Kubernetes Lease – Kubernetes Leader-Elector Sidecar Setup

What is Kubernetes Lease?

In Kubernetes, a Lease is a special resource (kind: Lease) in the **coordination.k8s.io/v1** API group that is used to implement leader election or distributed coordination among multiple pods.

A **Lease** represents a lightweight lock that a pod can acquire for a limited time to become the "leader." It contains metadata such as the current holder, acquisition time, and lease duration. Other pods can attempt to acquire the lease when it expires, ensuring that at most one pod is the leader at a time.

Key points:

i) Stored in the Kubernetes API server (backed by etcd).

ii) Usually used for **leader election** by controllers or custom sidecars.

iii) Helps prevent multiple replicas from performing the same operation simultaneously.

iv) The lease has fields like:

holderIdentity - the current leader's identifier

leaseDurationSeconds - how long the lease is valid

acquireTime - when the lease was acquired

renewTime - last time the leader renewed the lease

NOTE: Kubernetes Lease = a lightweight API-based lock for leader election among pods.

APPROACHES

i)   Use a Kubernetes client library (Java, Go, Python, etc.) in your app.

Example client libraries:

- Java: Fabric8 Kubernetes Client → LeaderElector with Lease

- Go: client-go → leaderelection package with LeaseLock

- Python: kubernetes library → custom Lease acquisition.

For Further Reference: https://www.linkedin.com/pulse/kubernetes-leases-leader-election-ensuring-high-suyash-gogte-tybbf

ii) Kubernetes Lease API Sidecar Leader Election

Pre-Requisites

    i) A running **Kubernetes cluster** (kubeadm-based is fine).

    ii) kubectl configured and pointing to your cluster.

    iii) At least v1.13+ Kubernetes (because leader election via Endpoints is supported from early versions).

    iv) 3 replicas of your application (or more) to test leader election.

    v) Main image: (e.g., nginx:1.25 as placeholder).

    vi) Leader-elector sidecar image: 'gcr.io/google_containers/leader-elector:0.4'.

Implementation

rbac.yaml

```yaml
apiVersion: v1

kind: ServiceAccount

metadata:

  name: leader-elector-sa

  namespace: default

---

apiVersion: rbac.authorization.k8s.io/v1

kind: Role

metadata:

  name: leader-elector-role

  namespace: default

rules:

# Endpoints-based leader election (required for gcr.io/google_containers/leader-elector:0.4)

- apiGroups: [""]

  resources: ["endpoints"]

  verbs: ["get", "create", "update", "patch"]

# Optional: pods read (some modes read pod identity)

- apiGroups: [""]

  resources: ["pods"]

  verbs: ["get", "list", "watch"]
```

```yaml
# Optional: future-proof if you ever switch to Lease
- apiGroups: ["coordination.k8s.io"]
  resources: ["leases"]
  verbs: ["get", "create", "update", "patch"]
---
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: leader-elector-binding
  namespace: default
subjects:
- kind: ServiceAccount
  name: leader-elector-sa
  namespace: default
roleRef:
  kind: Role
  name: leader-elector-role
  apiGroup: rbac.authorization.k8s.io
```

Apply: kubectl apply -f rbac.yaml

---

deployment.yaml
```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: my-app
  namespace: default
spec:
  replicas: 3
  selector:
    matchLabels:
      app: my-app
```

```yaml
  template:
    metadata:
      labels:
        app: my-app
    spec:
      serviceAccountName: leader-elector-sa
      containers:
      - name: main-app
        image: nginx:1.25
      - name: leader-elector
        image: gcr.io/google_containers/leader-elector:0.4
        args:
          - "--election=leader-election"   # Endpoints object name in 'default' ns
          - "--http=0.0.0.0:4040"          # sidecar status endpoint
          - "--ttl=30s"                    # renew period / ttl
      ports:
      - name: http
        containerPort: 4040
```

Apply: kubectl apply -f deployment.yaml

VERIFICATION

i) Command: `kubectl get po -A`

```
default        my-app-789986b684-8zlbx                   2/2      Running   0              39m
default        my-app-789986b684-9hck7                   2/2      Running   0              38m
default        my-app-789986b684-p8nfx                   2/2      Running   0              39m
```

ii)   Leader info via Endpoints annotation

Command: `kubectl get endpoints leader-election -n default -o yaml`

```
pranavpp37@k8s-master:~$
kubectl get endpoints leader-election -n default -o yaml
apiVersion: v1
kind: Endpoints
metadata:
  annotations:
    control-plane.alpha.kubernetes.io/leader: '{"holderIdentity":"my-app-789986b684-8zlbx","leaseDurationSeconds":30,"acquireTime":"2
025-12-29T11:10:58Z","renewTime":"2025-12-29T11:50:31Z","leaderTransitions":0}'
  creationTimestamp: "2025-12-29T11:08:02Z"
  name: leader-election
  namespace: default
  resourceVersion: "791440"
  uid: ac8ad671-55ca-4f88-b155-e8cca5ede95d
```

iii)   Extract leader pod name

Command: `kubectl get endpoints leader-election -o jsonpath='{.metadata.annotations.control-plane\.alpha\.kubernetes\.io/leader}' \`

  `| sed -E 's/.*"holderIdentity":"([^"]+)".*/\1/' && echo`

```
pranavpp37@k8s-master:~$
kubectl get endpoints leader-election -o jsonpath='{.metadata.annotations.control-plane\.alpha\.kubernetes\.io/leader}' \
  | sed -E 's/.*"holderIdentity":"([^"]+)".*/\1/' && echo
my-app-789986b684-8zlbx
```

iv)   Check logs of Leader

Command: `kubectl logs my-app-789986b684-8zlbx`

```
pranavpp37@k8s-master:~$ kubectl logs my-app-789986b684-8zlbx
Defaulted container "main-app" out of: main-app, leader-elector
/docker-entrypoint.sh: /docker-entrypoint.d/ is not empty, will attempt to perform configuration
/docker-entrypoint.sh: Looking for shell scripts in /docker-entrypoint.d/
/docker-entrypoint.sh: Launching /docker-entrypoint.d/10-listen-on-ipv6-by-default.sh
10-listen-on-ipv6-by-default.sh: info: Getting the checksum of /etc/nginx/conf.d/default.conf
10-listen-on-ipv6-by-default.sh: info: Enabled listen on IPv6 in /etc/nginx/conf.d/default.conf
/docker-entrypoint.sh: Sourcing /docker-entrypoint.d/15-local-resolvers.envsh
/docker-entrypoint.sh: Launching /docker-entrypoint.d/20-envsubst-on-templates.sh
/docker-entrypoint.sh: Launching /docker-entrypoint.d/30-tune-worker-processes.sh
/docker-entrypoint.sh: Configuration complete; ready for start up
2025/12/29 11:09:53 [notice] 1#1: using the "epoll" event method
2025/12/29 11:09:53 [notice] 1#1: nginx/1.25.5
2025/12/29 11:09:53 [notice] 1#1: built by gcc 12.2.0 (Debian 12.2.0-14)
2025/12/29 11:09:53 [notice] 1#1: OS: Linux 6.8.0-1045-gcp
2025/12/29 11:09:53 [notice] 1#1: getrlimit(RLIMIT_NOFILE): 1048576:1048576
2025/12/29 11:09:53 [notice] 1#1: start worker processes
2025/12/29 11:09:53 [notice] 1#1: start worker process 29
2025/12/29 11:09:53 [notice] 1#1: start worker process 30
```

Command: `kubectl logs my-app-789986b684-8zlbx -c leader-elector`

```
pranavpp37@k8s-master:~$ kubectl logs my-app-789986b684-8zlbx -c leader-elector
my-app-ddbc6cb96-wjnlf is the leader
I1229 11:09:53.185992       8 leaderelection.go:259] lock is held by my-app-ddbc6cb96-wjnlf and has not yet expired
I1229 11:10:06.132517       8 leaderelection.go:259] lock is held by my-app-ddbc6cb96-wjnlf and has not yet expired
I1229 11:10:22.101432       8 leaderelection.go:259] lock is held by my-app-ddbc6cb96-wjnlf and has not yet expired
I1229 11:10:35.587057       8 leaderelection.go:259] lock is held by my-app-ddbc6cb96-wjnlf and has not yet expired
I1229 11:10:47.031278       8 leaderelection.go:259] lock is held by my-app-ddbc6cb96-wjnlf and has not yet expired
my-app-789986b684-8zlbx is the leader
E1229 11:10:58.364566       8 event.go:247] Could not construct reference to: '&api.Endpoints{TypeMeta:unversioned.TypeMeta{Kind:"",
APIVersion:""}, ObjectMeta:api.ObjectMeta{Name:"leader-election", GenerateName:"", Namespace:"default", SelfLink:"", UID:"ac8ad671-55
ca-4f88-b155-e8cca5ede95d", ResourceVersion:"787275", Generation:0, CreationTimestamp:unversioned.Time{Time:time.Time{sec:63902603282
, nsec:0, loc:(*time.Location)(0x19072e0)}}, DeletionTimestamp:(*unversioned.Time)(nil), DeletionGracePeriodSeconds:(*int64)(nil), La
bels:map[string]string(nil), Annotations:map[string]string{"control-plane.alpha.kubernetes.io/leader":"{\"holderIdentity\":\"my-app-d
dbc6cb96-wjnlf\",\"leaseDurationSeconds\":30,\"acquireTime\":\"2025-12-29T11:08:02Z\",\"renewTime\":\"2025-12-29T11:09:47Z\",\"leader
Transitions\":0}"}}, Subsets:[]api.EndpointSubset(nil)}' due to: 'selfLink was empty, can't make reference'. Will not report event: '
Normal' '%v became leader' 'my-app-789986b684-8zlbx'
I1229 11:10:58.364782       8 leaderelection.go:180] sucessfully acquired lease default/leader-election
pranavpp37@k8s-master:~$
```

v)   Check logs of other pods

Command: `kubectl logs  my-app-789986b684-9hck7 -c leader-elector`

```
I1229 11:53:26.035041       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:53:36.413893       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:53:48.413910       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:53:59.522062       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:54:07.204637       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:54:20.514276       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:54:31.876585       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:54:42.437327       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:54:57.928738       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:55:07.559915       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:55:21.949250       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:55:29.774831       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:55:43.827615       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:55:56.966115       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:56:09.088473       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:56:17.244438       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:56:31.267448       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
I1229 11:56:46.690334       8 leaderelection.go:259] lock is held by my-app-789986b684-8zlbx and has not yet expired
```