CSI-based storage Orchestration System

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Agenda

- Background
- What's CSI
- FlexVolume vs CSI
- How CSI works
- CSI Usage Workflow
- CSI Sample Driver

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Background

1. In-tree Volume Plugins
   - Those are linked, compiled, built and shipped with the core k8s binaries
   - Development is tightly coupled and dependent on k8s releases
   - Bugs in volume plugin can crash critical k8s components, instead of just the plugin
   - Will not be accepted in the future
2. Out-of-Tree Volume Plugins (customized plugins by storage vendors)
   - FlexVolume driver
   - CSI driver (*)

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What's CSI

- Container Storage Interface (CSI) is a standardized mechanism for Container Orchestration Systems (COs), including Kubernetes, to expose arbitrary storage systems to containerized workloads. Storage Provider (SP) develops once and this works across a number of COs.
- The goal of CSI is to become the primary volume plugin system for k8s in the future.
- k8s 1.9 release has already included the alpha feature of CSI implementation.
- The CSI spec can be found at:

  https://github.com/container-storage-interface/spec/blob/master/spec.md

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CSI vs FlexVolume

Two mainstream Volume Plugin mechanisms in K8s – FlexVolume and CSI

1. FlexVolume plugin framework:
    - Makes the 3rd party storage providers' plugin as "out-of-tree" (same as CSI does)
    - exec based API for external volume plugins
    - Needs to access the root filesystem of node and master machines when deploying
    - Doesn't address the pain point of dependencies.
2. CSI overcomes the limitations of FlexVolume listed above. CSI is the preferred solution, for now CSI and FlexVolume can co-exist.

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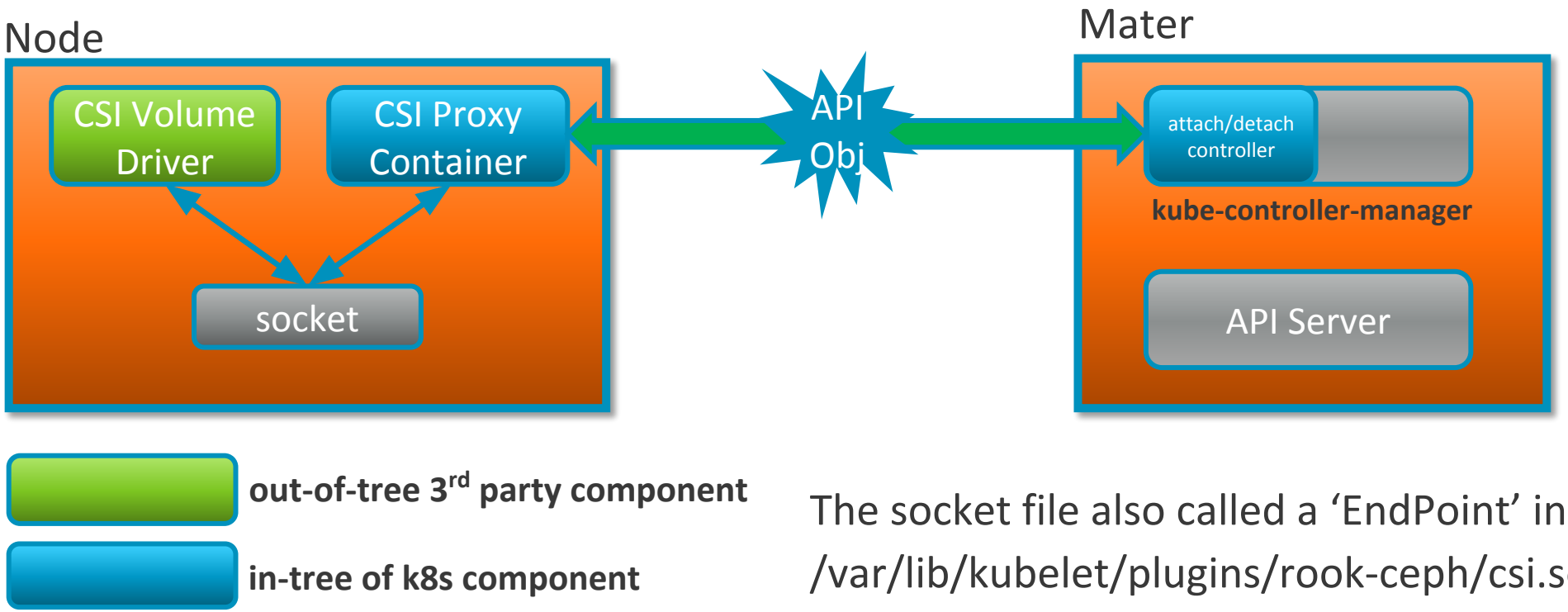
How CSI works

- A new in-tree CSI Volume plugin(K8s) + out-of-tree CSI Volume driver (3rd party)
- Communication channel via a Unix Domain Socket(UDS) created by 3rd Volume Driver



The socket file also called a 'EndPoint' in form of like:
/var/lib/kubelet/plugins/rook-ceph/csi.sock

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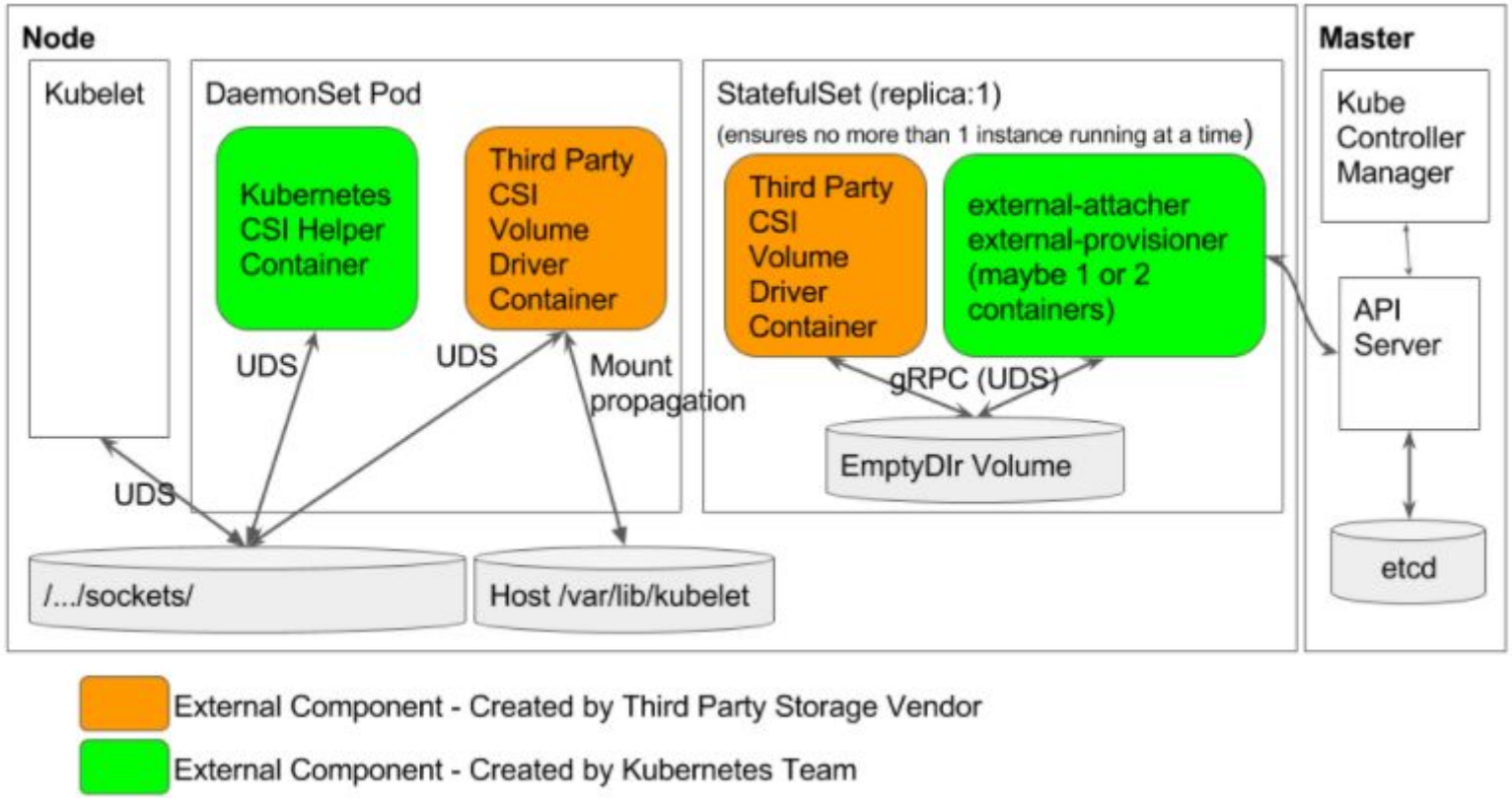
How CSI works

Recommended Mechanism for Deploying CSI Drivers on k8s



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How CSI works

1. Communication between k8s and the CSI driver – The ‘proxy’ containers by k8s team.

   *Proxy/Sidecar container that watches k8s **VolumeAttachment** objects and triggers **ControllerPublish/UnpublishVolume** against a CSI endpoint to call CSI driver*

- external-provisioner: Sidecar container that monitors ***PersistentVolumeClaim*** objects and triggers ***CreateVolume/DeleteVolume*** against the 3rd CSI volume driver.
- external-attacher: Sidecar container that monitors ***VolumeAttachment*** objects and triggers ***ControllerPublish/Unpublish*** against the 3rd CSI volume driver.
- driver-registrar: The container that 1) registers the CSI driver with kubelet and 2)adds the drivers custom NodeId to a label on the k8s Node API object.

UDS is used for communication between Sidecar Container and 3rd party CSI Driver.

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How CSI works

2. Codes repositories as the specific examples:
   - external-provisioner

     The codes hosted by https://github.com/kubernetes-csi/external-provisioner
   - external-attacher

     The codes hosted by https://github.com/kubernetes-csi/external-attacher
   - driver-registrar

     The codes hosted by https://github.com/kubernetes-csi/driver-registrar

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CSI Usage Workflow

1. Provisioning & Deleting

A cluster admin creates a ***StorageClass*** with the name of the external-provisioner (1:1).

An end user creates a PVC object referencing this ***StorageClass***, triggering the provisioner calls ***CreateVolue()*** of CSI driver

Storage Class Setup (By Administrator)

```
kind: StorageClass
apiVersion: storage.k8s.io/v1beta1
metadata:
    name: ext-storage
provisioner: com.example.team/csi-provisioner
parameters:
    type: pd-ssd
```

PersistentVolumeClain Creation (By User)

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
    name: request-for-storage
spec:
    resources:
        requests:
            storage: 5Gi
    storageClassName: ext-storage
```


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CSI Usage Workflow

2. Attaching & Detaching

VolumeAttachment captures the intent to attach or detach the specified volume to/from the specified node.

An external “attacher” watch the k8s API on behalf of the external CSI volume driver to handle attach/detach requests:

- A new k8s ***VolumeAttachment*** API object is created by k8s attach/detach controller
- external-attacher watches and calles ***ControllerPublishVolume*** against the CSI volume driver to attach the volume to the specified node.

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CSI Sample Driver

- https://github.com/kubernetes-csi/drivers

  The drivers here are provided purely for illustrative purpose, and should not be used for

  production workloads.

- The real CSI drivers are to be housed on their own repo, like:

  https://github.com/ceph/ceph-csi

Source: Alvaro Miranda

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Thank You!
Danke!
Merci!
谢谢!
ありがとう!
Gracias!
Kiitos!

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