmg7             1/1     Running   0          3d    10.42.5.24      worker01   <none>           <none>
pod/node-exporter-4ntgs                             1/1     Running   0          3d    172.16.25.152   node01     <none>           <none>
pod/node-exporter-mgr77                             1/1     Running   0          3d    172.16.25.153   node02     <none>           <none>
pod/node-exporter-tdwff                             1/1     Running   0          3d    172.16.25.154   node03     <none>           <none>
pod/node-exporter-tzmfl                             1/1     Running   0          3d    172.16.25.155   worker01   <none>           <none>
pod/node-exporter-vqfdc                             1/1     Running   0          3d    172.16.25.156   worker02   <none>           <none>
pod/prometheus-operator-6b479d5986-4kws7            1/1     Running   0          3d    10.42.30.86     worker02   <none>           <none>
pod/prometheus-prometheus-prometheus-0              2/2     Running   0          3d    10.42.30.92     worker02   <none>           <none>

NAME                                      TYPE        CLUSTER-IP      EXTERNAL-IP   PORT(S)                      AGE   SELECTOR
service/alertmanager-operated             ClusterIP   None            <none>        9093/TCP,9094/TCP,9094/UDP   3d    app.kubernetes.io/name=alertmanager
service/grafana                           ClusterIP   10.43.253.98    <none>        80/TCP                       3d    app.kubernetes.io/instance=prometheus,app.kubernetes.io/name=grafana
service/kube-state-metrics                ClusterIP   10.43.240.179   <none>        8080/TCP,8081/TCP            3d    app.kubernetes.io/instance=prometheus,app.kubernetes.io/name=kube-state-metrics
service/node-exporter                     ClusterIP   10.43.50.164    <none>        9100/TCP                     3d    app.kubernetes.io/instance=prometheus,app.kubernetes.io/name=prometheus-node-exporter
service/prometheus-alertmanager           ClusterIP   10.43.198.31    <none>        9093/TCP,8080/TCP            3d    alertmanager=prometheus-alertmanager,app.kubernetes.io/name=alertmanager
service/prometheus-operated               ClusterIP   None            <none>        9090/TCP                     3d    app.kubernetes.io/name=prometheus
service/prometheus-operator               ClusterIP   10.43.90.163    <none>        443/TCP                      3d    app=kube-prometheus-stack-operator,release=prometheus
service/prometheus-prometheus             ClusterIP   10.43.222.160   <none>        9090/TCP,8080/TCP            3d    app.kubernetes.io/name=prometheus,operator.prometheus.io/name=prometheus-prometheus

NAME                                  DESIRED   CURRENT   READY   UP-TO-DATE   AVAILABLE   NODE SELECTOR            AGE   CONTAINERS      IMAGES                                SELECTOR
daemonset.apps/node-exporter   5         5         5       5            5           kubernetes.io/os=linux   3d    node-exporter   quay.io/prometheus/node-exporter:v1.9.1   app.kubernetes.io/instance=prometheus,app.kubernetes.io/nam
e=prometheus-node-exporter

NAME                                  READY   UP-TO-DATE   AVAILABLE   AGE   CONTAINERS                                                IMAGES
    SELECTOR
deployment.apps/grafana               1/1     1            1           3d    grafana-sc-dashboard,grafana-sc-datasources,grafana       quay.io/kiwigrid/k8s-sidecar:1.30.3,quay.io/kiwigrid/k8s-sidecar:1.30.3,docker.io/grafana/grafana:12.
0.2   app.kubernetes.io/instance=prometheus,app.kubernetes.io/name=grafana
deployment.apps/kube-state-metrics    1/1     1            1           3d    kube-state-metrics                                        registry.k8s.io/kube-state-metrics/kube-state-metrics:v2.16.0
    app.kubernetes.io/instance=prometheus,app.kubernetes.io/name=kube-state-metrics
deployment.apps/prometheus-operator   1/1     1            1           3d    kube-prometheus-stack                                     quay.io/prometheus-operator/prometheus-operator:v0.83.0
      app=kube-prometheus-stack-operator,release=prometheus

NAME                                                DESIRED   CURRENT   READY   AGE   CONTAINERS                                                IMAGES
          SELECTOR
replicaset.apps/grafana-6b446579b6                  1         1         1       8h    grafana-sc-dashboard,grafana-sc-datasources,grafana       quay.io/kiwigrid/k8s-sidecar:1.30.3,quay.io/kiwigrid/k8s-sidecar:1.30.3,docker.io/grafana/grafa
na:12.0.2   app.kubernetes.io/instance=prometheus,app.kubernetes.io/name=grafana,pod-template-hash=6b446579b6
replicaset.apps/grafana-6b9fb5f595                  0         0         0       3d    grafana-sc-dashboard,grafana-sc-datasources,grafana       quay.io/kiwigrid/k8s-sidecar:1.30.3,quay.io/kiwigrid/k8s-sidecar:1.30.3,docker.io/grafana/grafa
na:12.0.2   app.kubernetes.io/instance=prometheus,app.kubernetes.io/name=grafana,pod-template-hash=6b9fb5f595
replicaset.apps/grafana-85b6cbfc5b                  0         0         0       9h    grafana-sc-dashboard,grafana-sc-datasources,grafana       quay.io/kiwigrid/k8s-sidecar:1.30.3,quay.io/kiwigrid/k8s-sidecar:1.30.3,docker.io/grafana/grafa
na:12.0.2   app.kubernetes.io/instance=prometheus,app.kubernetes.io/name=grafana,pod-template-hash=85b6cbfc5b
replicaset.apps/grafana-8658c54464                  0         0         0       3d    grafana-sc-dashboard,grafana-sc-datasources,grafana       quay.io/kiwigrid/k8s-sidecar:1.30.3,quay.io/kiwigrid/k8s-sidecar:1.30.3,docker.io/grafana/grafa
na:12.0.2   app.kubernetes.io/instance=prometheus,app.kubernetes.io/name=grafana,pod-template-hash=8658c54464
replicaset.apps/grafana-f86f489fb                   0         0         0       8h    grafana-sc-dashboard,grafana-sc-datasources,grafana       quay.io/kiwigrid/k8s-sidecar:1.30.3,quay.io/kiwigrid/k8s-sidecar:1.30.3,docker.io/grafana/grafa
na:12.0.2   app.kubernetes.io/instance=prometheus,app.kubernetes.io/name=grafana,pod-template-hash=f86f489fb
replicaset.apps/kube-state-metrics-7c4b9f4568       1         1         1       3d    kube-state-metrics                                        registry.k8s.io/kube-state-metrics/kube-state-metrics:v2.16.0
      app.kubernetes.io/instance=prometheus,app.kubernetes.io/name=kube-state-metrics,pod-template-hash=7c4b9f4568
replicaset.apps/prometheus-operator-6b479d5986      1         1         1       3d    kube-prometheus-stack                                     quay.io/prometheus-operator/prometheus-operator:v0.83.0
        app=kube-prometheus-stack-operator,pod-template-hash=6b479d5986,release=prometheus

NAME                                                READY   AGE   CONTAINERS                IMAGES
statefulset.apps/alertmanager-prometheus-alertmanager   1/1     3d    alertmanager,config-reloader   quay.io/prometheus/alertmanager:v0.28.1,quay.io/prometheus-operator/prometheus-config-reloader:v0.83.0
statefulset.apps/prometheus-prometheus-prometheus       1/1     3d    prometheus,config-reloader     quay.io/prometheus/prometheus:v3.5.0,quay.io/prometheus-operator/prometheus-config-reloader:v0.83.0
root@lb:~# kubectl get gateway -n monitoring -o wide
NAME      AGE
grafana-gateway   3d
root@lb:~# kubectl get virtualservice -n monitoring -o wide
NAME      GATEWAYS             HOSTS                    AGE
grafana-ui  ["grafana-gateway"]  ["grafana.spantosh.tk"]  3d
```

Figure 6: monitoring

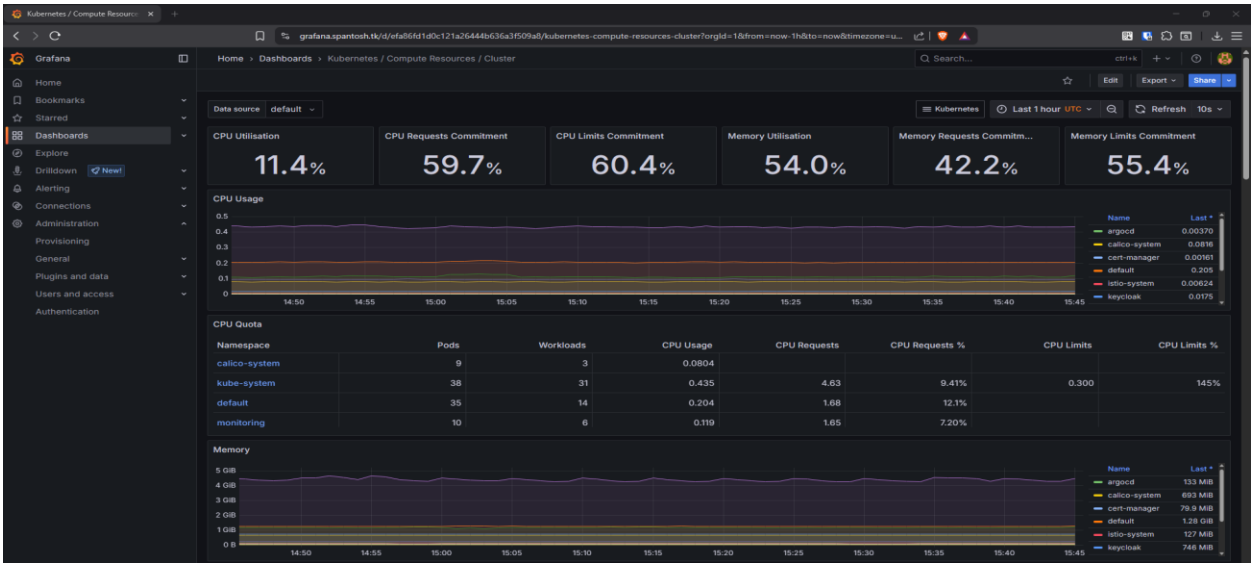

Figure 7: Grafana Dashboard

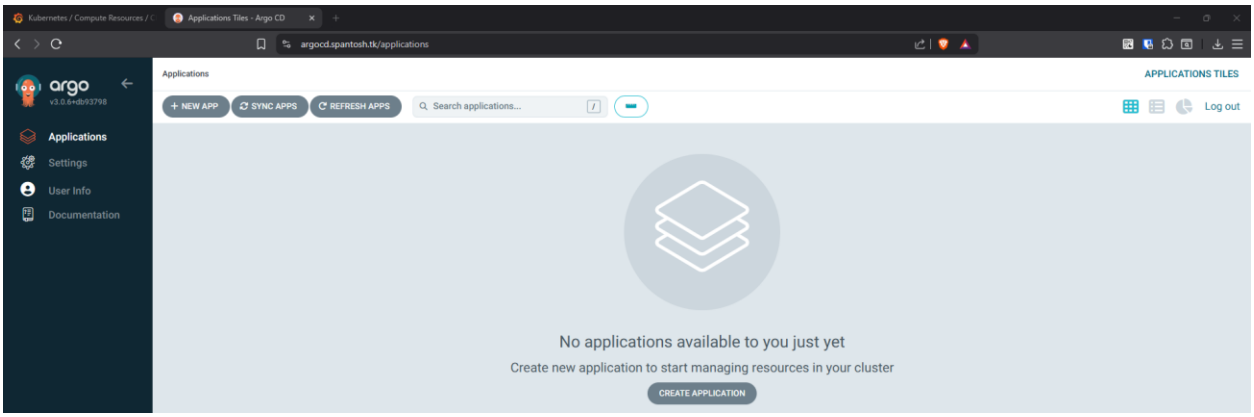

Figure 8: Argocd-UI

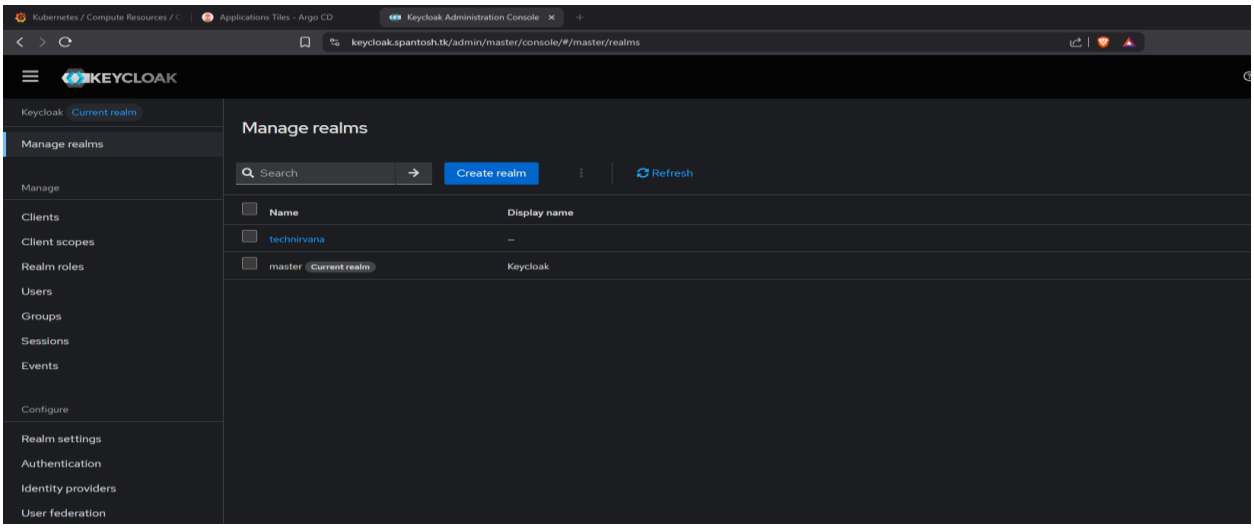

Figure 9: key cloak-UI