Kanister.io

Using cloud native approach to organize data protection

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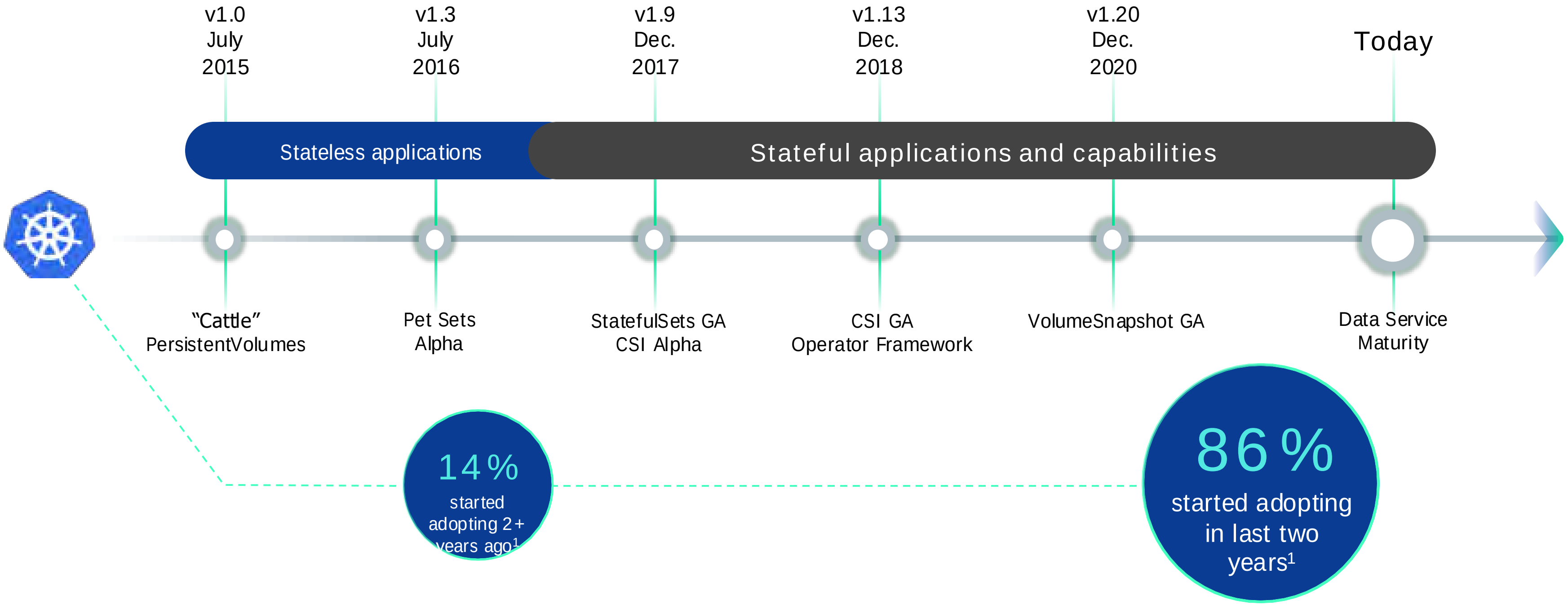
Motivation: Data on Kubernetes

- Myth: everything is stateless on Kubernetes
  - Kubernetes cluster and application configuration has state
  - Secrets, RBAC, DNS, etc
  - CNCF Study 2020: 55% of respondents running stateful workloads
  - Audit requirements unsatisfied: proof of point in time cluster state configuration
- Myth: with GitOps I can recover a cluster with all applications
  - Stateful workloads still need to backup artifacts outside the cluster
  - Audit, forensics, point-in-time recovery concerns are still there
- Myth: with public cloud I am protected
  - Cloud providers recommend you set up disaster recovery
- Myth: etcd backups protect Kubernetes data
  - Etcd restore almost never gets applications into desired state

From Stateless to Stateful



v1.0
July
2015

v1.3
July
2016

v1.9
Dec.
2017

v1.13
Dec.
2018

v1.20
Dec.
2020

Today

Stateless applications

Stateful applications and capabilities

“Cattle”
PersistentVolumes

Pet Sets
Alpha

StatefulSets GA
CSI Alpha

CSI GA
Operator Framework

VolumeSnapshot GA

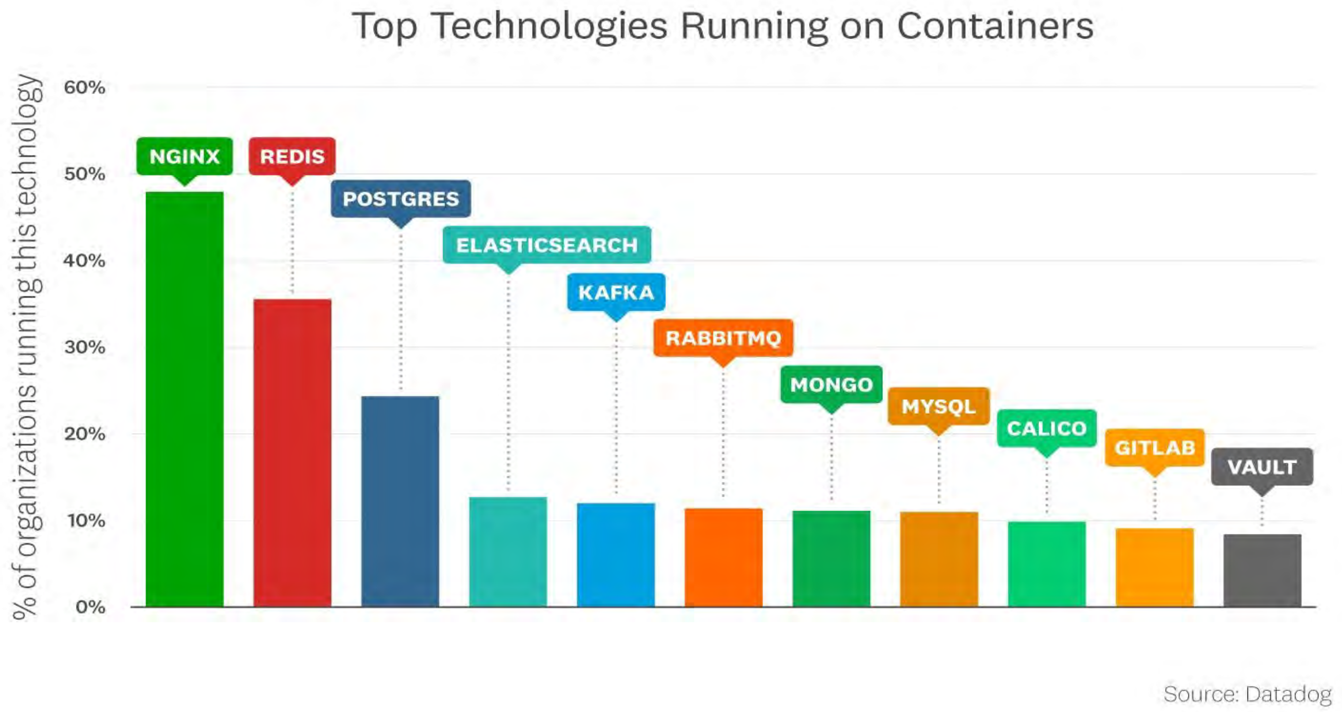
Data Service
Maturity

14%
started adopting 2+ years ago[1]

86%
started adopting in last two years[1]

[1] 2022 Data on Kubernetes Report (N=500+)

Applications on Kubernetes



[Datadog Real-World Container Use Report – Nov 2022]

3-2-1 backup rule

3

Different Copies Of Data

2

Different Media

1

Of which is offsite

Source: The DAM Book: Digital Asset Management for Photographers, Peter Krogh, 2005.

- https://community.veeam.com/blogs-and-podcasts-57/3-2-1-1-0-golden-backup-rule-569
- https://www.cisa.gov/uscert/sites/default/files/publications/data_backup_options.pdf

The Challenge: Complex Workflows

- One application includes many domains
  - *Difficult to separate concerns of different domain experts*

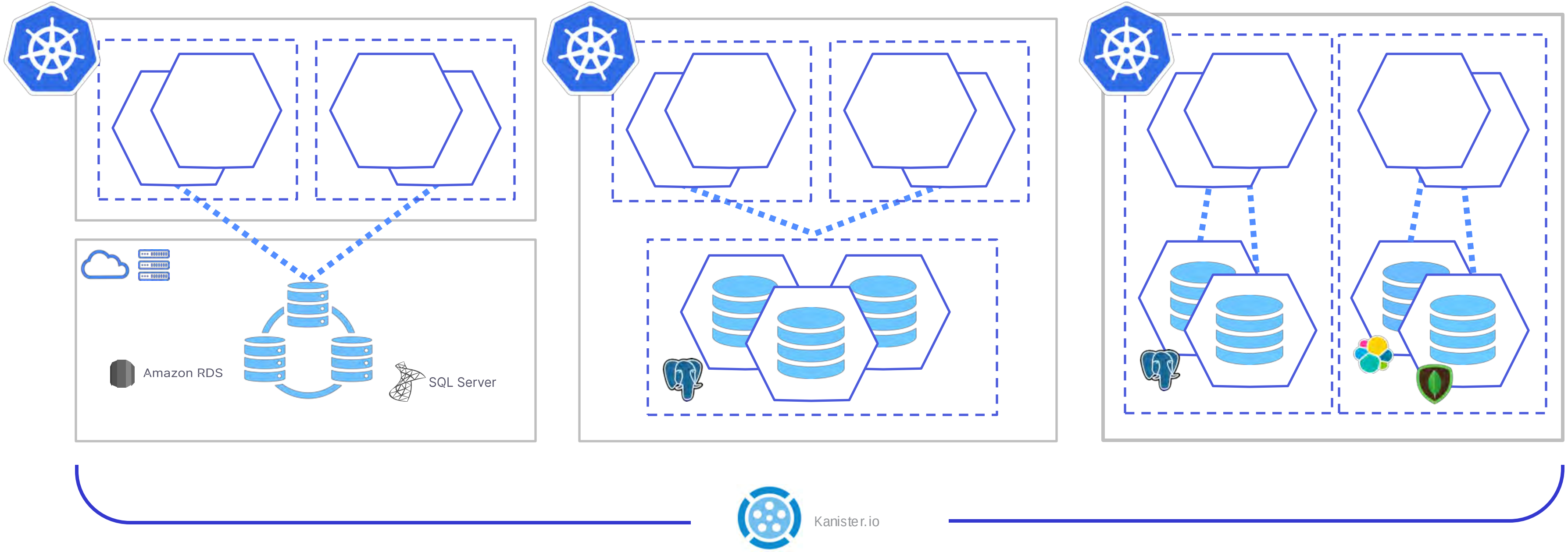
- Many moving parts
  - Different types of backups
    - *Logical backups*
    - *Volume snapshots*
    - *Provider specific API calls – Amazon RDS, data service operators*

  - Application Lifecycle
    - *Scale up/down workloads*
    - *Quiesce/Unquiesce*

  - Different types of targets
    - *Object storage*
    - *Vendor targets*

Cloud Native Deployment Patterns

Application using data services outside of Kubernetes	Data services in Kubernetes – separate from Application	Application includes data services – all in Kubernetes



The Challenge: Flavours of Data Management

- Storage-centric snapshots
  - Provided by the underlying file or block storage
  - Crash-consistent
- Storage-centric with data service hooks
  - Freeze/unfreeze data service layer during snapshot process
- Data service-centric
  - Use database specific utilities
  - mysqldump, pg_dump, mongodump etc.
- Application-centric
  - Exercise all the above capabilities in a coordinated manner

Kanister.io: CNCF sandbox history

- 2017: Created & launched @ KubeCon NA
- 2023-06-20: Submitted to CNCF
- 2023-09-19: Vote passes for Acceptance https://github.com/cncf/sandbox/issues/46 Project Onboarding: https://github.com/cncf/toc/issues/1172
- 2023-11-07: Veeam Press Release, adopter and ISV support

CNCF Project Maturity:

Sandbox

Incubating

Graduated

Kanister Contribution to CNCF (Sandbox)

kanister.io

CLOUD NATIVE
COMPUTING FOUNDATION

Kanister community blueprints:

Amazon RDS
Cassandra
PostgreSQL
MySQL
MongoDB
SQL Server
K8ssandra
Elasticsearch

Growing database diversity, e.g., Vector databases

Weaviate
Milvus
Pinecone

Data on Kubernetes Growth

Databases (SQL/NoSQL) lead the growth of stateful workloads on Kubernetes, database diversity and deployments continue to increase data protection requirements

Kanister.io

Data protection operations in a cloud native, extensible manner for application consistent backup and recovery. Kanister has been an open source project and community since 2017.

Rapid Release and Innovation

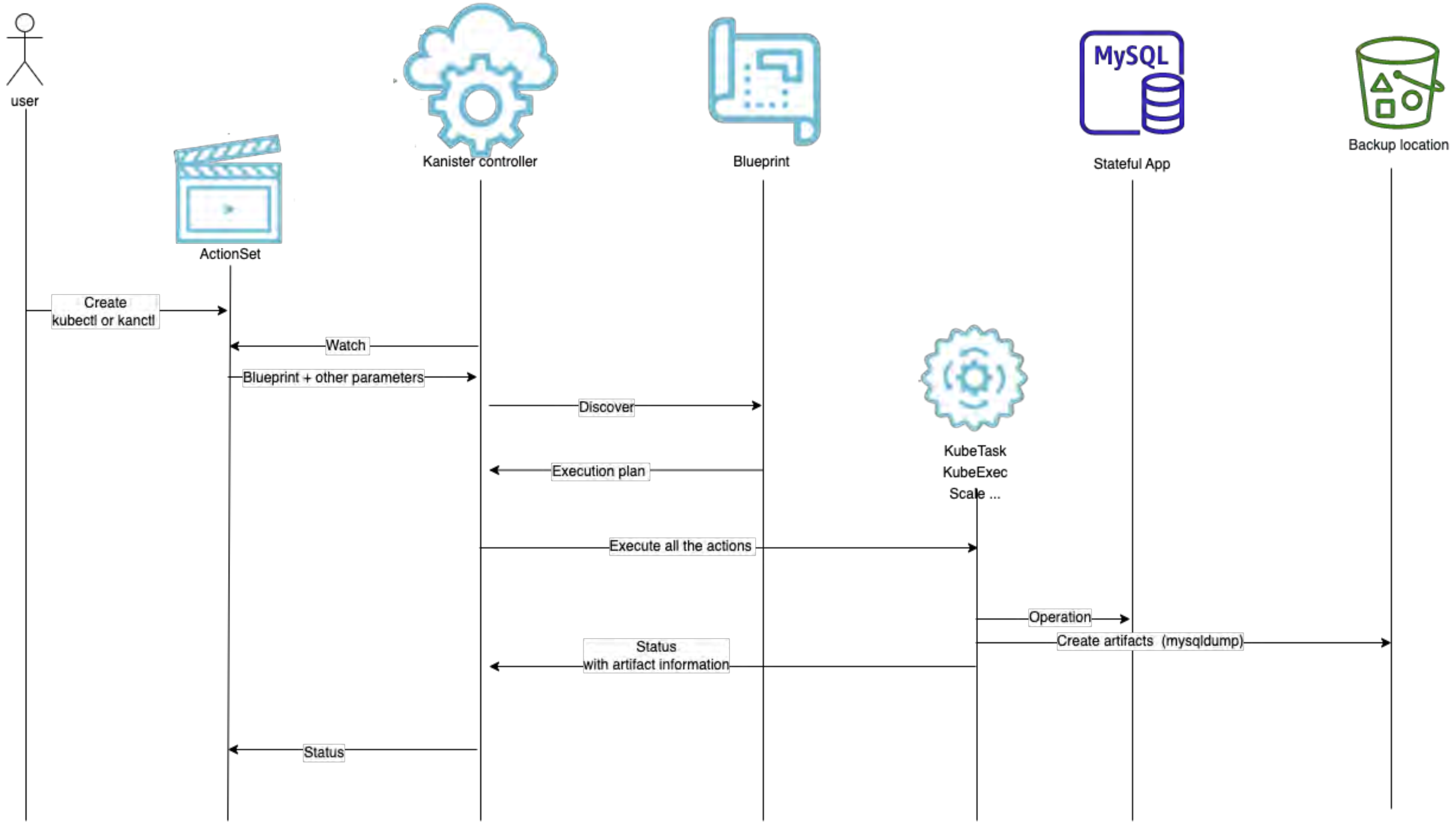
0.94 Prometheus metrics, OCP 4.13 support, Grype security scanner
0.92 MongoDB Atlas blueprint
0.91 OCP 4.12 support, AWS RDS Postgres blueprint
0.90 Kopia controller, Incremental Elastic blueprint

How Kanister.io Orchestrates Data Protection

A Kanister controller, installed by Helm chart, provides new Custom Resource Definitions:

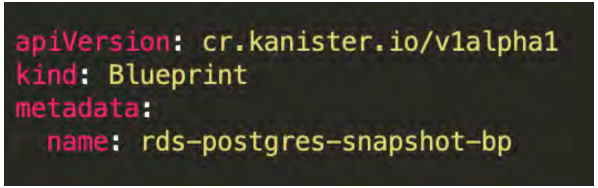
- Blueprint
  - Defines workflows for backup, restore and delete operations
  - Part of your infrastructure setup
- ActionSet
  - Runs an action to backup, restore and delete
  - Created on backup and restore action, contains status of operation
- Profile
  - Defines target destination for backups or sources for restores, e.g. S3 bucket

Kanister: in Action

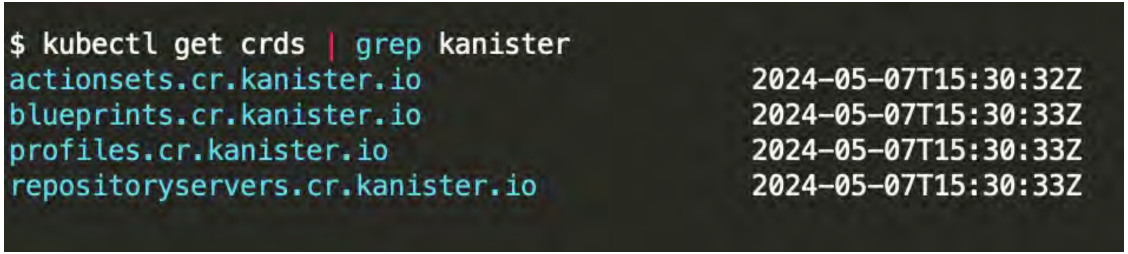


Breaking down the Blueprint

Blueprints are custom resources



```yaml
apiVersion: cr.kanister.io/v1alpha1
kind: Blueprint
metadata:
  name: rds-postgres-snapshot-bp
```

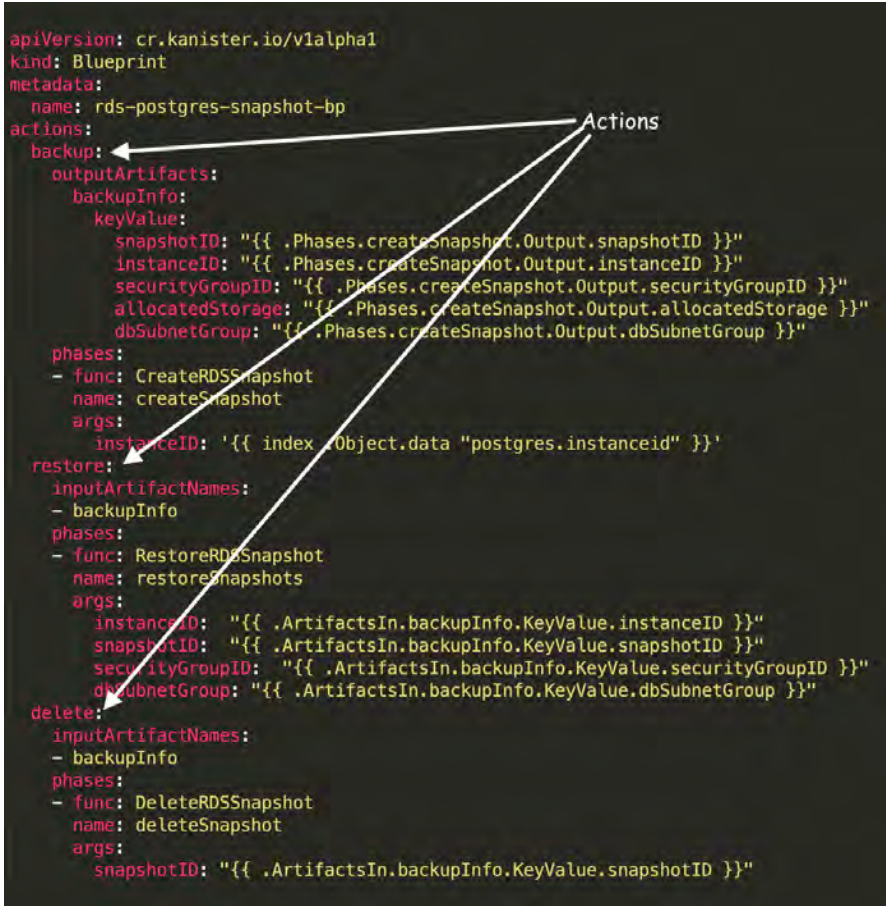


```
$ kubectl get crds | grep kanister
actionsets.cr.kanister.io                          2024-05-07T15:30:32Z
blueprints.cr.kanister.io                          2024-05-07T15:30:33Z
profiles.cr.kanister.io                            2024-05-07T15:30:33Z
repositoryservers.cr.kanister.io                   2024-05-07T15:30:33Z
```

https://github.com/kanisterio/kanister/blob/master/examples/aws-rds/postgresql/rds-postgres-snap-blueprint.yaml

Blueprints are templates for actions

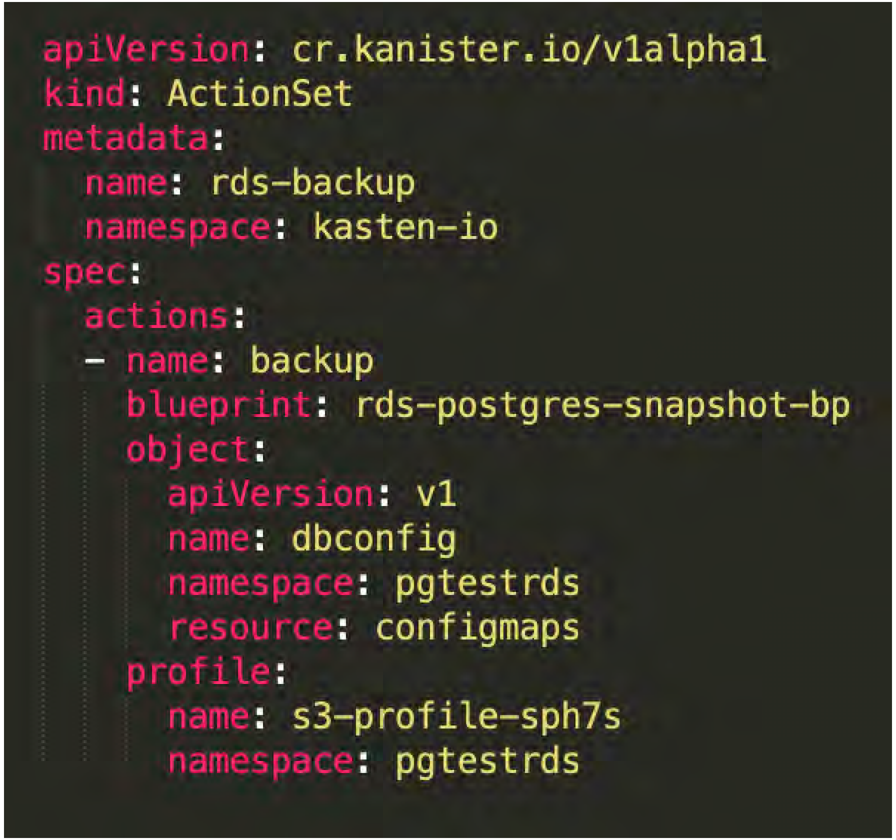
- ‘backup’, ‘restore’, ‘delete’ are actions
- Actions have phases
- Each phase executes a Function



```
apiVersion: cr.kanister.io/v1alpha1
kind: Blueprint
metadata:
  name: rds-postgres-snapshot-bp
actions:
  backup:
    outputArtifacts:
      backupInfo:
        keyValue:
          snapshotID: "{{ .Phases.createSnapshot.Output.snapshotID }}"
          instanceID: "{{ .Phases.createSnapshot.Output.instanceID }}"
          securityGroupID: "{{ .Phases.createSnapshot.Output.securityGroupID }}"
          allocatedStorage: "{{ .Phases.createSnapshot.Output.allocatedStorage }}"
          dbSubnetGroup: "{{ .Phases.createSnapshot.Output.dbSubnetGroup }}"
    phases:
    - func: CreateRDSSnapshot
      name: createSnapshot
      args:
        instanceID: '{{ index .Object.data "postgres.instanceid" }}'
  restore:
    inputArtifactNames:
    - backupInfo
    phases:
    - func: RestoreRDSSnapshot
      name: restoreSnapshots
      args:
        instanceID:  "{{ .ArtifactsIn.backupInfo.KeyValue.instanceID }}"
        snapshotID:  "{{ .ArtifactsIn.backupInfo.KeyValue.snapshotID }}"
        securityGroupID:  "{{ .ArtifactsIn.backupInfo.KeyValue.securityGroupID }}"
        dbSubnetGroup: "{{ .ArtifactsIn.backupInfo.KeyValue.dbSubnetGroup }}"
  delete:
    inputArtifactNames:
    - backupInfo
    phases:
    - func: DeleteRDSSnapshot
      name: deleteSnapshot
      args:
        snapshotID: "{{ .ArtifactsIn.backupInfo.KeyValue.snapshotID }}"
```

ActionSets execute actions

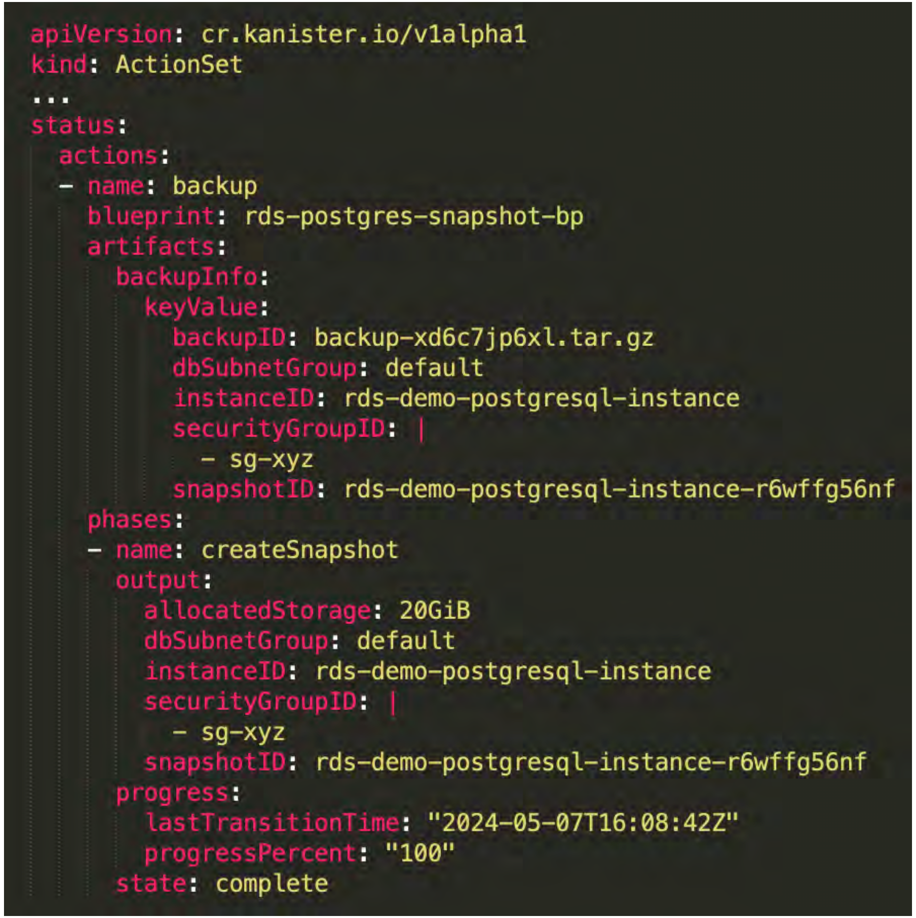
- Target blueprint and action name
- Each action provide template values
- All actions in actionset execute in parallel
- Phases run sequentially



```yaml
apiVersion: cr.kanister.io/v1alpha1
kind: ActionSet
metadata:
  name: rds-backup
  namespace: kasten-io
spec:
  actions:
  - name: backup
    blueprint: rds-postgres-snapshot-bp
    object:
      apiVersion: v1
      name: dbconfig
      namespace: pgtestrds
      resource: configmaps
    profile:
      name: s3-profile-sph7s
      namespace: pgtestrds
```

ActionSets track status

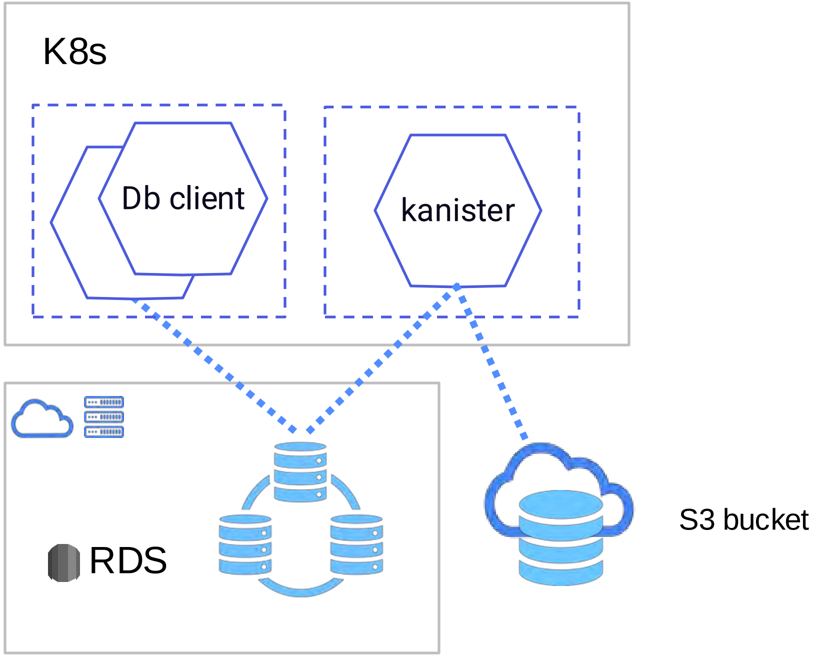
- Each phase has progress and state
- ActionSet produces artifacts



```
apiVersion: cr.kanister.io/v1alpha1
kind: ActionSet
...
status:
  actions:
  - name: backup
    blueprint: rds-postgres-snapshot-bp
    artifacts:
      backupInfo:
        keyValue:
          backupID: backup-xd6c7jp6xl.tar.gz
          dbSubnetGroup: default
          instanceID: rds-demo-postgresql-instance
          securityGroupID: |
            - sg-xyz
          snapshotID: rds-demo-postgresql-instance-r6wffg56nf
    phases:
    - name: createSnapshot
      output:
        allocatedStorage: 20GiB
        dbSubnetGroup: default
        instanceID: rds-demo-postgresql-instance
        securityGroupID: |
          - sg-xyz
        snapshotID: rds-demo-postgresql-instance-r6wffg56nf
      progress:
        lastTransitionTime: "2024-05-07T16:08:42Z"
        progressPercent: "100"
      state: complete
```

Demo: RDS backup

Demo infra setup



Advantage of kanister approach

- We shipped backup off from RDS into object storage
- We ran all operations on K8s runners
- We can have blueprints and for all services in the same catalog in K8s
- We have backups metadata (actionsets) in K8s

Kanister integrations

Kanister functions

- Custom Logic
  - KubeExec
  - KubeTask
- Resource Lifecycle
  - Scale up/down workloads
  - KubeTask with kubectl command
- Handle PVC
  - Backup/Restore/DeleteData
  - PrepareData
- Volume Snapshots
  - Create/Restore/Delete
- Amazon RDS
  - Create/Restore/Delete
  - ExportSnapshotToRegion

Providers supported

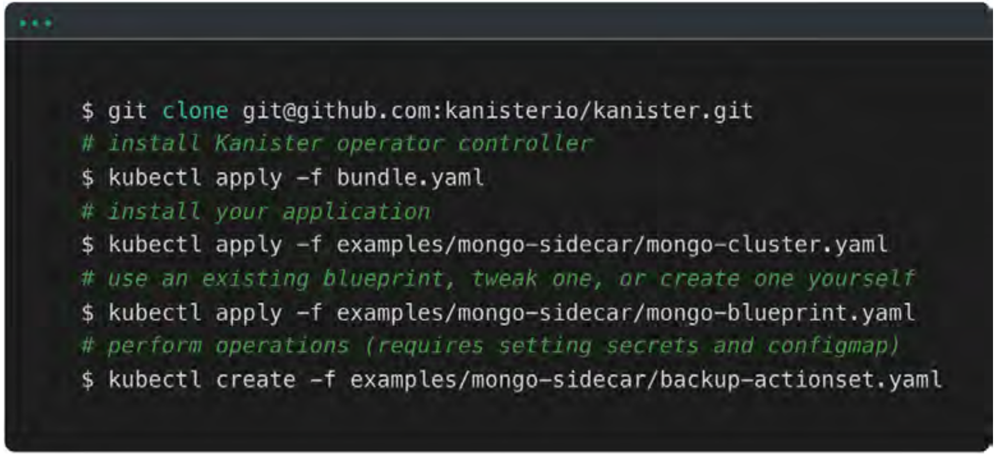
- Object Storage
  - Amazon S3
  - S3 Compliant
  - Azure Blob
  - Google Cloud Storage

- Block/File Storage (in-tree)
  - Amazon EBS/EFS
  - Azure Disk
  - Google Persistent Disk
  - IBM Disk
  - CSI

Thank you!

Kanister resources:

- github.com/kanisterio/kanister
- @kanisterio
- #kanisterio
- tiny.cc/kanisterio



```
$ git clone git@github.com:kanisterio/kanister.git
# install Kanister operator controller
$ kubectl apply -f bundle.yaml
# install your application
$ kubectl apply -f examples/mongo-sidecar/mongo-cluster.yaml
# use an existing blueprint, tweak one, or create one yourself
$ kubectl apply -f examples/mongo-sidecar/mongo-blueprint.yaml
# perform operations (requires setting secrets and configmap)
$ kubectl create -f examples/mongo-sidecar/backup-actionset.yaml
```