



DevOps World



Jenkins World

Jenkins Kubernetes Operator



About



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Senior Cloud Engineer

- AWS and Azure
- custom Kubernetes distribution
- Golang



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History



Jenkins snowflake



No one knew how it worked...



Manual



Amazon
EC2



Software
Developers



Manual

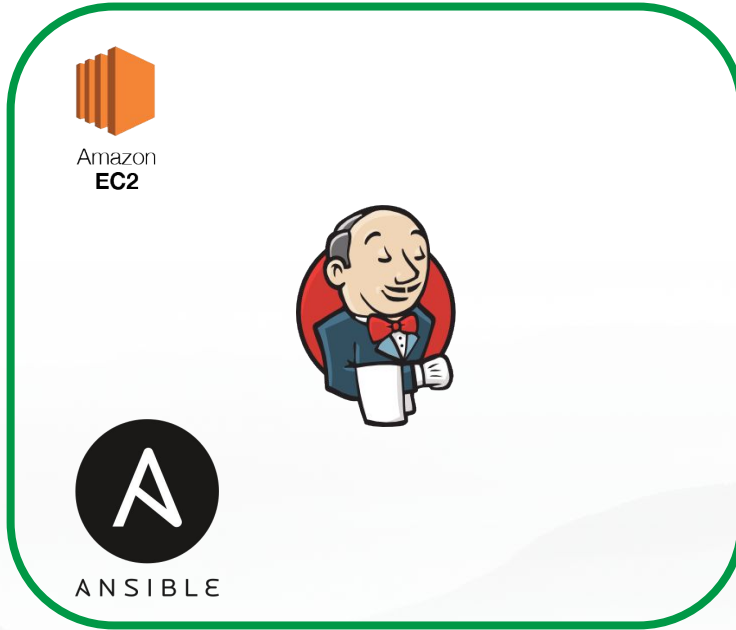
- Jenkins out of date (unsecure)
- cloud infrastructure built by hand
- tons of unnecessary files in the Jenkins home
- no auto-scaling
- extremely high MTTR



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Automated



ANSIBLE



Software
Developers



Automated

- very hard to write
- even harder to maintain
- changes “by hand” will brake deployment scripts
- significant problems with automatic plugins installation
- very limited immutability
- no auto-scaling
- no self-healing
- medium MTTR



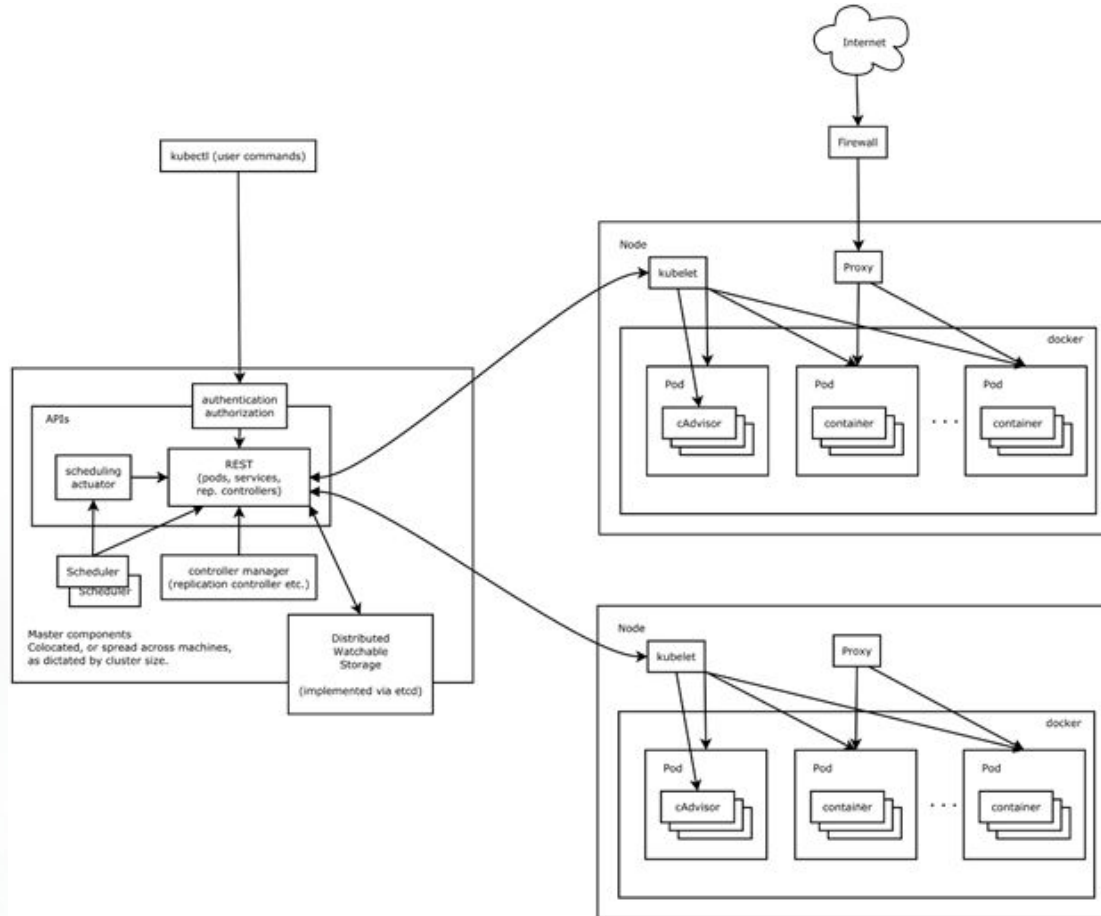
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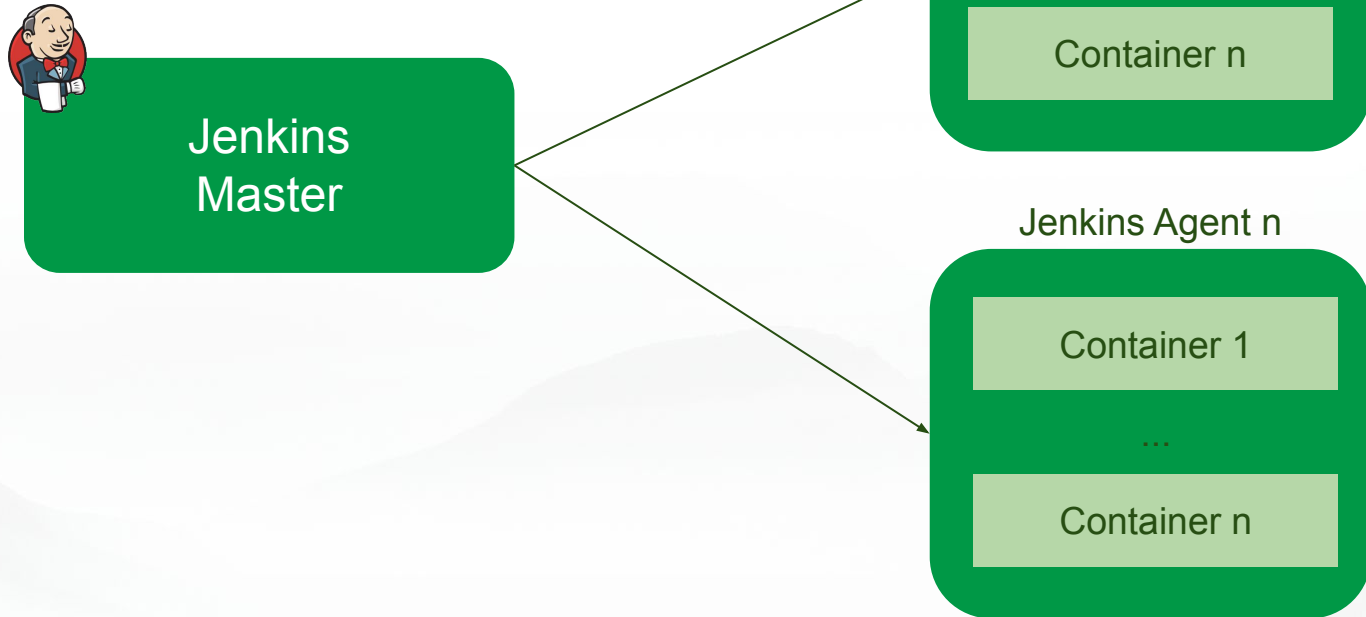
Jenkins Kubernetes



1.4



Jenkins & Kubernetes - why?



Jenkins & plain manifests

- ServiceAccount
- Role
- RoleBinding
- Deployment
- ConfigMap
- Secret
- Service
- PersistentVolumeClaim

```
kind: ServiceAccount  
apiVersion: v1  
metadata:  
  name: jenkins
```

```
kind: Deployment  
apiVersion: apps/v1  
metadata:  
  name: jenkins  
spec:  
  replicas: 1  
  spec:  
    serviceAccountName: jenkins  
    containers:  
      - image: jenkins/jenkins:lts  
        name: jenkins-master  
        volumeMounts:  
          - name: config  
            mountPath: /etc/jenkins/config  
    volumes:  
      - name: config  
        configMap:  
          name: jenkins
```



Jenkins & Helm



```
master:  
  componentName: "jenkins-master"  
  image: "jenkins/jenkins"  
  tag: "lts"  
  imagePullPolicy: "Always"  
  imagePullSecretName:  
  numExecutors: 0  
  customJenkinsLabels: [ ]
```



Jenkins & Helm



```
master:  
  componentName: "jenkins-master"  
  image: "jenkins/jenkins"  
  tag: "lts"  
  imagePullPolicy: "Always"  
  imagePullSecretName:  
  numExecutors: 0  
  customJenkinsLabels: [ ]
```

“Think twice before using Helm”



Kubernetes

- high cost / high gain
- high immutability
- auto-scaling
- limited self-healing
- errors not visible for end users
- low MTTR



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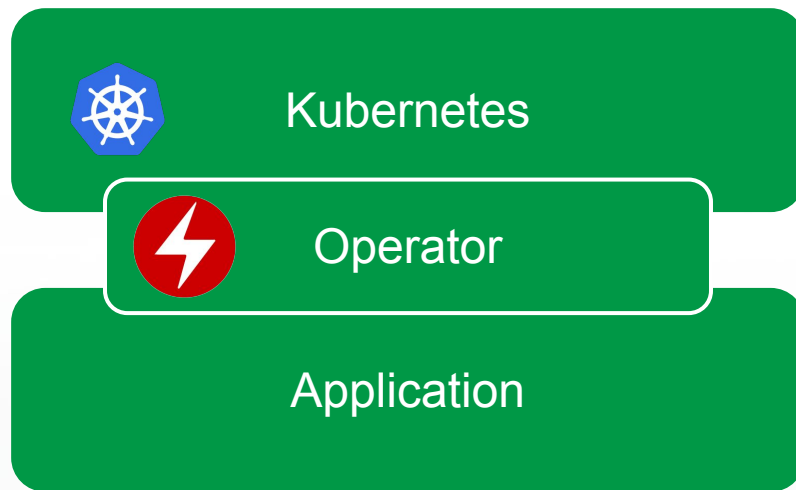
Jenkins Kubernetes Operator



Operator



Operator



Operator

- Kubernetes native
- separate software
- includes domain or application-specific knowledge
- reliably manages an application
- extends Kubernetes API through a set of CustomResourceDefinitions



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Custom Resource Definition

- analogous to a class
- new API
- seamless integration with existing API
- kubectl support

```
apiVersion: apiextensions.k8s.io/v1beta1
kind: CustomResourceDefinition
metadata:
  name: kafkas.kafka.strimzi.io
spec:
  group: kafka.strimzi.io
  version: v1beta1
  scope: Namespaced
  names:
    kind: Kafka
    listKind: KafkaList
    singular: kafka
    plural: kafkas
```



Custom Resource

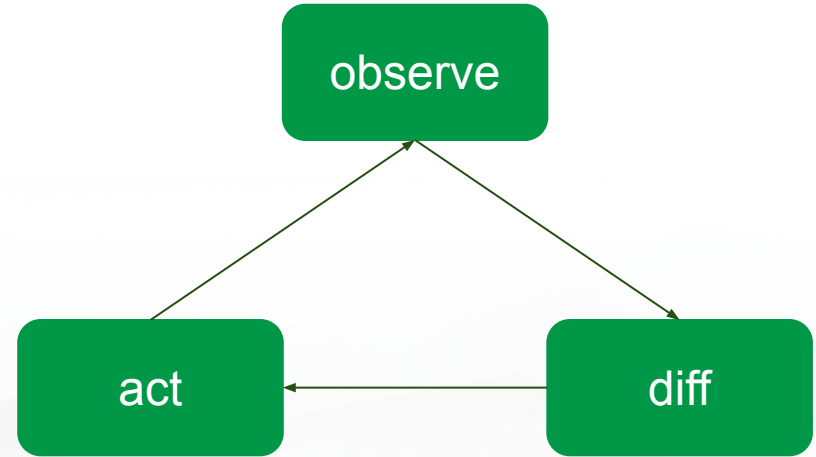
- analogous to an object
- represents Kafka cluster instance

```
apiVersion: kafka.strimzi.io/v1beta1
kind: Kafka
metadata:
  name: example
spec:
  version: 2.3.0
  replicas: 3
```

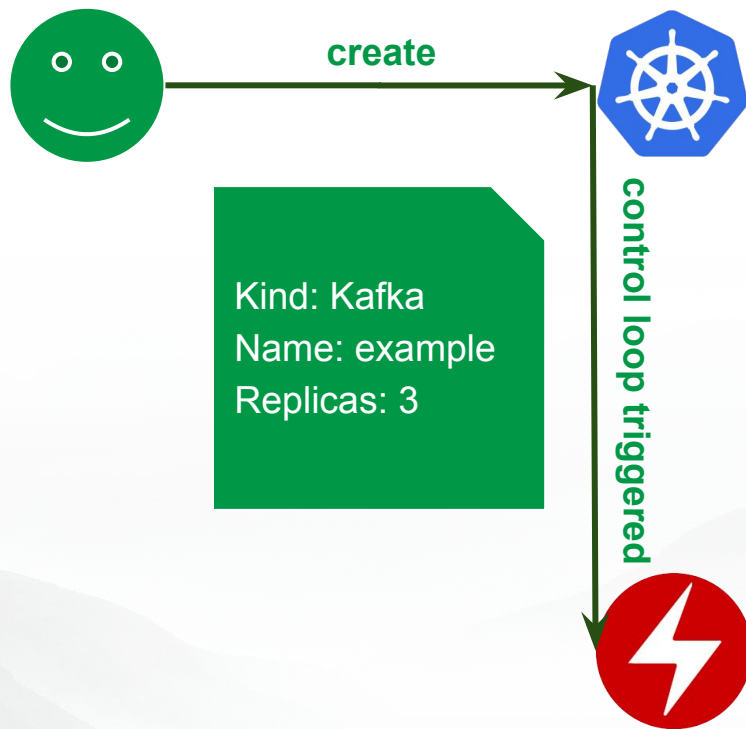


Control loop

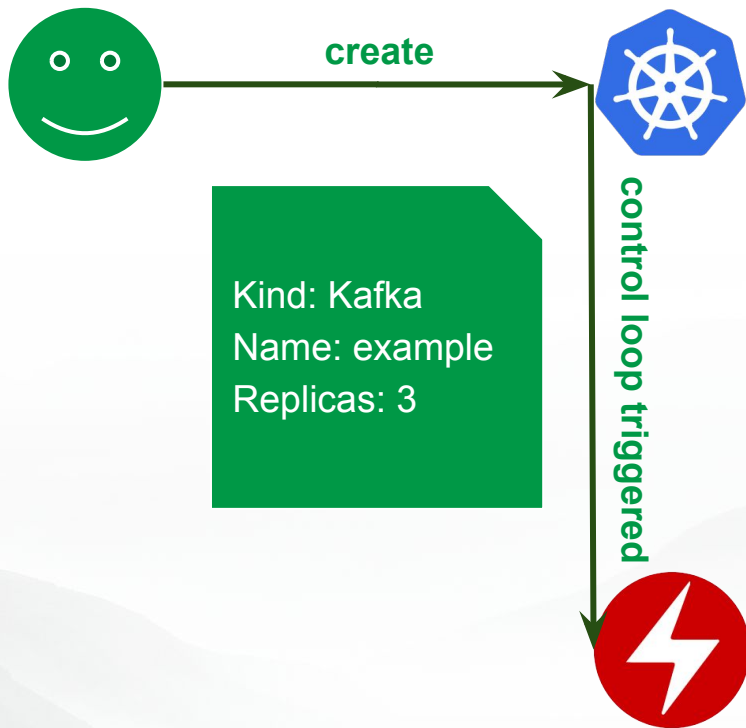
- uses a watch operation on a Kubernetes resources
- analyzes difference between actual and desired state
- acts only on changes



Observe



Diff



Actual:

Desired:

Kind: StatefulSet
Name: example
Replicas: 3
Image: kafka



Act



create



create pods

Kafka 1

Kafka 2

Kafka 3

Kind: Kafka
Name: example
Replicas: 3

control loop triggered

create statefulset



Actual:

Desired:

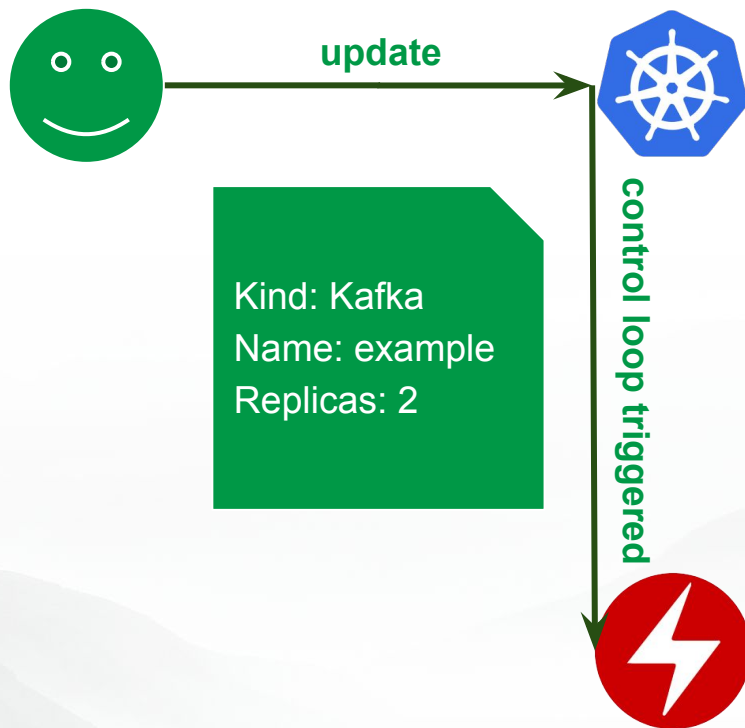
Kind: StatefulSet
Name: example
Replicas: 3
Image: kafka



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Observe



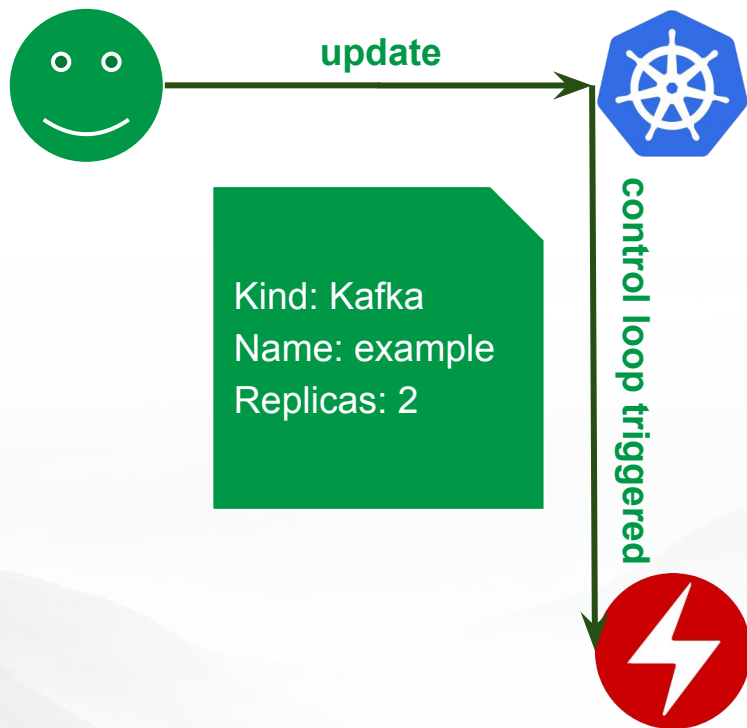
Kafka 1

Kafka 2

Kafka 3



Diff



Kafka 1

Kafka 2

Kafka 3

Actual:

Kind: StatefulSet
Name: example
Replicas: 3
Image: kafka

Desired:

Kind: StatefulSet
Name: example
Replicas: 2
Image: kafka



Act



update



delete pod

Kafka 1

Kafka 2

~~Kafka 3~~

Kind: Kafka
Name: example
Replicas: 2

control loop triggered

update statefulset



Actual:

Kind: StatefulSet
Name: example
Replicas: 3
Image: kafka

Desired:

Kind: StatefulSet
Name: example
Replicas: 2
Image: kafka



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OPERATOR FRAMEWORK



Operator SDK

- tools for scaffolding and code generation to bootstrap a new project fast
- high level APIs and abstractions to write the operational logic more intuitively
- extensions to cover common operator use cases

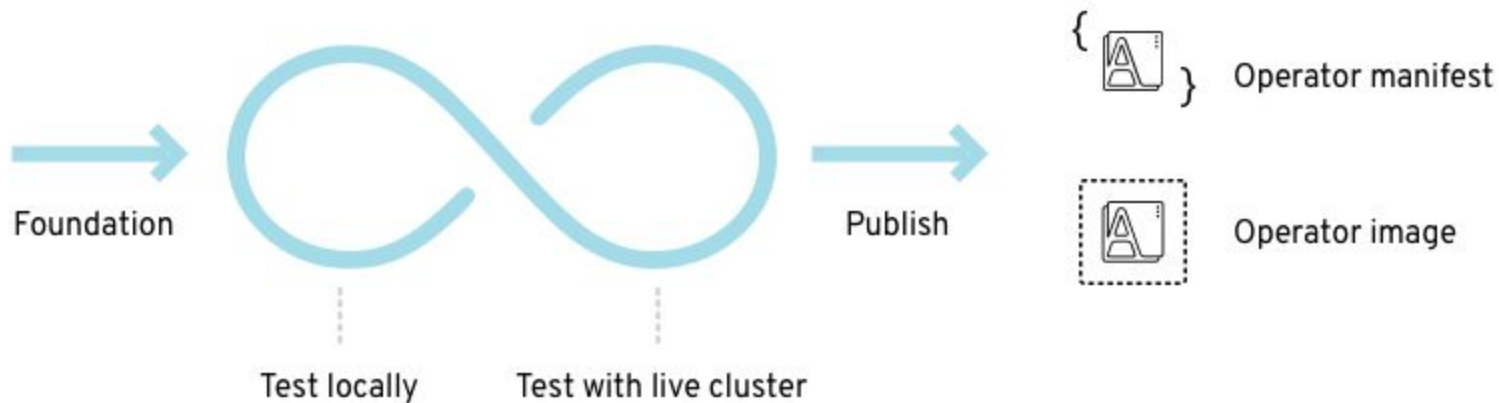


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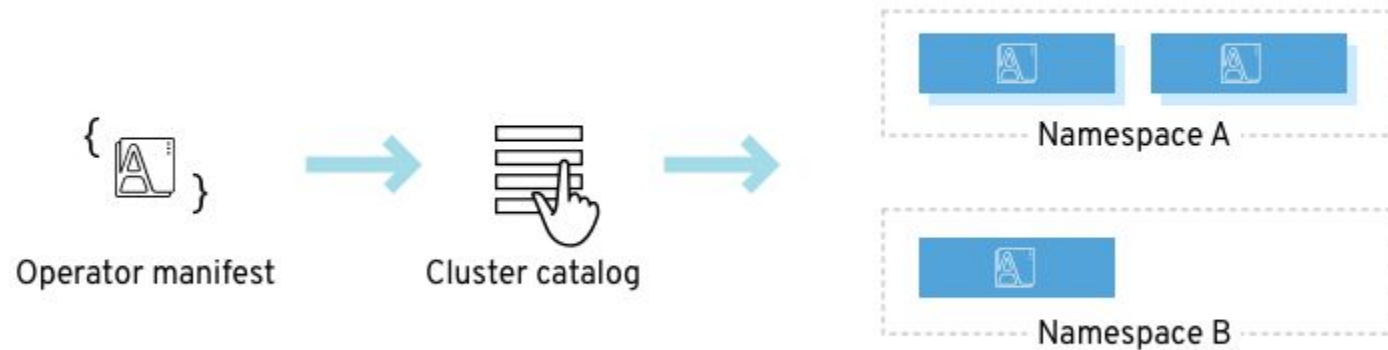
Operator SDK

Operator SDK *Build, test, iterate*



Operator Lifecycle Manager

Operator Lifecycle Manager *Install & update across clusters*



Welcome to OperatorHub.io

OperatorHub.io is a new home for the Kubernetes community to share Operators. Find an existing Operator or list your own today.

CATEGORIES

77 ITEMS

VIEW  ▾ SORT A-Z ▾

AI/Machine Learning

Application Runtime

Big Data

Cloud Provider

Database

Developer Tools

Integration & Delivery

Logging & Tracing

Monitoring

Networking



Akka Cluster Operator
provided by Lightbend, Inc.

Run Akka Cluster applications
on OpenShift.



Altinity ClickHouse Operator
provided by Altinity

ClickHouse Operator manages
full lifecycle of ClickHouse
clusters.



Apache CouchDB
provided by IBM

Apache CouchDB™ is a highly
available NOSQL database for
web and mobile applications



Apache Spark Operator
provided by radanalytics.io

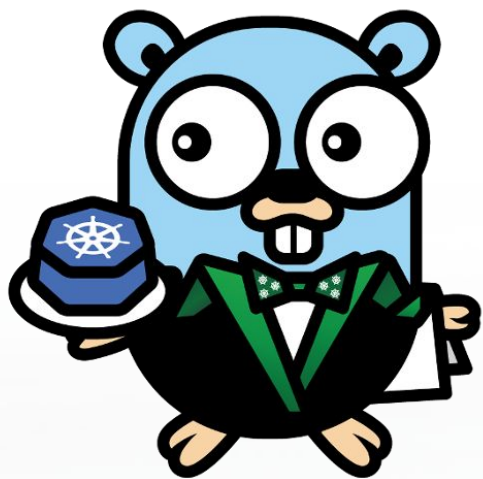
An operator for managing the
Apache Spark clusters and
intelligent applications that



Appsody Operator
provided by Appsody

Deploys Appsody based
applications





Jenkins

OPERATOR



Problems

- mutable (Jenkins home)
- no configuration as code
- no-autoscaling
- no self-healing
- plugins management
- backup and restore for jobs history and artifacts
- no security by default
- errors not visible for end users
- lack of end to end tests
- orphaned builds (no JNLP connection)



Goals

- run Jenkins on top of Kubernetes
- configuration in one place
- keep Jenkins instance configured
- make Jenkins immutable
- scale Jenkins agents
- make default configuration secure
- make backups of Jenkins builds history and artifacts
- make errors more visible for end users
- reduce Jenkins master unavailability



Operator



Kubernetes



Operator



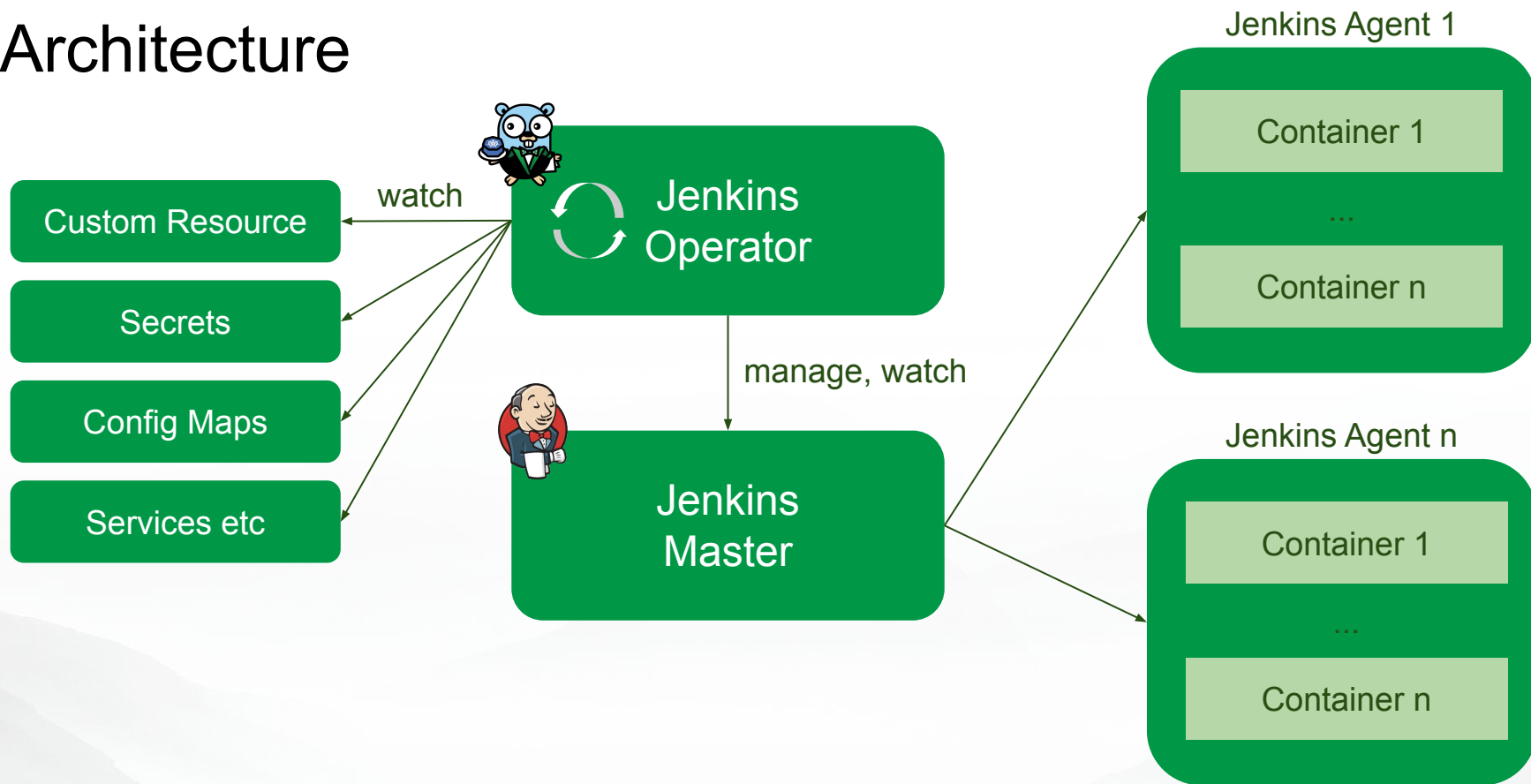
Jenkins



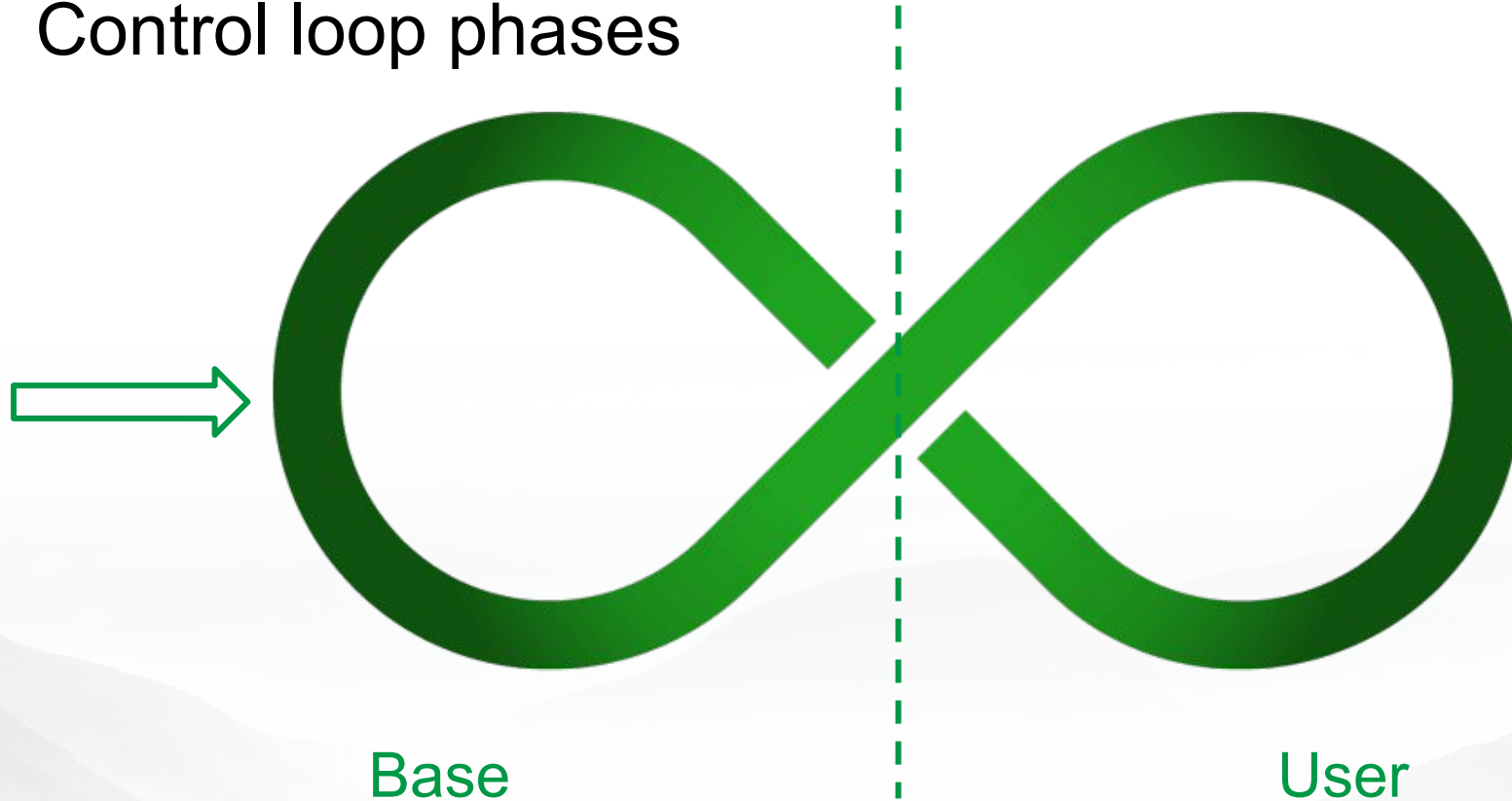
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Architecture



Control loop phases



Base phase

- set default Jenkins Custom Resource values
- validate
- ensure required resources (services, service accounts etc)
- ensure Jenkins master pod
- detect Jenkins pod start-up issues
- install plugins
- create a Jenkins user for the operator
- create Jenkins API token
- run base configuration (groovy scripts)



User phase

- validate
- ensure and run Jenkins seed jobs
- restore backup
- ensure user configuration (groovy scripts)
- ensure user configuration (Configuration as Code)
- create a backup
- enable backup trigger



Jenkins Custom Resources



```
apiVersion: apiextensions.k8s.io/v1beta1
kind: CustomResourceDefinition
metadata:
  name: jenkins.jenkins.io
spec:
  group: jenkins.io
  names:
    kind: Jenkins
    listKind: JenkinsList
    plural: jenkins
    singular: jenkins
  scope: Namespaced
  versions:
    - name : v1alpha2
      served: true
      storage: true
    - name : v1alpha1
      served: true
      storage: false
```



```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  master:
    containers:
      - name: jenkins-master
        image: jenkins/jenkins:lts
        resources:
          limits:
            cpu: 1500m
            memory: 3Gi
          requests:
            cpu: "1"
            memory: 500Mi
```



```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  master:
    containers:
      - name: jenkins-master
        image: jenkins/jenkins:lts
        resources:
          limits:
            cpu: 1500m
            memory: 3Gi
          requests:
            cpu: "1"
            memory: 500Mi
```



```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  groovyScripts:
    configurations:
      - name: user-config
  secret:
    name: "user-config-secrets"
```



```
kind: Secret
apiVersion: v1
type: Opaque
metadata:
  name: user-config-secrets
stringData:
  EXECUTORS_AMOUNT: "6"
```

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: user-config
data:
  1-configure-executors.groovy: |
    import jenkins.*
    import jenkins.model.*
    import hudson.*
    import hudson.model.*
    Jenkins jenkins = Jenkins.getInstance()
    jenkins.setNumExecutors(Integer.valueOf(secrets["EXECUTORS_AMOUNT"]))
```



```
kind: Secret
apiVersion: v1
type: Opaque
metadata:
  name: user-config-secrets
stringData:
  EXECUTORS_AMOUNT: "6"
```

```
apiVersion: v1
kind: ConfigMap
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  name: user-config
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```




```
kind: Secret
apiVersion: v1
type: Opaque
metadata:
  name: user-config-secrets
stringData:
  EXECUTORS_AMOUNT: "6"
```

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: user-config
data:
  1-configure-executors.groovy: |
    import jenkins.*
    import jenkins.model.*
    import hudson.*
    import hudson.model.*
    Jenkins jenkins = Jenkins.getInstance()
    jenkins.setNumExecutors(Integer.valueOf(secrets["EXECUTORS_AMOUNT"]))
```



```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  configurationAsCode:
    configurations:
      - name: user-config
    secret:
      name: "user-config-secrets"
```



```
kind: Secret
apiVersion: v1
type: Opaque
metadata:
  name: user-config-secrets
stringData:
  SYSTEM_MESSAGE: "Psss secret value"
```

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: user-config
data:
  1-system-message.yaml: |
    jenkins:
      systemMessage: ${SYSTEM_MESSAGE}
```



```
kind: Secret
apiVersion: v1
type: Opaque
metadata:
  name: user-config-secrets
stringData:
  SYSTEM_MESSAGE: "Psss secret value"
```

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: user-config
data:
  1-system-message.yaml: |
    jenkins:
      systemMessage: ${SYSTEM_MESSAGE}
```



```
kind: Secret
apiVersion: v1
type: Opaque
metadata:
  name: user-config-secrets
stringData:
  SYSTEM_MESSAGE: "Psss secret value"
```

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: user-config
data:
  1-system-message.yaml: |
    jenkins:
      systemMessage: ${SYSTEM_MESSAGE}
```



```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  master:
    basePlugins:
    - name: kubernetes
      version: 1.18.3
    - name: workflow-job
      version: "2.34"
    - name: workflow-aggregator
      version: "2.6"
    - name: git
      version: 3.12.0
    - name: job-dsl
      version: "1.76"
    - name: configuration-as-code
      version: "1.29"
    - name: configuration-as-code-support
      version: "1.19"
    - name: kubernetes-credentials-provider
      version: 0.12.1
```



```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  master:
    plugins:
      - name: simple-theme-plugin
        version: 0.5.1
```



```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  seedJobs:
    - id: jenkins-operator
      targets: "cicd/jobs/*.jenkins"
      description: "Jenkins Operator repository"
      repositoryBranch: master
      repositoryUrl: https://github.com/jenkinsci/kubernetes-operator.git
```




```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  seedJobs:
    - id: jenkins-operator
      targets: "cicd/jobs/*.jenkins"
      description: "Jenkins Operator repository"
      repositoryBranch: master
      repositoryUrl: https://github.com/jenkinsci/kubernetes-operator.git
```



```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  seedJobs:
    - id: jenkins-operator
      targets: "cicd/jobs/*.jenkins"
      description: "Jenkins Operator repository"
      repositoryBranch: master
      repositoryUrl: https://github.com/jenkinsci/kubernetes-operator.git
```



```
#!/usr/bin/env groovy
```

```
pipelineJob('build-jenkins-operator') {  
    displayName('Build jenkins-operator')  
    logRotator {  
        numToKeep(10)  
        daysToKeep(30)  
    }  
    definition {  
        cpsScm {  
            scm {  
                git {  
                    remote {  
                        url('https://github.com/jenkinsci/kubernetes-operator.git')  
                        credentials('jenkins-operator')  
                    }  
                    branches('*/master')  
                }  
            }  
        }  
        scriptPath('cicd/pipelines/build.jenkins')  
    }  
}
```



```
#!/usr/bin/env groovy
pipelineJob('build-jenkins-operator') {
    displayName('Build jenkins-operator')
    logRotator {
        numToKeep(10)
        daysToKeep(30)
    }
    definition {
        cpsScm {
            scm {
                git {
                    remote {
                        url('https://github.com/jenkinsci/kubernetes-operator.git')
                        credentials('jenkins-operator')
                    }
                    branches('*/master')
                }
            }
        }
        scriptPath('cicd/pipelines/build.jenkins')
    }
}
```



```
#!/usr/bin/env groovy
pipelineJob('build-jenkins-operator') {
    displayName('Build jenkins-operator')
    logRotator {
        numToKeep(10)
        daysToKeep(30)
    }
    definition {
        cpsScm {
            scm {
                git {
                    remote {
                        url('https://github.com/jenkinsci/kubernetes-operator.git')
                        credentials('jenkins-operator')
                    }
                    branches('*/master')
                }
            }
        }
        scriptPath('cicd/pipelines/build.jenkins')
    }
}
```



Seed jobs

```
#!/usr/bin/env groovy
def label = "build-jenkins-operator-${UUID.randomUUID().toString()}"
podTemplate(label: label,
    containers: [
        containerTemplate(name: 'go', image: 'golang:1-alpine', command: 'cat', ttyEnabled: true),
    ],
) {
    node(label) {
        stage('Init') {
            timeout(time: 3, unit: 'MINUTES') {
                checkout scm
            }
        }
        stage('Dep') {
            container('go') {
                sh 'make dep'
            }
        }
        stage('Test') {
            container('go') {
                sh 'make test'
            }
        }
        stage('Build') {
            container('go') {
                sh 'make build'
            }
        }
    }
}
```



Seed jobs

```
#!/usr/bin/env groovy
def label = "build-jenkins-operator-${UUID.randomUUID().toString()}"
podTemplate(label: label,
    containers: [
        containerTemplate(name: 'go', image: 'golang:1-alpine', command: 'cat', ttyEnabled: true),
    ],
) {
    node(label) {
        stage('Init') {
            timeout(time: 3, unit: 'MINUTES') {
                checkout scm
            }
        }
        stage('Dep') {
            container('go') {
                sh 'make dep'
            }
        }
        stage('Test') {
            container('go') {
                sh 'make test'
            }
        }
        stage('Build') {
            container('go') {
                sh 'make build'
            }
        }
    }
}
```



Backup & restore

```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  master:
    containers:
      - name: backup
        env:
          - name: BACKUP_DIR
            value: /backup
          - name: JENKINS_HOME
            value: /jenkins-home
          - name: BACKUP_COUNT
            value: "20"
        image: virtuslab/jenkins-operator-backup-pvc:v0.0.6
    volumeMounts:
      - mountPath: /jenkins-home
        name: jenkins-home
      - mountPath: /backup
        name: backup
    volumes:
      - name: backup
        persistentVolumeClaim:
          claimName: jenkins-backup
```



Backup & restore

```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  master:
    containers:
      - name: backup
        env:
          - name: BACKUP_DIR
            value: /backup
          - name: JENKINS_HOME
            value: /jenkins-home
          - name: BACKUP_COUNT
            value: "20"
        image: virtuslab/jenkins-operator-backup-pvc:v0.0.6
        volumeMounts:
          - mountPath: /jenkins-home
            name: jenkins-home
          - mountPath: /backup
            name: backup
    volumes:
      - name: backup
        persistentVolumeClaim:
          claimName: jenkins-backup
```



Backup & restore

```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  master:
    containers:
      - name: backup
        env:
          - name: BACKUP_DIR
            value: /backup
          - name: JENKINS_HOME
            value: /jenkins-home
          - name: BACKUP_COUNT
            value: "20"
        image: virtuslab/jenkins-operator-backup-pvc:v0.0.6
    volumeMounts:
      - mountPath: /jenkins-home
        name: jenkins-home
      - mountPath: /backup
        name: backup
    volumes:
      - name: backup
        persistentVolumeClaim:
          claimName: jenkins-backup
```



```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: jenkins-backup
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 20Gi
```



```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  backup:
    containerName: backup
    action:
      exec:
        command:
          - /home/user/bin/backup.sh
    interval: 30
    makeBackupBeforePodDeletion: true
  restore:
    containerName: backup
    action:
      exec:
        command:
          - /home/user/bin/restore.sh
```



```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  backup:
    containerName: backup
    action:
      exec:
        command:
          - /home/user/bin/backup.sh
    interval: 30
    makeBackupBeforePodDeletion: true
  restore:
    containerName: backup
    action:
      exec:
        command:
          - /home/user/bin/restore.sh
```



```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  backup:
    containerName: backup
    action:
      exec:
        command:
          - /home/user/bin/backup.sh
    interval: 30
    makeBackupBeforePodDeletion: true
  restore:
    containerName: backup
    action:
      exec:
        command:
          - /home/user/bin/restore.sh
```



```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  notifications:
    - loggingLevel: info
      verbose: true
      name: slack
      slack:
        webHookURLSecretKeySelector:
          secret:
            name: user-config-secrets
          key: SLACK_WEBHOOK
```



```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  notifications:
    - loggingLevel: info
      verbose: true
      name: slack
      slack:
        webHookURLSecretKeySelector:
          secret:
            name: user-config-secrets
          key: SLACK_WEBHOOK
```




```
apiVersion: jenkins.io/v1alpha2
kind: Jenkins
metadata:
  name: example
spec:
  notifications:
    - loggingLevel: info
      verbose: true
      name: slack
      slack:
        webHookURLSecretKeySelector:
          secret:
            name: user-config-secrets
          key: SLACK_WEBHOOK
```



Demo

- custom theme (simple-theme-plugin)
- amount of executors - 3 (groovy script)
- system message (CasC plugin)
- backup on PVC
- seed job
- notifications on Slack



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Roadmap

- support for OpenShift
- static agents and agents pools
- plugins caching
- blue-green deployment?



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Questions?



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Save the date
OCTOBER
2020

2019 WAS A BLAST!

3

DAYS

7

SPHERES



13

WORKSHOPS

OVER **100**

SPEAKERS
& TRAINERS

MORE
THAN **120**

TALKS

NEARLY **600**

ATTENDEES



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Thank you



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