DEVCONF.cz

Case Study: Volume Populators for Virtual Disks?

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Associate Manager and Principal Software Engineer

My journey at Red Hat

I have been working at Red Hat for over a decade:

- 2012 - 2018 oVirt / Red Hat Virtualization
- 2018 – 2019 KubeVirt / OpenShift Virtualization
- 2019 – 2020 Other (non-virtualization) OpenShift areas
- 2020 – 2022 oVirt / Red Hat Virtualization
- 2022 – Forklift / Migration Toolkit for Virtualization

Forklift / MTV

What is it about?

Forklift is an extension to Kubernetes that migrates virtual machines to KubeVirt / OpenShift Virtualization from traditional virtualization platforms

Forklift 2.4:

- vSphere
- oVirt / Red Hat Virtualization
- OpenStack / Red Hat OpenStack Platform

Planned in Forklift 2.5:

- OVA
- KubeVirt to KubeVirt

Designed for Mass Migration of VMs

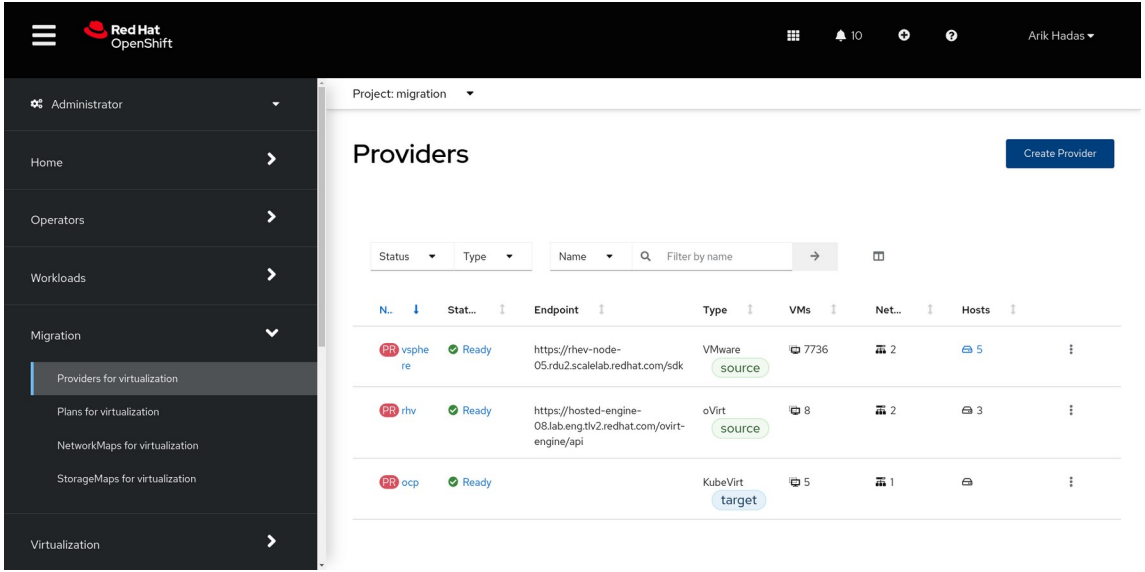
"Migrate virtual machines at scale to OpenShift in a few simple steps. Provide source and destination credentials, map infrastructure, and create migration plans"

MTV’s mission statement

How to start a migration in Forklift

Few simple steps using an easy to use UI

- Define a source provider
- Define a target provider (optional)
- Create a migration plan
  - Select virtual machines
  - Set Network mappings
  - Set Storage mappings
- Start the migration plan



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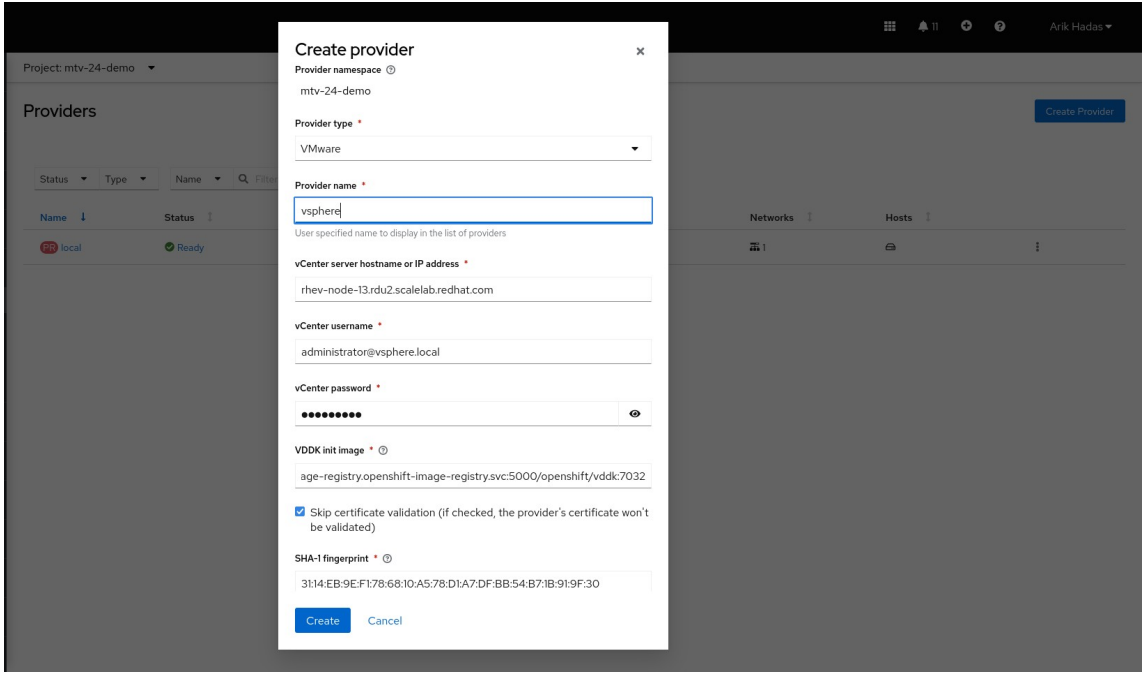

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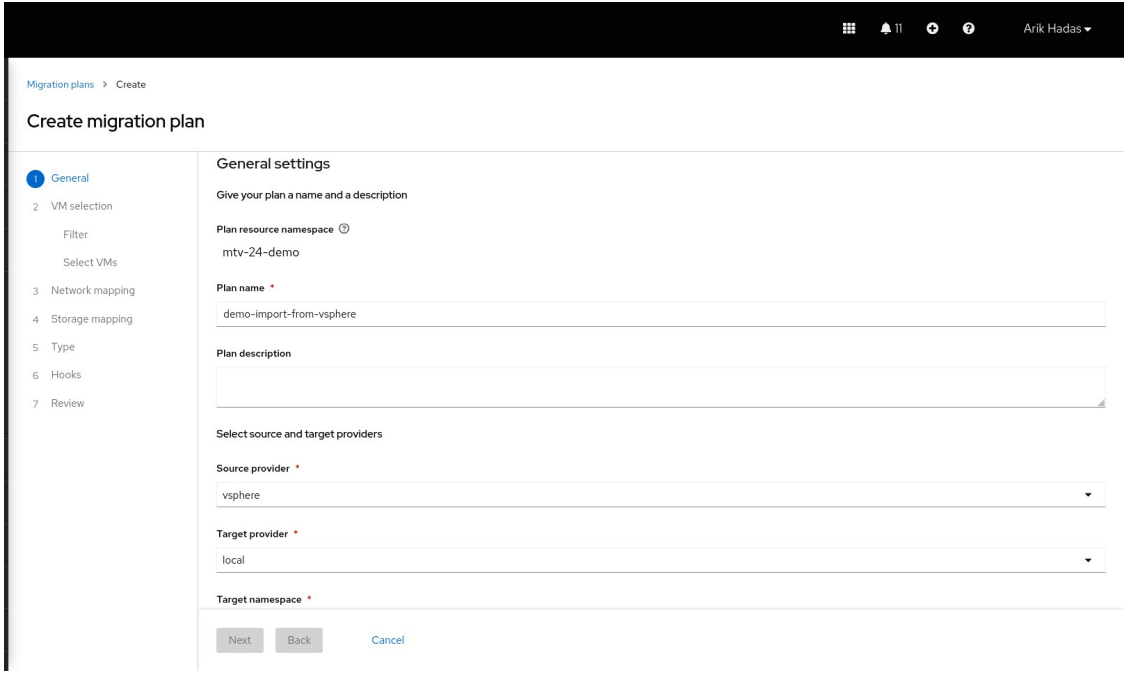

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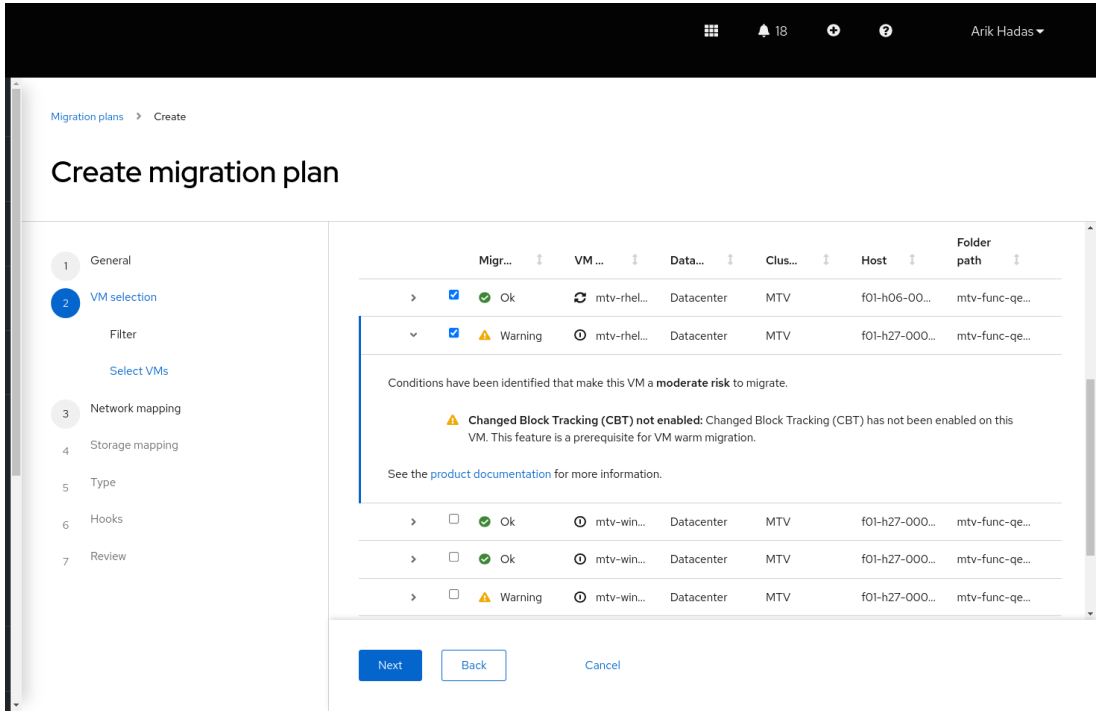

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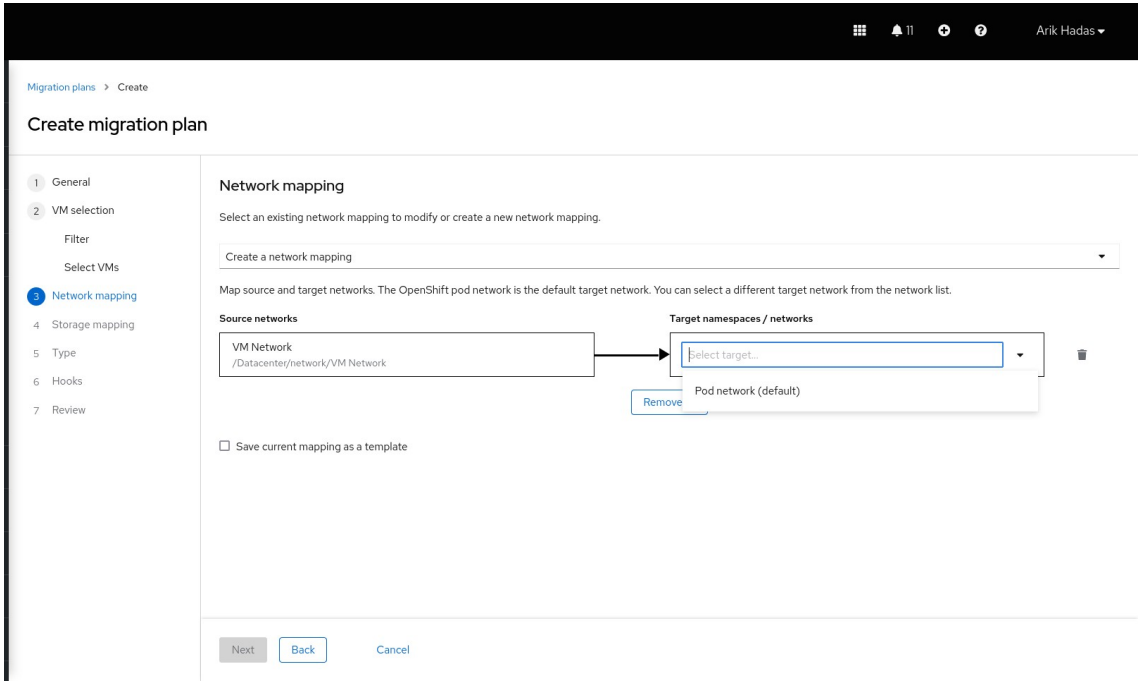

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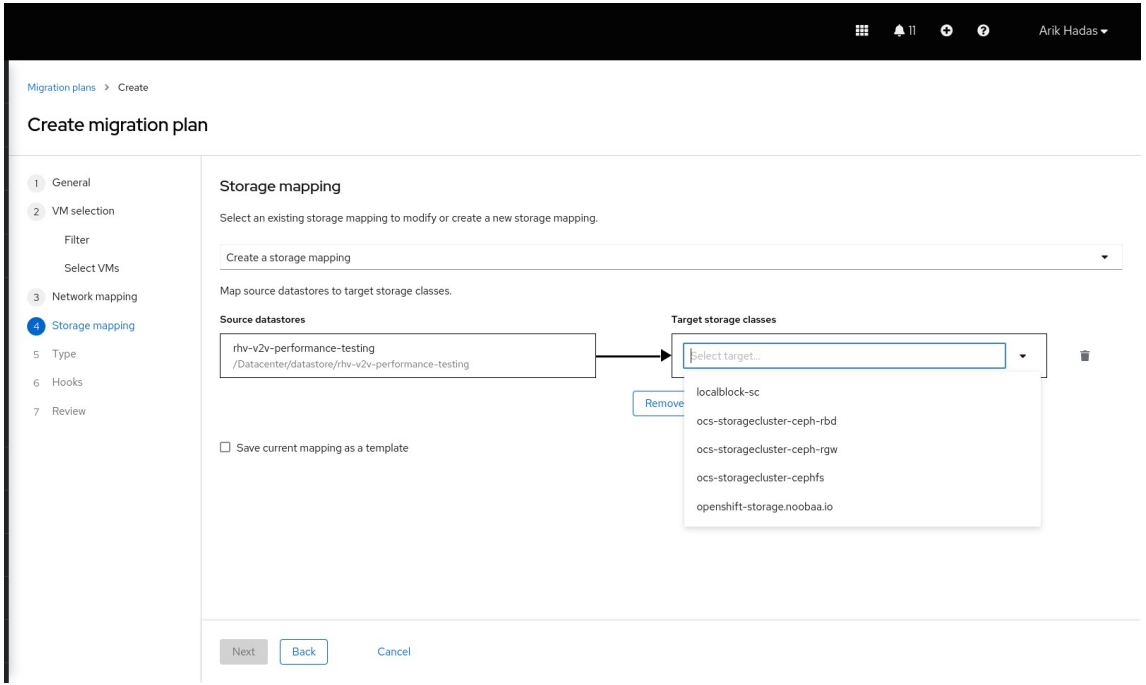

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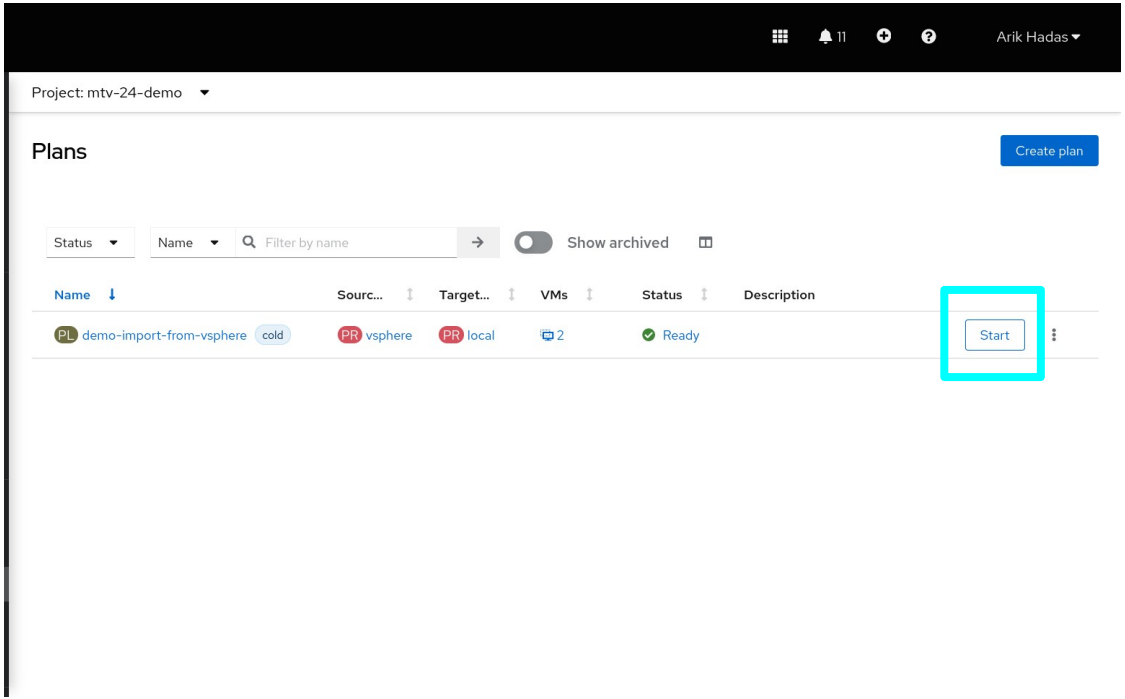
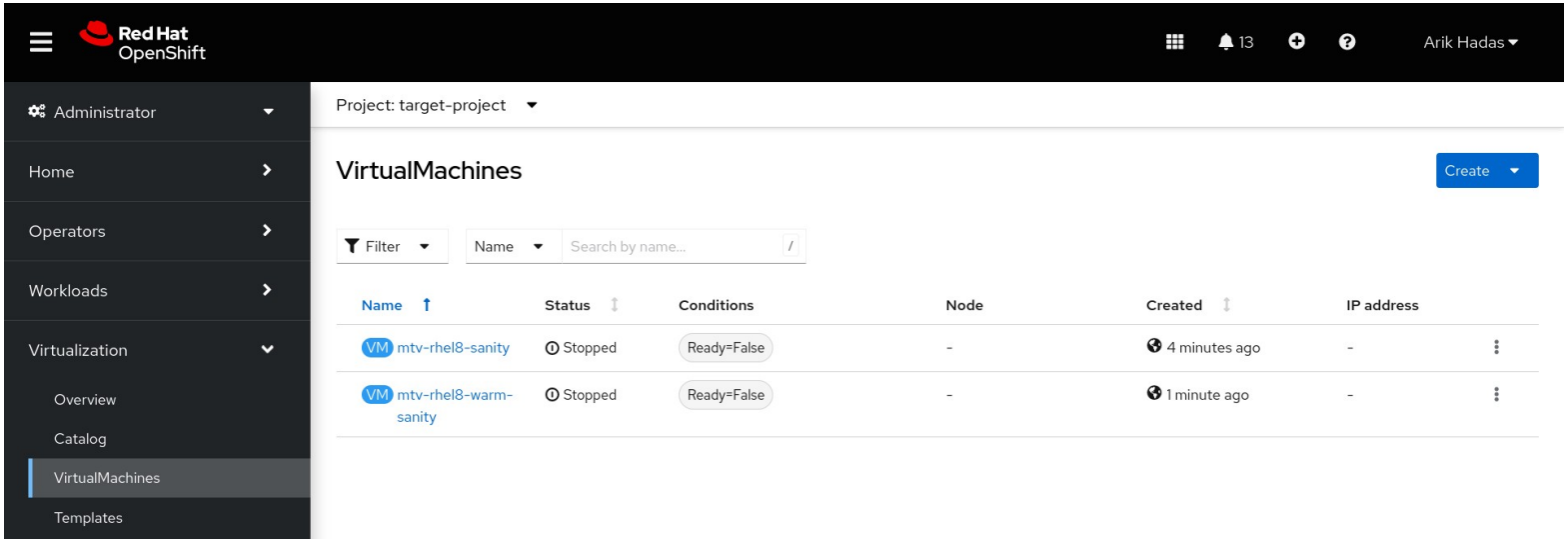


Finally: virtual machines in KubeVirt

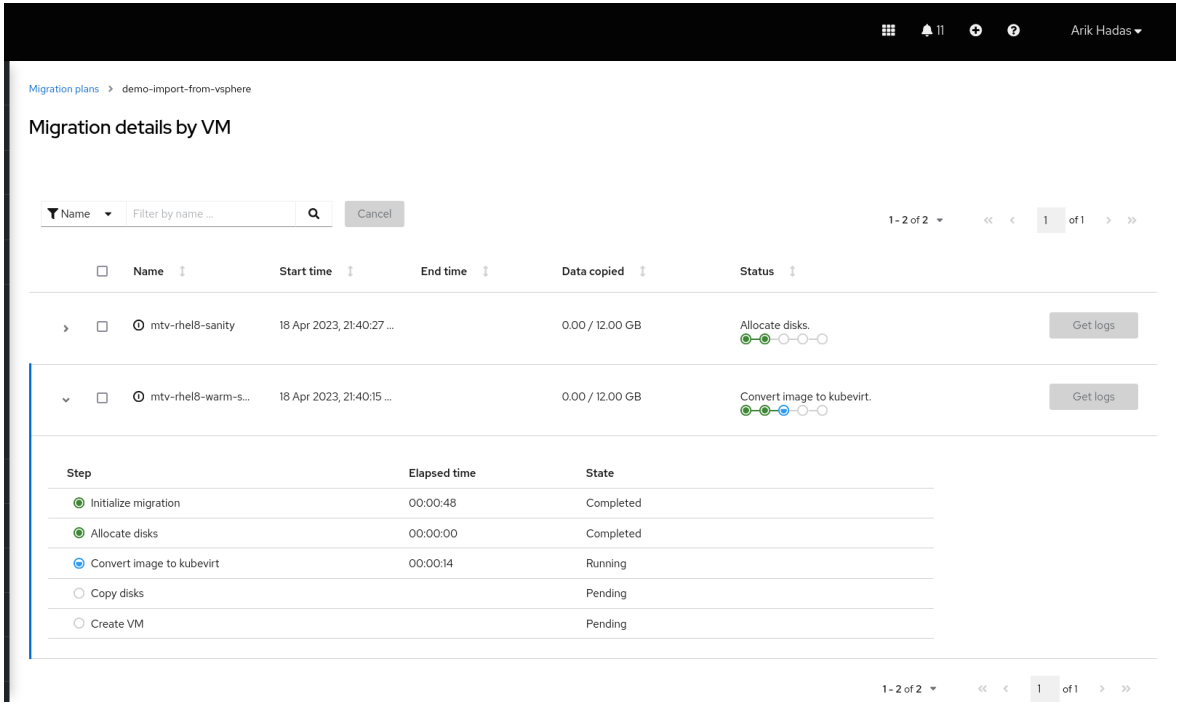
The migrated VMs can start in containers within the **target** k8s / OpenShift cluster



But what happens in between?

What is going on during the migration

- Disks are converted (optional)
- Disks are copied
- VM configuration is converted



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Our focus today

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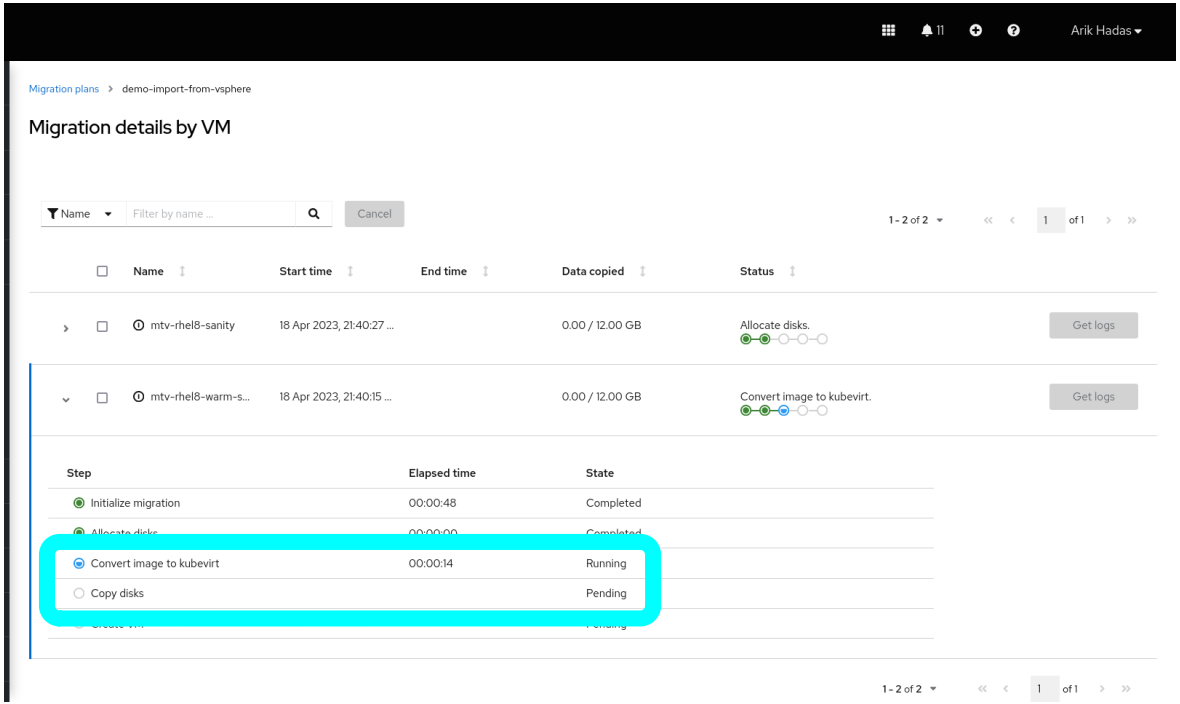


Volume populators

The volume populators feature

Setting up PVC and data source CR


```yaml
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: example-pvc
spec:
  accessModes:
  - ReadWriteOnce
  resources:
    requests:
      storage: 10Mi
  dataSourceRef:
    apiGroup: hello.example.com
    kind: Hello
    name: example-hello
  volumeMode: Filesystem
```

```yaml
apiVersion: hello.example.com/v1alpha1
kind: Hello
metadata:
  name: example-hello
spec:
  fileName: example.txt
  fileContents: Hello, world!
```

The volume populators feature

Let’s use this PVC

```yaml
apiVersion: batch/v1
kind: Job
metadata:
  name: example-job
spec:
  template:
    spec:
      containers:
        - name: example-container
          image: busybox:latest
          command:
            - cat
            - /mnt/example.txt
          volumeMounts:
            - name: vol
              mountPath: /mnt
      restartPolicy: Never
      volumes:
        - name: vol
          persistentVolumeClaim:
            claimName: example-pvc
```

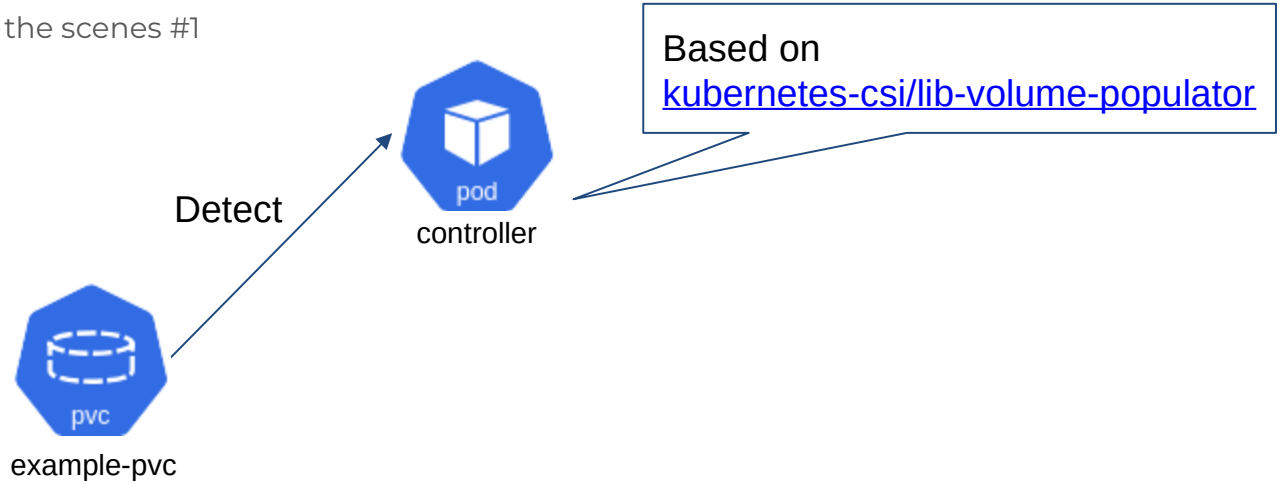
```
kubectl wait --for=condition=Complete job/example-job
```

```
kubectl logs job/example-job
```

```
Hello, world!
```

The volume populators feature

What happened behind the scenes #1



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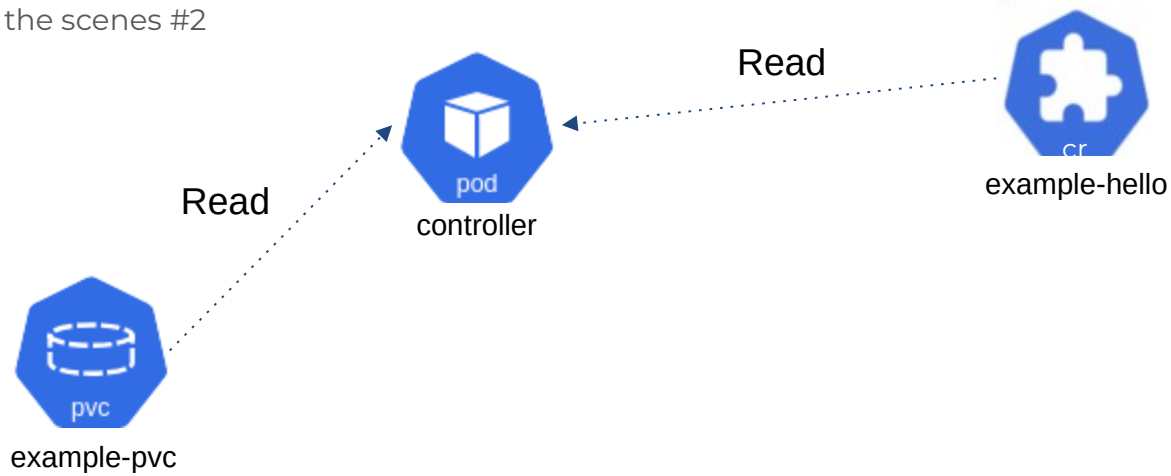
What happened behind the scenes #2



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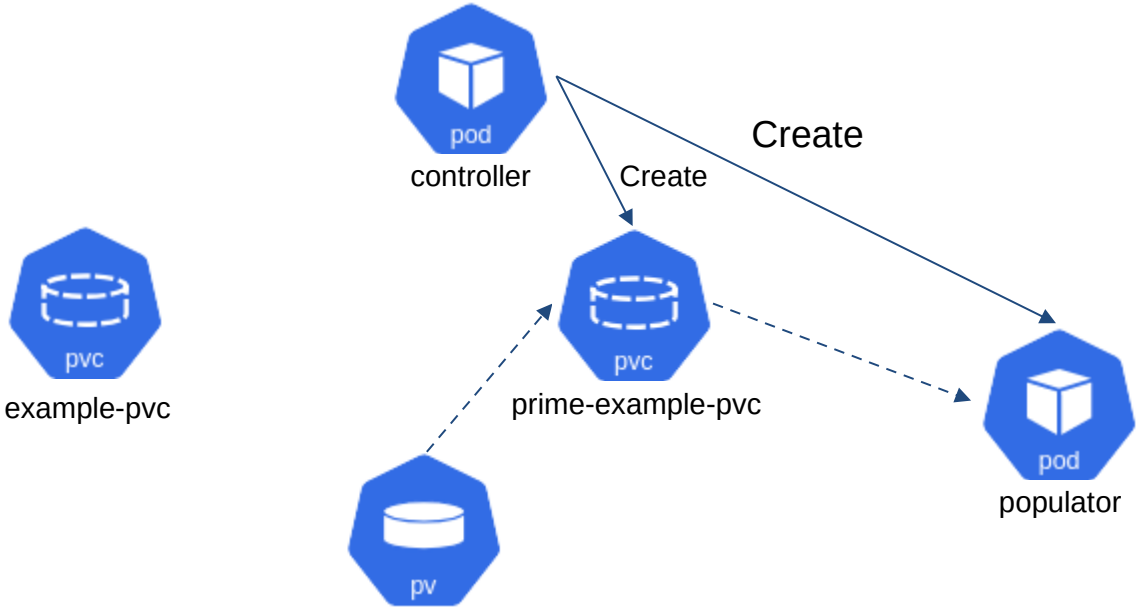
What happened behind the scenes #3



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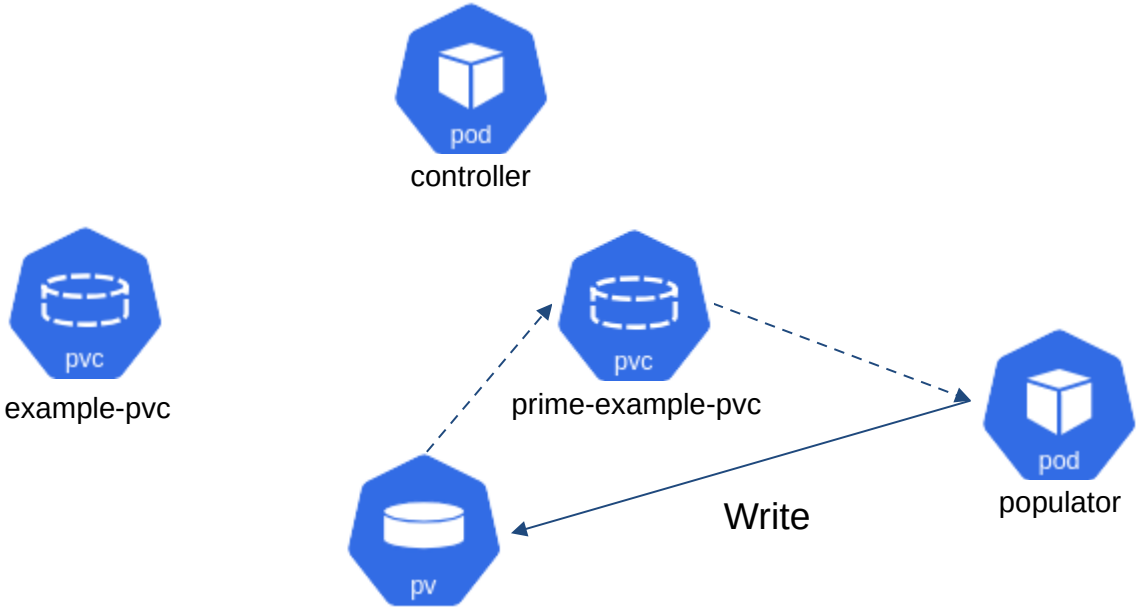
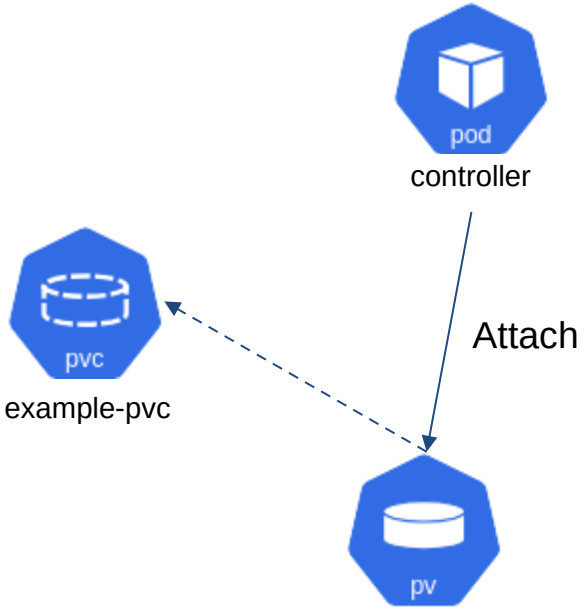
What happened behind the scenes #4

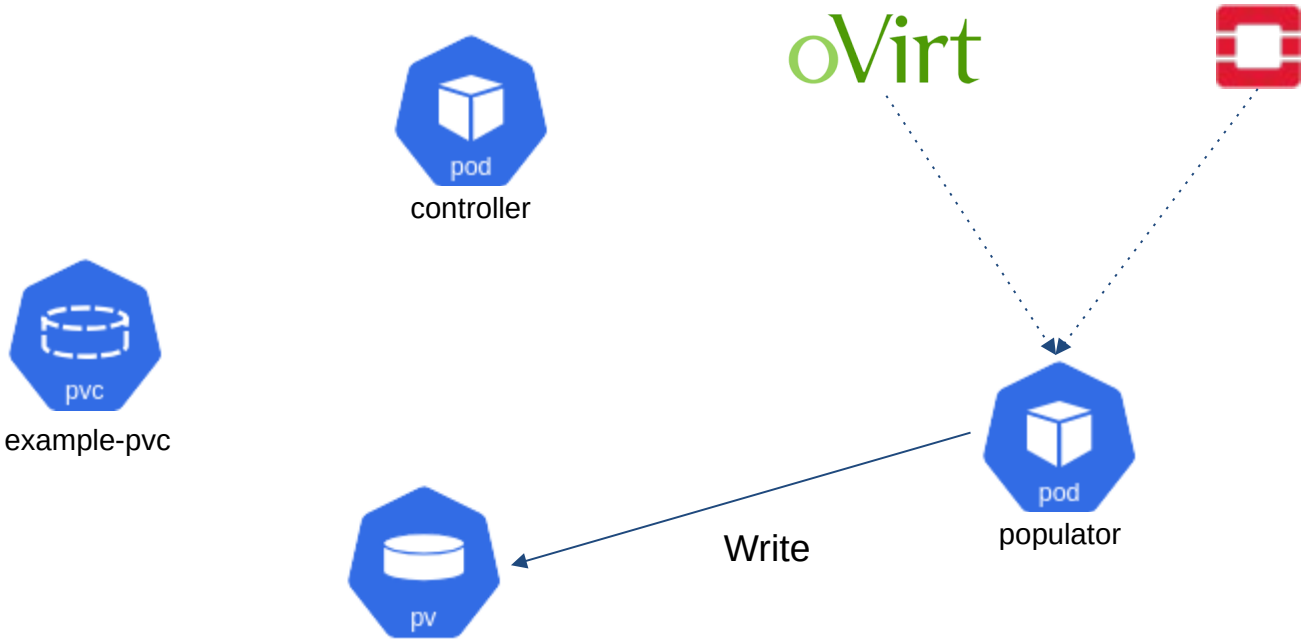


The volume populators feature

What happened behind the scenes #5



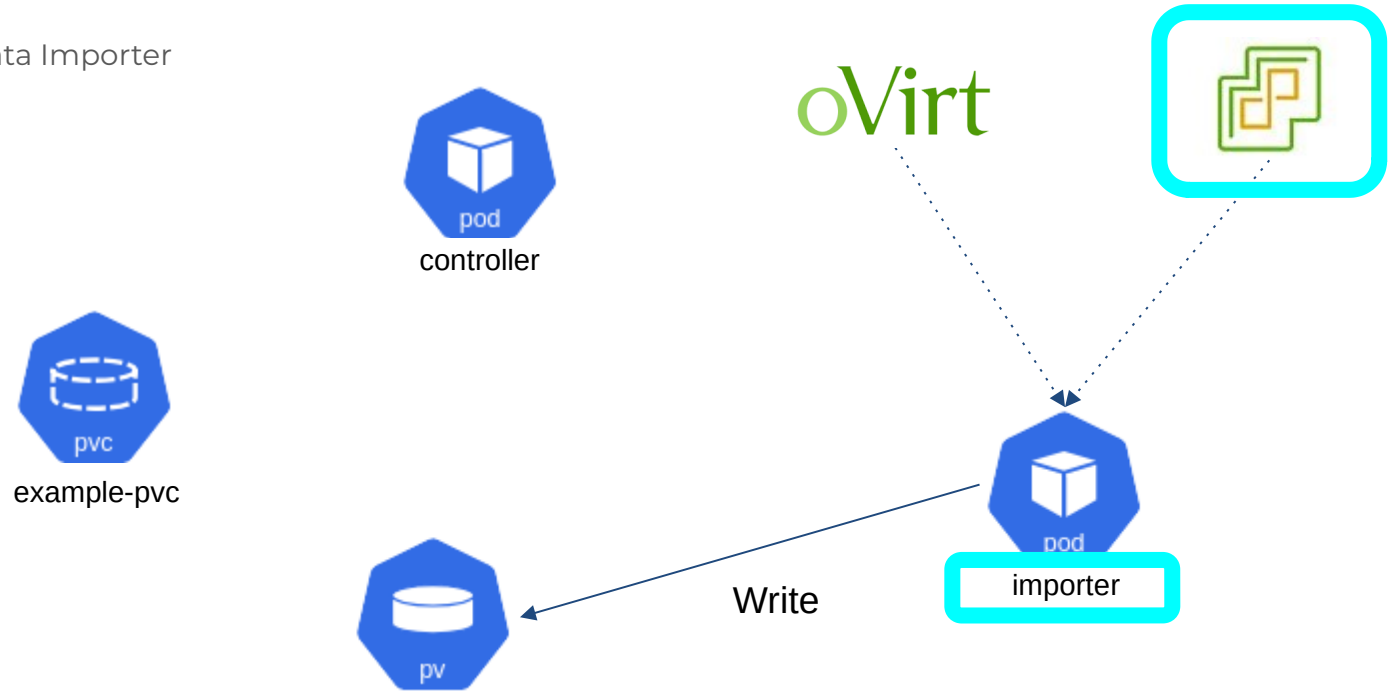
Volume populators in Forklift



Looks familiar?

Implementation with CDI

CDI == Containerized Data Importer



Containerized Data Importer (CDI)

What is it about?

- Importing data to k8s/Openshift
  - Predated volume populators
- Based on Data Volume
- Supports additional sources
- Used by Forklift
  - Partially replaced in Forklift 2.4

```yaml
apiVersion: cdi.kubevirt.io/v1beta1
kind: DataVolume
metadata:
  name: "test-dv"
spec:
  source:
      imageio:
         url: "http://<ovirt engine url>/ovirt-engine/api"
         secretRef: "endpoint-secret"
         certConfigMap: "tls-certs"
         diskId: "1"
  pvc:
    accessModes:
      - ReadWriteOnce
    resources:
      requests:
        storage: "500Mi"
```

Comparison of both solutions

CDI

Extension to Kubernetes
Importer per-disk
Supports multi-stage (warm) migration
Implementation of client code in Go
Extensible
Integrated in KubeVirt
PV allocation tailored to virtual disks

Volume Populators

Integrated in Kubernetes
Populator pod per-disk
No support for multi-stage migration
Can use “native” clients
Pluggable
Integration in KubeVirt: WIP
No VM-awareness

Why did we choose volume populators

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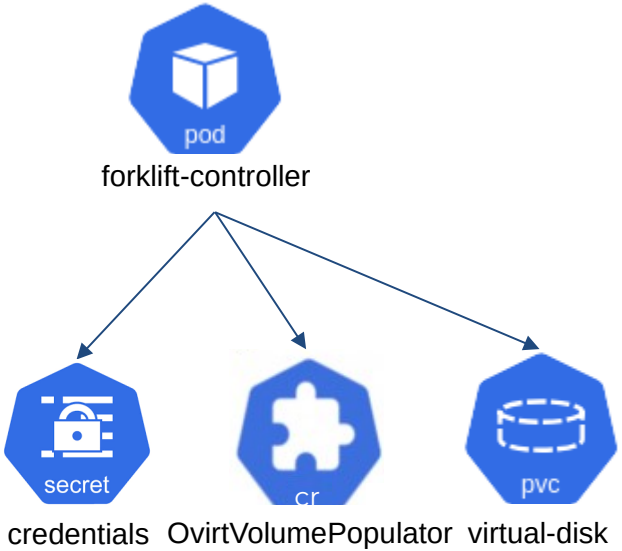
Our volume populators

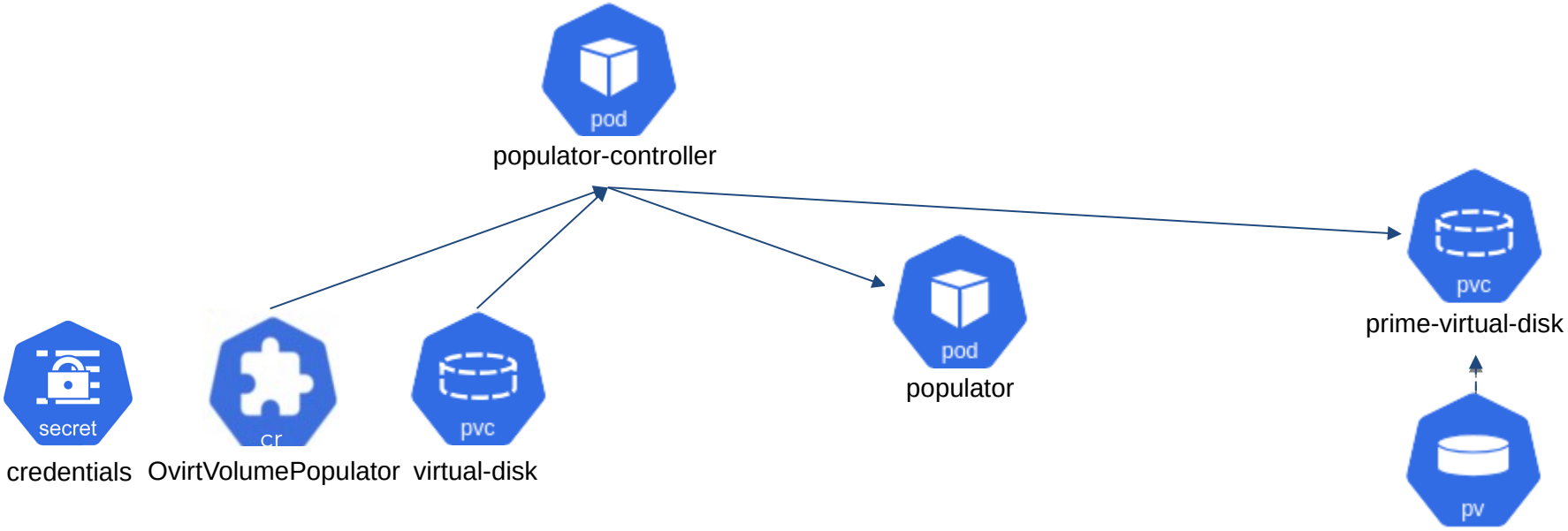
Volume populator for oVirt / RHV

The forklift-controller creates relevant resources during migration



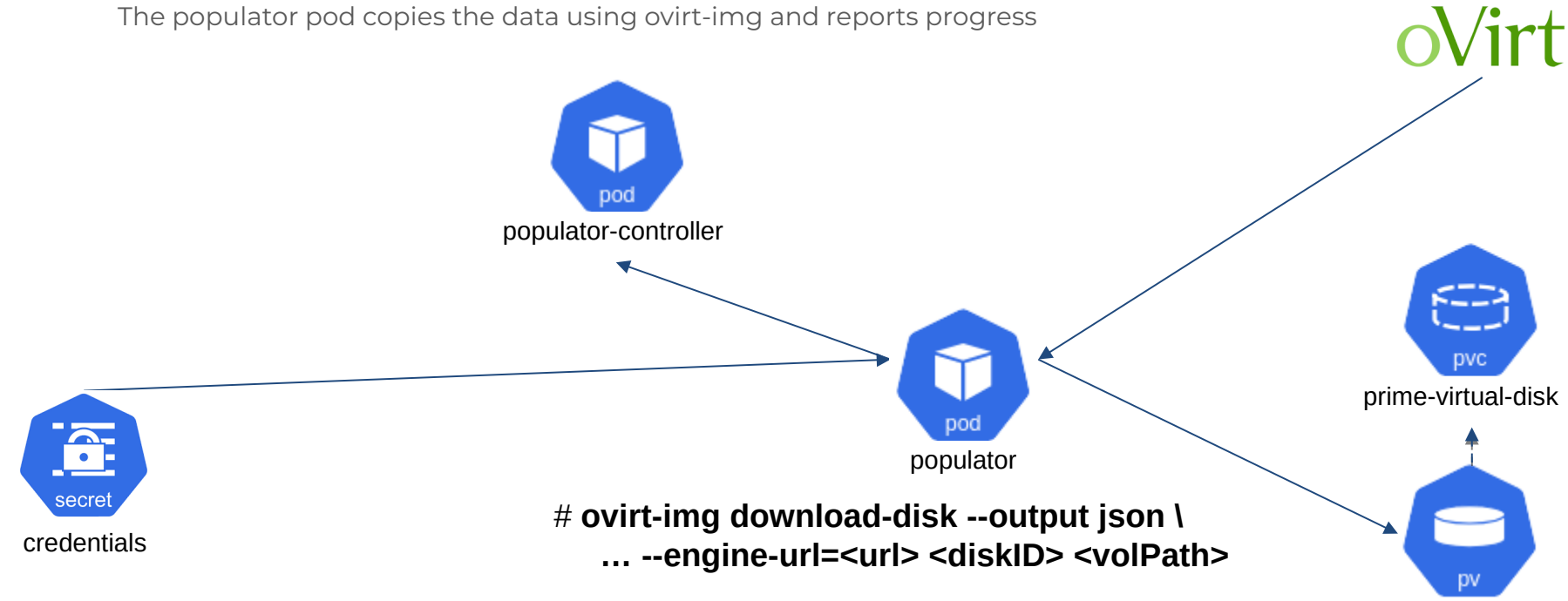
Volume populator for oVirt / RHV

The populator-controller detects PVC + ovvp and create populator pod and prime-PVC



Volume populator for oVirt / RHV

The populator pod copies the data using ovirt-img and reports progress



Volume populator for OpenStack

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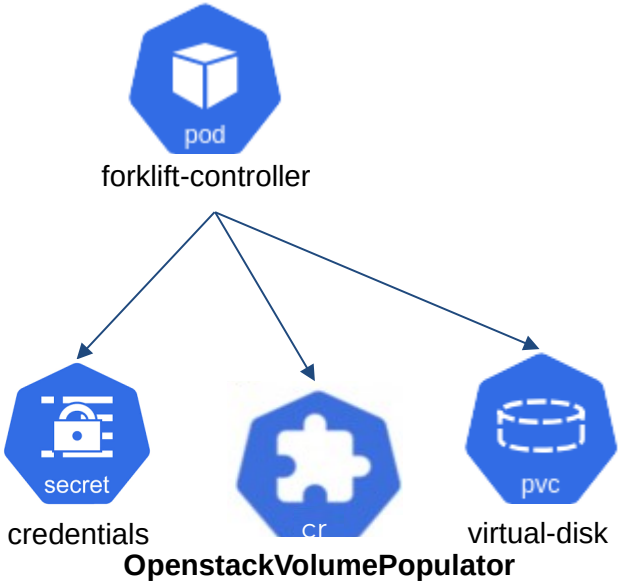
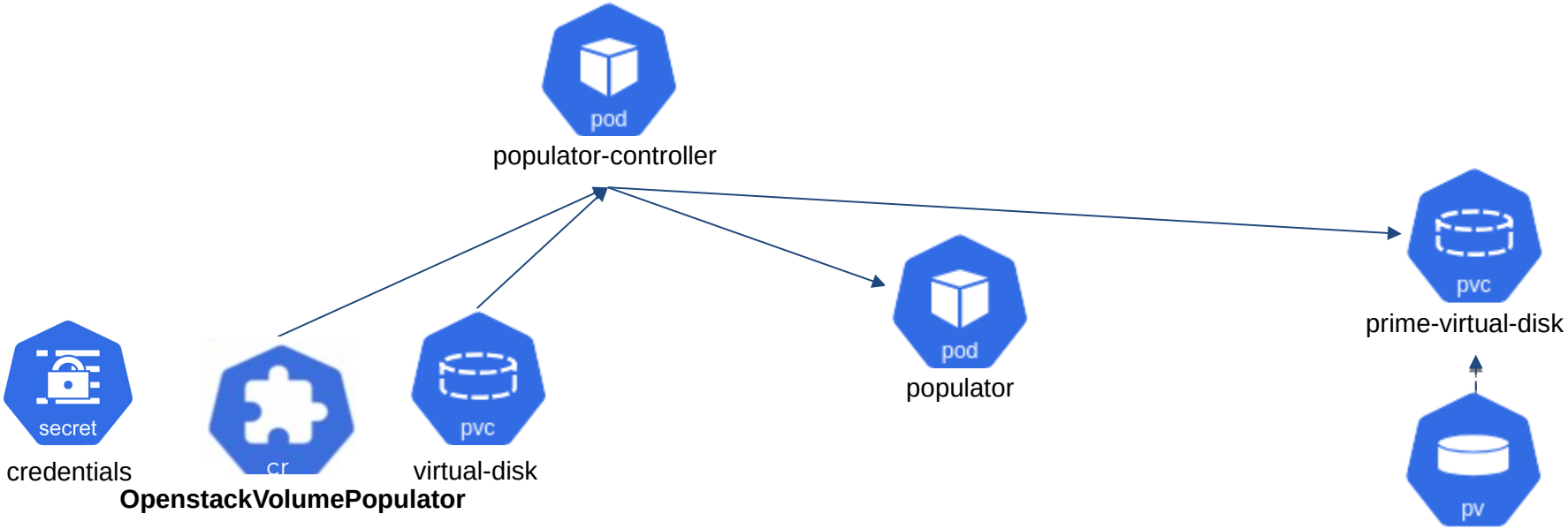


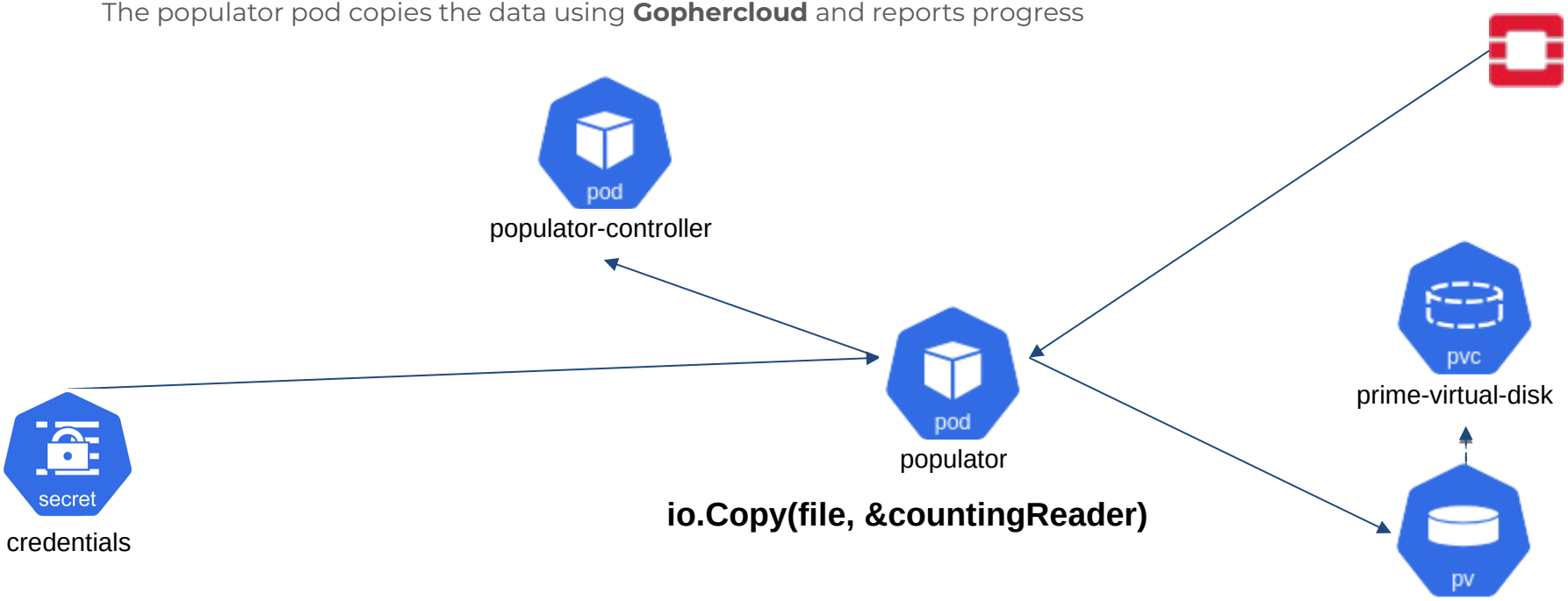
Volume populator for OpenStack

The populator-controller detects PVC + **osvp** and create populator pod and prime-PVC



Volume populator for OpenStack

The populator pod copies the data using **Gophercloud** and reports progress



Achievements

- Improved migrations from oVirt / RHV
  - Transfers were accelerated
  - Added “insecure transfers”
  - Can potentially deprecate CDI code
- Introduced migrations from OpenStack
  - Similar transfer mechanism to that of oVirt / RHV
  - Without adding code to CDI

Challenges and Insights

Delegate volume allocation to CDI

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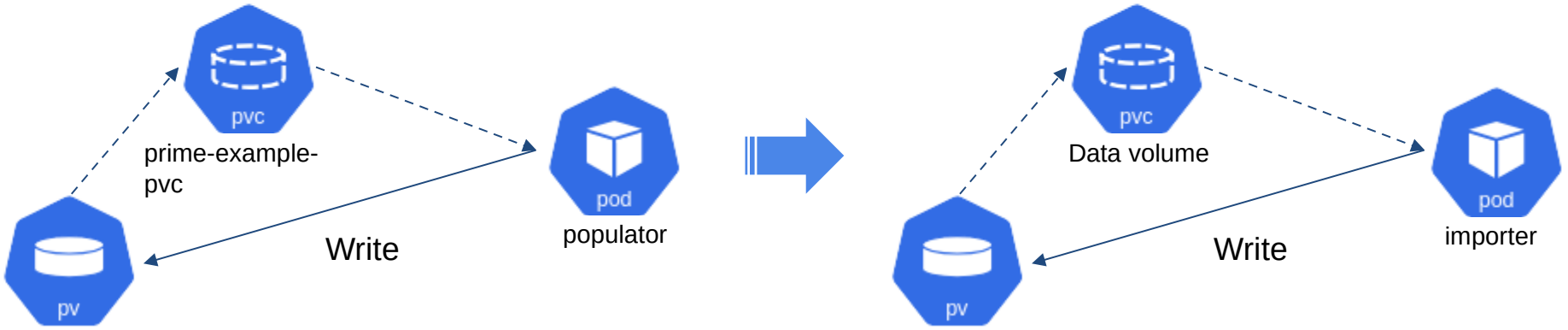

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As a result, we create PVCs instead

... and had to implement similar logic for:

- Access modes
- Disk overhead

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Copying data from remote environments can take significant time (few hours)

Thus we report the progress of the data transfer during the migration

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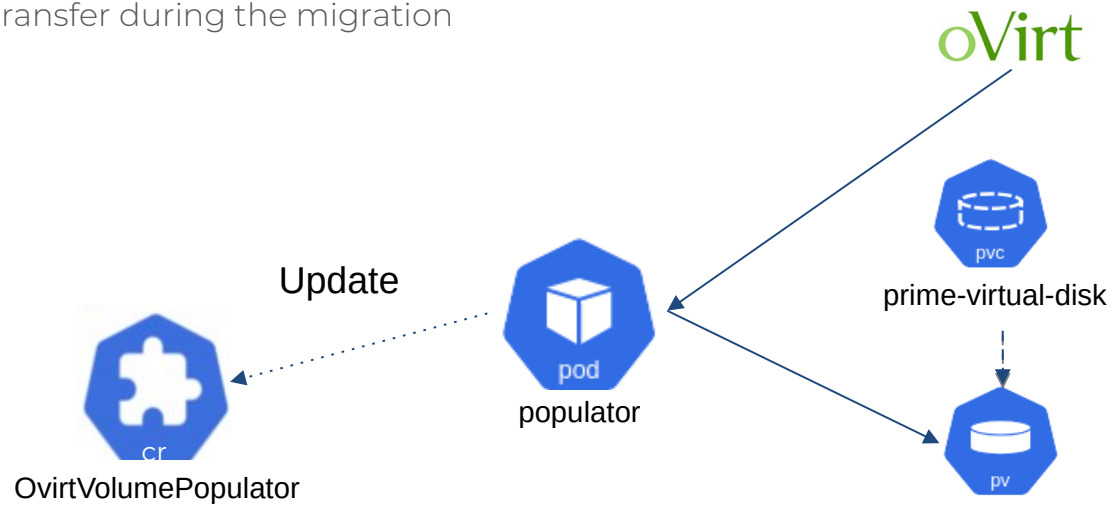

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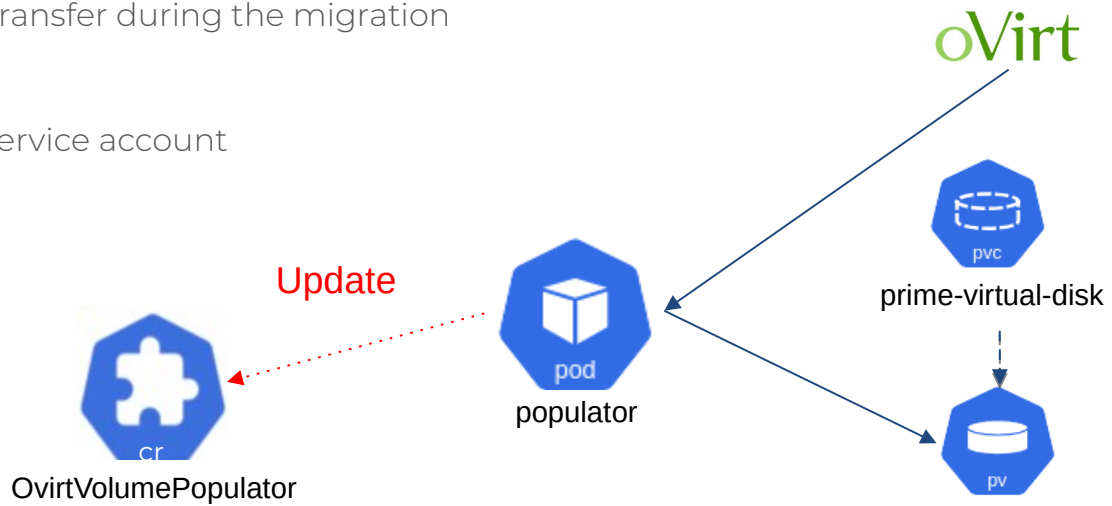

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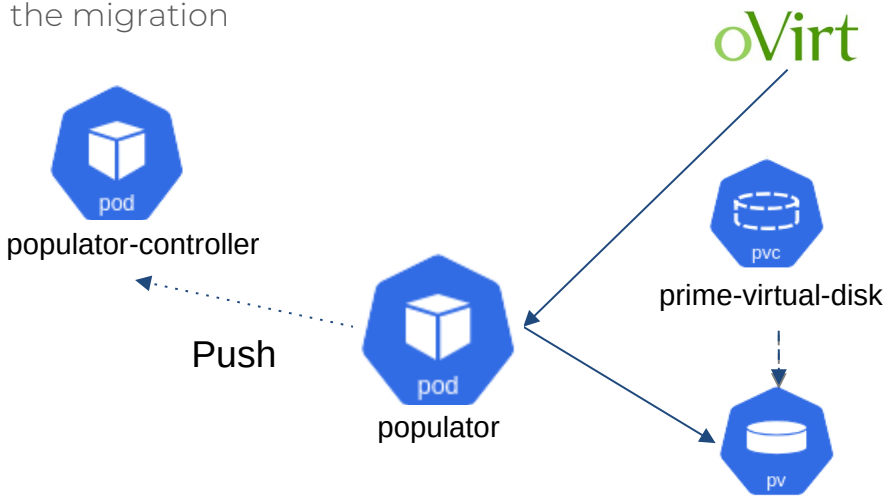

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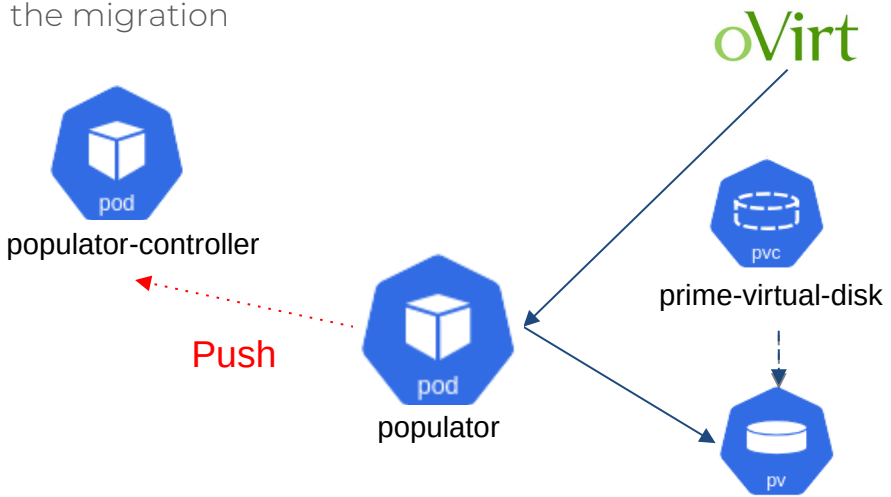
- Requires the populator pod to ‘know’ about the controller



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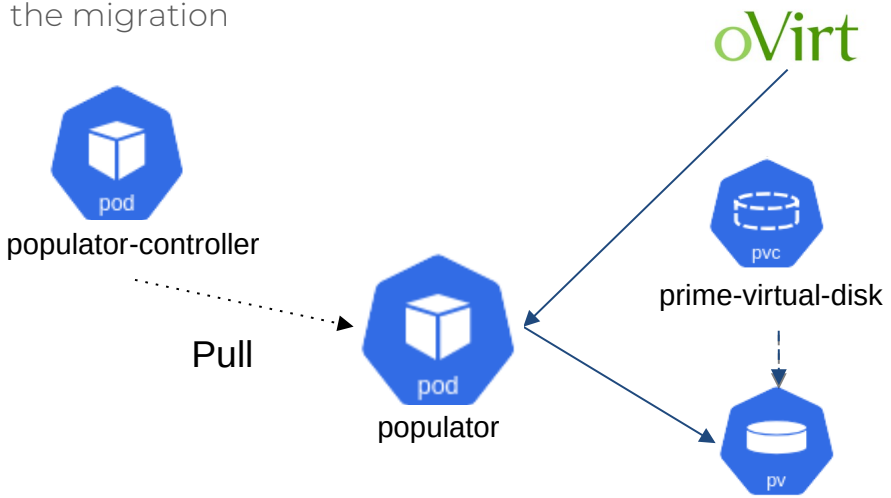

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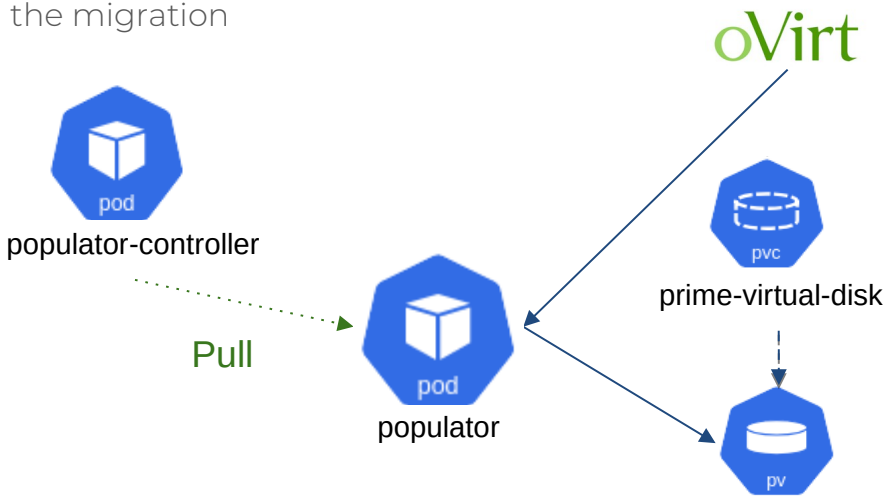

Dynamic volume provisioning

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Further analysis revealed it failed on statically provisioned storage classes

- An issue in the lib-volume-populator library

Discussed with maintainers of kubernetes-csi/lib-volume-populator

- Have not reached a consensus on a way to resolve this

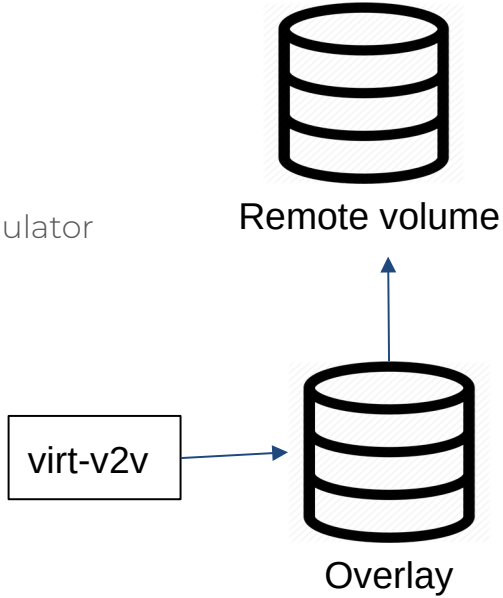
Blocked use of volume populators for statically provisioned storage classes in Forklift

Conversion of multi-volume disks

When converting a VM from vSphere, virt-v2v operates on an overlay

- To inspect the content of a disk
- To modify the content of a disk

Conversion of a single-volume disk can be implemented with a volume populator



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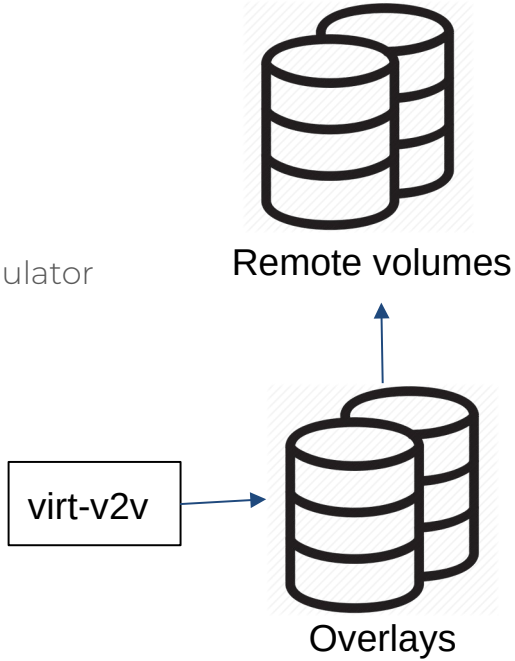

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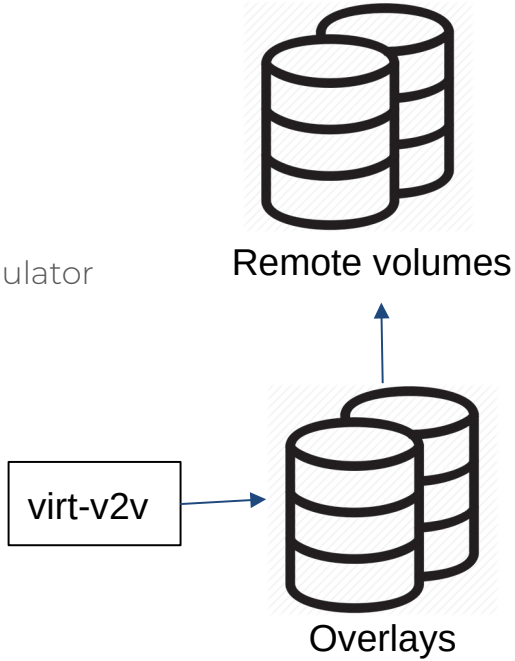
Filed [kubernetes-csi/lib-volume-populator#40]

We think about modifying the code in (our fork of) lib-volume-populator



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- Managing CRDs on a remote cluster is complex
- Reporting the progress to a remote cluster is challenging

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Approach #1: CRDs would be defined and processed by controllers on the source cluster

✓ Approach #2:: let CDI deploy CRDs and control the flow (WIP)

More adaptations to migration flow

- Create populator pods in target namespaces
  - To ease debugging and cleanup (owner-references)
  - No need to hide prime-PVCs and populator pods
- Limit restarts of populator pods to 3 (by default)
  - To conclude migration failed and gather logs
- Correlate created resources with a migration using a label
  - For cleanup of migration resources
- Respect selected transfer network

Conclusion

So, volume populators for virtual disks?

- Generally yes
  - We achieved the basic functionality for VM migration
  - Can be integrated into KubeVirt with CDI (WIP)
- But doesn't completely fit for VM migration
  - We had to introduce a variety of changes to the controller library
    - … and eventually forked it
  - Additional work is required for advanced functionality
    - Remote migrations, warm migrations, conversion of multi-volume disks

Questions?

Thank you!